SEVENTH EDITION

THE HANDBOOK of FIXED INCOME SECURITIES

EDITED BY

Frank J. Fabozzi

WITH STEVEN V. MANN

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Seventh Edition

FRANK J. FABOZZI, Ph.D., CFA, CPA
Editor

With the assistance of
STEVEN V. MANN, Ph.D.

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PREFACE

This book is designed to provide extensive coverage of the wide range of fixed income products and fixed income portfolio management strategies. Each chapter is written by an authority on the subject.

The seventh edition of the *Handbook* is divided into eight parts. Part 1 provides general information about the investment features of fixed income securities, the risks associated with investing in fixed income securities, and background information about fixed income primary and secondary markets. The basics of fixed income analytics—bond pricing, yield measures, spot rates, forward rates, total return, and price volatility measures (duration and convexity)—are described in Part 2.

Part 3 covers bonds (domestic and foreign), money market instruments, and structured products (mortgages, mortgage-backed securities, and asset-backed securities). Credit analysis of corporate bonds, municipal bonds, and structured products and credit risk modeling are covered in Part 4.

Part 5 builds on the analytical framework explained in Part 2. In this part, two methodologies for valuing fixed income securities are discussed: the lattice model and the Monte Carlo model. A by-product of these models is the option-adjusted spread. Comprehensive coverage on analyzing and fitting the yield curve and measuring interest-rate risk for the purpose of controlling risk by hedging are provided.

The more popular fixed income portfolio management strategies are covered in Part 6. In addition to active strategies and structured portfolio strategies (indexing, immunization, and dedication), coverage includes managing international fixed income portfolios, transition management, and financing positions in the bond market.

Part 7 covers interest-rate derivative instruments and their portfolio management applications. Derivative instruments include futures/forward contracts, options, interest-rate swaps, and interest-rate agreements (caps and floors). The basic feature of each instrument is described as well as how it is valued and used to control the risk of a fixed income portfolio. The basics of credit derivatives are also explained.

Part 8 has two chapters on equity-linked securities. Not only are the securities described, but state-of-the-art valuation models and portfolio strategies are explained.

The following 22 chapters are new to the seventh edition:

- The Primary and Secondary Bond Markets
- Calculating Investment Returns
- Overview of Forward Rate Analysis
- The Eurobond Market
- Emerging Markets Debt
- Stable Value Investments
- An Overview of Mortgages and the Mortgage Market
- Agency Mortgage-Backed Securities
- Collateralized Mortgage Obligations
- Residential Asset-Backed Securities
- Credit Card Asset-Backed Securities
- Cash-Collateralized Debt Obligations
- Synthetic CDOs
- Credit Risk Modeling
- Rating Agency Approach to Structured Finance
- A Framework for Analyzing Yield-Curve Trades
- The Market Yield Curve and Fitting the Term Structure of Interest Rates
- Hedging Interest-Rate Risk with Term-Structure Factor Models
- Quantitative Management of Benchmarked Portfolios
- Financing Positions in the Bond Market
- Transition Management
- Introduction to Credit Derivatives

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Editor

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The first edition of *The Handbook of Fixed Income Securities* was published two decades ago. Over the years and seven editions of the book, I have benefited from the guidance of many participants in the various sectors of the bond market. I would like to extend my deep personal appreciation to the contributing authors in all editions of the book. Steven Mann, in particular, coauthored eight of the chapters in the current edition with me.

There are two individuals whom I would like to single out who contributed to the first six editions and are now retired from the industry: Jane Tripp Howe and Richard Wilson. Jane is widely recognized as one of the top corporate credit analysts. She contributed not only to the *Handbook* but also to several other books that I edited. She was my "go to" person when I needed a chapter on any aspect of corporate credit analysis. In the seventh edition, I have revised the chapter by Jane on corporate bond credit analysis and thank her for granting me permission to use the core of her chapter that appeared in the sixth edition. Let me add a historical footnote concerning another important contribution of Jane to the profession. In the first edition of the *Handbook*, Jane contributed a chapter entitled "A Corporate Bond Index Fund" based on her research that appeared in the November 1978 *Proceedings* published by the Center for Research Securities Prices, Graduate School of Business, University of Chicago. In that chapter, Jane made the argument for investing in a corporate bond index and discussed the operational process of running a corporate bond indexed portfolio. At the time, this was a novel idea. While the notion of indexing in common stock was being debated in the 1970s, little attention was given to this form of investing in the bond market.

Richard Wilson contributed several chapters to the various editions of the *Handbook*. When I began my study of the fixed income market in the late 1970s, he served as my mentor. There were so many nuances about the institutional aspects of the market that were not in print. His historical perspective and his insights helped me form my view of the market. In addition, from his many contacts in the industry, he identified for me potential contributors to the first edition.

I also would like to acknowledge the following individuals who provided various forms of assistance in this project:

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THE HANDBOOK OF FIXED INCOME SECURITIES

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PART
ONE
BACKGROUND

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CHAPTER
ONE

OVERVIEW OF THE TYPES AND FEATURES OF FIXED INCOME SECURITIES

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This chapter will explore some of the most important features of bonds, preferred stock, and structured products and provide the reader with a taxonomy of terms and concepts that will be useful in the reading of the specialized chapters to follow.

BONDS

Type of Issuer

One important characteristic of a bond is the nature of its issuer. Although foreign governments and firms raise capital in U.S. financial markets, the three largest issuers of debt are domestic corporations, municipal governments, and the federal government and its agencies. Each class of issuer, however, features additional and significant differences.

Domestic corporations, for example, include regulated utilities as well as unregulated manufacturers. Furthermore, each firm may sell different kinds of bonds: Some debt may be publicly placed, whereas other bonds may be sold directly to one or only a few buyers (referred to as a *private placement*); some debt is collateralized by specific assets of the company, whereas other debt may be unsecured. Municipal debt is also varied: "General obligation" bonds (GOs) are backed by the full faith, credit, and taxing power of the governmental unit issuing them; "revenue bonds," on the other hand, have a safety, or creditworthiness, that depends on the vitality and success of the particular entity (such as toll roads, hospitals, or water systems) within the municipal government issuing the bond.

The U.S. Treasury has the most voracious appetite for debt, but the bond market often receives calls from its agencies. Federal government agencies include federally related institutions and government-sponsored enterprises (GSEs).

It is important for the investor to realize that, by law or practice or both, these different borrowers have developed different ways of raising debt capital over the years. As a result, the distinctions among the various types of issuers correspond closely to differences among bonds in yield, denomination, safety of principal, maturity, tax status, and such important provisions as the call privilege, put features, and sinking fund. As we discuss the key features of fixed income securities, we will point out how the characteristics of the bonds vary with the obligor or issuing authority. A more extensive discussion is provided in later chapters in this book that explain the various instruments.

Maturity

A key feature of any bond is its *term-to-maturity,* the number of years during which the borrower has promised to meet the conditions of the debt (which are contained in the bond's indenture). A bond's term-to-maturity is the date on which the debt will cease and the borrower will redeem the issue by paying the face value, or principal. One indication of the importance of the maturity is that the code word or name for every bond contains its maturity (and coupon). Thus the title of the Anheuser Busch Company bond due, or maturing, in 2016 is given as "Anheuser Busch $8^5/_8$s of 2016." In practice, the words *maturity, term,* and *term-to-maturity* are used interchangeably to refer to the number of years remaining in the life of a bond. Technically, however, *maturity* denotes the date the bond will be redeemed, and either *term* or *term-to-maturity* denotes the number of years until that date.

A bond's maturity is crucial for several reasons. First, maturity indicates the expected life of the instrument, or the number of periods during which the holder of the bond can expect to receive the coupon interest and the number of years before the principal will be paid. Second, the yield on a bond depends substantially on its maturity. More specifically, at any given point in time, the yield offered on a long-term bond may be greater than, less than, or equal to the yield offered on a short-term bond. As will be explained in Chapter 7, the effect of maturity on the yield depends on the *shape of the yield curve*. Third, the volatility of a bond's price is closely associated with maturity: Changes in the market level of rates will wrest much larger changes in price from bonds of long maturity than from otherwise similar debt of shorter life.[1] Finally, as explained in Chapter 2, there are other risks associated with the maturity of a bond.

When considering a bond's maturity, the investor should be aware of any provisions that modify, or permit the issuer to modify, the maturity of a bond. Although corporate bonds (referred to as "corporates") are typically *term bonds* (issues that have a single maturity), they often contain arrangements by which the issuing firm either can or must retire the debt early, in full or in part. Some corporates, for example, give the issuer a *call privilege,* which permits the issuing firm to redeem the bond before the scheduled maturity under certain conditions (these conditions are discussed below). Municipal bonds may have the same provision. Although the U.S. government no longer issues bonds that have a call privilege, there are a few outstanding issues with this provision. Many industrials and some utilities have *sinking-fund provisions,* which mandate that the firm retire a substantial portion of the debt, according to a prearranged schedule, during its life and before the stated maturity. Municipal bonds may be *serial bonds* or, in essence, bundles of bonds with differing maturities. (Some corporates are of this type, too.)

Usually, the maturity of a corporate bond is between 1 and 30 years. This is not to say that there are not outliers. In fact, financially sound firms have begun to issue longer-term debt in order to lock in long-term attractive financing. For example, in the late 1990s, there were approximately 90 corporate bonds issued with maturities of 100 years.

Although classifying bonds as "short term," "intermediate term," and "long term" is not universally accepted, the following classification is typically used. Bonds with a maturity of 1 to 5 years are generally considered short term; bonds with a maturity between 5 and 12 years are viewed as intermediate term (and are often called *notes*). Long-term bonds are those with a maturity greater than 12 years.

Coupon and Principal

A bond's *coupon* is the periodic interest payment made to owners during the life of the bond. The coupon is always cited, along with maturity, in any quotation of a bond's price. Thus one might hear about the "IBM 6.5 due in 2028" or the "Campell Soup 8.875 due in 2021" in discussions of current bond trading. In these examples, the coupon cited is in fact the *coupon rate,* that is, the rate of interest that, when multiplied by the *principal, par value, or face value* of the bond, provides the dollar value of the coupon payment. Typically, but not universally, for bonds issued in the United States, the coupon payment is made in semiannual installments. An important exception is mortgage-backed and asset-backed securities that usually deliver monthly cash flows. In contrast, for bonds issued in some European bond markets and all bonds issued in the *Eurobond*

1. Chapter 9 discusses this point in detail.

market, the coupon payment is made annually. Bonds may be *bearer bonds* or *registered bonds.* With bearer bonds, investors clip coupons and send them to the obligor for payment. In the case of registered issues, bond owners receive the payment automatically at the appropriate time. All new bond issues must be registered.

There are a few corporate bonds (mostly railroad issues), called *income bonds,* that contain a provision permitting the firm to omit or delay the payment of interest if the firm's earnings are too low. They have been issued as part of bankruptcy reorganizations or to replace a preferred-stock offering of the issuer. A variant of this bond type, *deferrable bonds* (also called *trust preferred* and *debt/equity hybrids*), witnessed explosive growth in the 1990s. Deferrable bonds are deeply subordinated debt instruments that give the issuer the option to defer coupon payment up to five years in the event of financial distress.

Zero-coupon bonds have been issued by corporations and municipalities since the early 1980s. For example, Coca-Cola Enterprises has a zero-coupon bond outstanding due June 20, 2020 that was issued on May 9, 1995. Although the U.S. Treasury does not issue zero-coupon debt with a maturity greater than one year, such securities are created by government securities dealers. Merrill Lynch was the first to do this with its creation of Treasury Investment Growth Receipts (TIGRs) in August 1982. The most popular zero-coupon Treasury securities today are those created by government dealer firms under the Treasury's Separate Trading of Registered Interest and Principal Securities (STRIPS) Program. Just how these securities—commonly referred to as *Treasury strips*—are created will be explained in Chapter 10. The investor in a zero-coupon security typically receives interest by buying the security at a price below its principal, or maturity value, and holding it to the maturity date. The reason for the issuance of zero-coupon securities is explained in Chapter 10. However, some zeros are issued at par and accrue interest during the bond's life, with the accrued interest and principal payable at maturity.

Governments and corporations also issue *inflation-indexed bonds* whose coupon payments are tied to an inflation index. These securities are designed to protect bondholders from the erosion of purchasing power of fixed nominal coupon payments due to inflation. For example, in January 1997, the U.S. Treasury auctioned a 10-year Treasury note whose semiannual coupon interest depends on the rate of inflation as measured by the Consumer Price Index for All Urban Consumers (i.e., CPI-U). The coupon payments are adjusted annually. These issues are referred to as "Treasury Inflation-Protection Securities" (TIPS). As of this writing, the Treasury issues TIPS with 5-year, 10-year, and 20-year maturities. Some corporations followed the Treasury and issued inflation-indexed bonds of their own.[2]

2. For examples of these issues, see Andrew Rossen, Michael Schumacher, and John Cassaudoumecq, "Corporate and Agency Inflation-Linked Securities," Chapter 18 in John Brynjolfsson and Frank J. Fabozzi (eds.), *Handbook of Inflation-Indexed Bonds* (New Hope, PA: Frank J. Fabozzi Associates, 1999).

There are securities that have a coupon rate that increases over time. These securities are called *step-up notes* because the coupon rate "steps up" over time. For example, a six-year step-up note might have a coupon rate that is 5% for the first two years, 5.8% for the next two years, and 6% for the last two years. Alternatively, there are securities that have a coupon rate that can decrease over time but never increase. For example, in June 1998, the Tennessee Valley Authority issued 30-year 6.75% putable automatic rate reset securities (PARRS), also known as *ratchet bonds.* Beginning five years after issuance and annually thereafter, the bond's coupon rate is automatically reset to either the current 30-year constant maturity Treasury yield plus 94 basis points or to 6.75%, whichever is lower. The coupon rate may decline if Treasury yields decline, but it will never increase. This bond also contains a contingent put option such that if the coupon rate is lowered, the bond is putable at par. Ratchet bonds were designed as substitutes for callable bonds.

In contrast to a coupon rate that is fixed for the bond's entire life, the term *floating-rate security* or *floater* encompasses several different types of securities with one common feature: The coupon rate will vary over the instrument's life. The coupon rate is reset at designated dates based on the value of some reference rate adjusted for a spread. For example, consider a floating-rate note issued in September 2003 by Columbus Bank & Trust that matured on March 15, 2005. The floater delivers cash flows quarterly and has a coupon formula equal to the three-month LIBOR plus 12 points.

Typically, floaters have coupon rates that reset more than once a year (e.g., semiannually, quarterly, or monthly). Conversely, the term *adjustable-rate* or *variable-rate security* refers to those issues whose coupon rates reset not more frequently than annually.

There are several features about floaters that deserve mention. First, a floater may have a restriction on the maximum (minimum) coupon rate that will be paid at any reset date called a *cap* (*floor*). Second, while the reference rate for most floaters is a benchmark interest rate or an interest rate index, a wide variety of reference rates appear in the coupon formulas. A floater's coupon could be indexed to movements in foreign exchange rates, the price of a commodity (e.g., crude oil), movements in an equity index (e.g., the S&P 500), or movements in a bond index (e.g., the Merrill Lynch Corporate Bond Index). Third, while a floater's coupon rate normally moves in the same direction as the reference rate moves, there are floaters whose coupon rate moves in the opposite direction from the reference rate. These securities are called *inverse floaters* or *reverse floaters.* As an example, consider an inverse floater issued by the Federal Home Loan Bank in April 1999. This issue matured in April 2002 and delivered quarterly coupon payments according to the following formula:

$$18\% - 2.5 \times (\text{three-month LIBOR})$$

This inverse floater had a floor of 3% and a cap of 15.5%. Finally, *range notes* are floaters whose coupon rate is equal to the reference rate (adjusted for a spread) as long as the reference rate is within a certain range on the reset date. If the reference rate is outside the range, the coupon rate is zero for that period. Consider a range note issued by Sallie Mae in August 1996 that matured in August 2003. This issue made coupon payments quarterly. The investor earned three-month LIBOR + 155 basis points for every day during this quarter that the three-month LIBOR was between 3% and 9%. Interest accrued at 0% for each day that the three-month LIBOR was outside this range. As a result, this range note had a floor of 0%.

Structures in the *high-yield (junk bond) sector* of the corporate bond market have introduced variations in the way coupon payments are made. For example, in a leveraged buyout or recapitalization financed with high-yield bonds, the heavy interest payment burden the corporation must bear places severe cash-flow constraints on the firm. To reduce this burden, firms involved in leveraged buyouts (LBOs) and recapitalizations have issued deferred-coupon structures that permit the issuer to defer making cash interest payments for a period of three to seven years. There are three types of deferred-coupon structures: (1) deferred-interest bonds, (2) step-up bonds, and (3) payment-in-kind bonds. These structures are described in Chapter 13.

Another high-yield bond structure allows the issuer to reset the coupon rate so that the bond will trade at a predetermined price. The coupon rate may reset annually or reset only once over the life of the bond. Generally, the coupon rate will be the average of rates suggested by two investment banking firms. The new rate will then reflect the level of interest rates at the reset date and the credit spread the market wants on the issue at the reset date. This structure is called an *extendible reset bond.* Notice the difference between this bond structure and the floating-rate issue described earlier. With a floating-rate issue, the coupon rate resets based on a fixed spread to some benchmark, where the spread is specified in the indenture and the amount of the spread reflects market conditions at the time the issue is first offered. In contrast, the coupon rate on an extendible reset bond is reset based on market conditions suggested by several investment banking firms at the time of the reset date. Moreover, the new coupon rate reflects the new level of interest rates and the new spread that investors seek.

One reason that debt financing is popular with corporations is that the interest payments are tax-deductible expenses. As a result, the true after-tax cost of debt to a profitable firm is usually much less than the stated coupon interest rate. The level of the coupon on any bond is typically close to the level of yields for issues of its class at the time the bond is first sold to the public. Some bonds are issued initially at a price substantially below par value (called *original-issue discount bonds,* or *OIDs*), and their coupon rate is deliberately set below the current market rate. However, firms usually try to set the coupon at a level that will make the market price close to par value. This goal can be accomplished by placing the coupon rate near the prevailing market rate.

To many investors, the coupon is simply the amount of interest they will receive each year. However, the coupon has another major impact on an investor's experience with a bond. The coupon's size influences the volatility of the bond's price: The larger the coupon, the less the price will change in response to a change in market interest rates. Thus the coupon and the maturity have opposite effects on the price volatility of a bond. This will be illustrated in Chapter 9.

The principal, par value, or face value of a bond is the amount to be repaid to the investor either at maturity or at those times when the bond is called or retired according to a repayment schedule or sinking-fund provisions. But the principal plays another role, too: It is the basis on which the coupon or periodic interest rests. The coupon is the product of the principal and the coupon rate. For most corporate issues, the face value is $1,000; many government bonds have larger principals starting with $10,000; and most municipal bonds come in denominations of $5,000.

Participants in the bond market use several measures to describe the potential return from investing in a bond: current yield, yield-to-maturity, yield-to-call for a callable bond, and yield-to-put for a putable bond. A *yield-to-worst* is often quoted for bonds. This is the lowest yield of the following: yield-to-maturity, yields to all possible call dates, and yields to all put dates. The calculation and limitations of these yield measures are explained and illustrated in Chapter 5.

The prices of most bonds are quoted as percentages of par or face value. To convert the price quote into a dollar figure, one simply divides the price by 100 (converting it to decimal) and then multiplies by the par value. The following table illustrates this.

Par Value	Price Quote	Price as a Percentage of Par	Price in Dollars
$ 1,000	$91\frac{3}{4}$	91.75	$ 917.50
5,000	$102\frac{1}{2}$	102.5	5,125.00
10,000	$87\frac{1}{4}$	87.25	8,725.00
25,000	$100\frac{3}{4}$	100.875	25,218.75
100,000	$71\frac{9}{32}$	71.28125	71,281.25
500,000	$97\frac{5}{32}$	97.078125	485,390.63
1,000,000	$88\frac{111}{256}$	88.43359375	884,335.94

There is a unique way of quoting pricing in the secondary market for Treasury bonds and notes. This convention is explained in Chapter 10.

Call and Refunding Provisions

If a bond's indenture contains a *call feature* or *call provision,* the issuer retains the right to retire the debt, fully or partially, before the scheduled maturity date. The chief benefit of such a feature is that it permits the borrower, should market rates fall, to replace the bond issue with a lower-interest-cost issue. The call feature has added value for corporations and municipalities. It may in the future help them to escape the restrictions that frequently characterize their bonds (about the disposition of assets or collateral). The call feature provides an additional benefit to corporations, which might want to use unexpectedly high levels of cash to retire outstanding bonds or might wish to restructure their balance sheets.

The call provision is detrimental to investors, who run the risk of losing a high-coupon bond when rates begin to decline. When the borrower calls the issue, the investor must find other outlets, which presumably would have lower yields than the bond just withdrawn through the call privilege. Another problem for the investor is that the prospect of a call limits the appreciation in a bond's price that could be expected when interest rates decline.

Because the call feature benefits the issuer and places the investor at a disadvantage, callable bonds carry higher yields than bonds that cannot be retired before maturity. This difference in yields is likely to grow when investors believe that market rates are about to fall and that the borrower may be tempted to replace a high-coupon debt with a new low-coupon bond. (Such a transaction is called *refunding.*) However, the higher yield alone is often not sufficient compensation to the investor for granting the call privilege to the issuer. Thus the price at which the bond may be called, termed the *call price,* is normally higher than the principal or face value of the issue. The difference between call price and principal is the *call premium,* whose value may be as much as one year's interest in the first few years of a bond's life and may decline systematically thereafter.

An important limitation on the borrower's right to call is the *period of call protection,* or *deferment period,* which is a specified number of years in the early life of the bond during which the issuer may not call the debt. Such protection is another concession to the investor, and it comes in two forms. Some bonds are *noncallable* (often abbreviated NC) for any reason during the deferment period; other bonds are *nonrefundable* (NF) for that time. The distinction lies in the fact that nonrefundable debt may be called if the funds used to retire the bond issue are obtained from internally generated funds, such as the cash flow from operations or the sale of property or equipment, or from nondebt funding such as the sale of common stock. Thus, although the terminology is unfortunately confusing, a nonrefundable issue may be refunded under the circumstances just described and, as a result, offers less call protection than a noncallable bond, which cannot be called for any reason except to satisfy sinking-fund requirements, explained later. Beginning in early 1986, a number of corporations issued long-term debt with extended call protection, not refunding protection. A number are noncallable for the issue's life, such as Dow Chemical Company's $8^5/_8$s due in 2006. The issuer is expressly prohibited from redeeming the issue prior to maturity. These *noncallable-for-life issues* are referred to as *bullet bonds*. If a bond does not have any protection against an early call, then it is said to be *currently callable.*

Since the mid-1990s, an increasing number of public debt issues include a so-called *make-whole call provision*. Make-whole call provisions have appeared routinely in privately placed issues since the late 1980s. In contrast to the standard call feature that contains a call price fixed by a schedule, a make-whole call price varies inversely with the level of interest rates. A make-whole call price (i.e., redemption amount) is typically the sum of the present values of the remaining coupon payments and principal discounted at a yield on a Treasury security that matches the bond's remaining maturity plus a spread. For example, on January 22, 1998, Aluminum Company of America (Alcoa) issued $300 million in bonds with a make-whole call provision that mature on January 15, 2028. These bonds are redeemable at any time in whole or in part at the issuer's option. The redemption price is the greater of (1) 100% of the principal amount plus accrued interest or (2) the make-whole redemption amount plus accrued interest. In this case, the make-whole redemption amount is equal to the sum of the present values of the remaining coupon and principal payments discounted at the Adjusted Treasury Rate plus 15 basis points.[3] The Adjusted Treasury Rate is the bond-equivalent yield on a U.S. Treasury security having a maturity comparable to the remaining maturity of the bonds to be redeemed. Each holder of the bonds will be notified at least 30 days but not more than 60 days prior to the redemption date. This issue is callable at any time, as are most issues with make-whole call provisions. Note that the make-whole call price increases as interest rates decrease, so if the issuer exercises the make-whole call provision when interest rates have decreased, the bondholder receives a higher call price. Make-whole call provisions thus provide investors with some protection against reinvestment rate risk.

A key question is, When will the firm find it profitable to refund an issue? It is important for investors to understand the process by which a firm decides whether to retire an old bond and issue a new one. A simple and brief example will illustrate that process and introduce the reader to the kinds of calculations a bondholder will make when trying to predict whether a bond will be refunded.

Suppose that a firm's outstanding debt consists of $300 million par value of a bond with a coupon of 10%, a maturity of 15 years, and a lapsed deferment period. The firm can now issue a bond with a similar maturity for an interest rate of 7.8%. Assume that the issuing expenses and legal fees amount to $2 million. The call price on the existing bond issue is $105 per $100 par value. The firm must pay, adjusted for taxes, the sum of call premium and expenses. To simplify the calculations, assume a 30% tax rate. This sum is then $11,190,000.[4] Such a transaction would save the firm a yearly sum of $4,620,000 in interest (which equals the interest of $30 million on the existing bond less the $23.4 million on the new, adjusted for taxes) for the next 15 years.[5] The rate of return on a payment of $11,900,000 now in exchange for a savings of $4,620,000 per year for 15 years is about 38%.

3. A 30/360 day-count convention is employed in this present-value calculation.

4. Both expenses are tax deductible for the firm. The total expense is the call premium of $15 million plus the issuing expenses and legal fees of $2 million. The after-tax cost is equal to the before-tax cost times (1 − tax rate). Hence the after-tax cost is $17 million times (1 − 0.3), or $11,900,000.

5. The new interest expense would be $300 million times 0.078. The after-tax cost of the interest saving is $6.6 million times (1 − 0.3).

This rate far exceeds the firm's after-tax cost of debt (now at 7.8% times 0.7, or 5.46%) and makes the refunding a profitable economic transaction.

In municipal securities, refunding often refers to something different, although the concept is the same. Municipal bonds can be *prerefunded* prior to maturity (usually on a call date). Here, instead of issuing new bonds to retire the debt, the municipality will issue bonds and use the proceeds to purchase enough risk-free securities to fund all the cash flows on the existing bond issue. It places these in an irrevocable trust. Thus the municipality still has two issues outstanding, but the old bonds receive a new label—they are "prerefunded." If Treasury securities are used to prerefund the debt, the cash flows on the bond are guaranteed by Treasury obligations in the trust. Thus they become AAA rated and trade at higher prices than previously. Municipalities often find this an effective means of lowering their cost of debt.

Sinking-Fund Provision

The *sinking-fund provision,* which is typical for publicly and privately issued industrial bonds and not uncommon among certain classes of utility debt, requires the obligor to retire a certain amount of the outstanding debt each year. Generally, the retirement occurs in one of two ways. The firm may purchase the amount of bonds to be retired in the open market if their price is below par, or the company may make payments to the trustee who is empowered to monitor the indenture and who will call a certain number of bonds chosen by lottery. In the latter case, the investor would receive the prearranged call price, which is usually par value. The schedule of retirements varies considerably from issue to issue. Some issuers, particularly in the private-placement market, retire most, if not all, of their debt before maturity. In the public market, some companies may retire as little as 20 to 30% of the outstanding par value before maturity. Further, the indenture of many issues includes a deferment period that permits the issuer to wait five years or more before beginning the process of sinking-fund retirements.

There are three advantages of a sinking-fund provision from the investor's perspective. The sinking-fund requirement ensures an orderly retirement of the debt so that the final payment, at maturity, will not be too large. Second, the provision enhances the liquidity of some debt, especially for smaller issues with thin secondary markets. Third, the prices of bonds with this requirement are presumably more stable because the issuer may become an active participant on the buy side when prices fall. For these reasons, the yields on bonds with sinking-fund provisions tend to be less than those on bonds without them.

The sinking fund, however, can work to the disadvantage of an investor. Suppose that an investor is holding one of the early bonds to be called for a sinking fund. All the time and effort put into analyzing the bond has now been wasted, and the investor will have to choose new instruments for purchase. Also, an investor holding a bond with a high coupon at the time rates begin to fall is still forced to relinquish the issue. For this reason, in times of high interest rates, one might find investors demanding higher yields from bonds with sinking funds than from other debt.

The sinking-fund provision also may harm the investor's position through the *optional acceleration feature,* a part of many corporate bond indentures. With this option, the corporation is free to retire more than the amount of debt the sinking fund requires (and often a multiple thereof) and to do it at the call price set for sinking-fund payments. Of course, the firm will exercise this option only if the price of the bond exceeds the sinking-fund price (usually near par), and this happens when rates are relatively low. If, as is typically the case, the sinking-fund provision becomes operative before the lapse of the call-deferment period, the firm can retire much of its debt with the optional acceleration feature and can do so at a price far below that of the call price it would have to pay in the event of refunding. The impact of such activity on the investor's position is obvious: The firm can redeem at or near par many of the bonds that appear to be protected from call and that have a market value above the face value of the debt.

Put Provisions

A *putable bond* grants the investor the right to sell the issue back to the issuer at par value on designated dates. The advantage to the investor is that if interest rates rise after the issue date, thereby reducing the value of the bond, the investor can force the issuer to redeem the bond at par. Some issues with put provisions may restrict the amount that the bondholder may put back to the issuer on any one put date. Put options have been included in corporate bonds to deter unfriendly takeovers. Such put provisions are referred to as "poison puts."

Put options can be classified as *hard puts* and *soft puts.* A hard put is one in which the security must be redeemed by the issuer only for cash. In the case of a soft put, the issuer has the option to redeem the security for cash, common stock, another debt instrument, or a combination of the three. Soft puts are found in convertible debt, which we describe next.

Convertible or Exchangeable Debt

A *convertible bond* is one that can be exchanged for specified amounts of common stock in the issuing firm: The conversion cannot be reversed, and the terms of the conversion are set by the company in the bond's indenture. The most important terms are *conversion ratio* and *conversion price.* The conversion ratio indicates the number of shares of common stock to which the holder of the convertible has a claim. For example, Amazon.com issued $1.25 billion in convertibles in January 1999 that mature in 2009. These convertibles carry a 4.75% coupon with a conversion ratio of 6.408 shares for each bond. This translates to a conversion price of $156.055 per share ($1,000 par value divided by the conversion ratio 6.408) at the time of issuance. The conversion price at issuance is also referred to as the *stated conversion price.*

The conversion privilege may be permitted for all or only some portion of the bond's life. The conversion ratio may decline over time. It is always adjusted proportionately for stock splits and stock dividends. Convertible bonds are typically callable by the issuer. This permits the issuer to force conversion of the issue. (Effectively, the issuer calls the bond, and the investor is forced to convert the bond or allow it to be called.) There are some convertible issues that have call protection. This protection can be in one of two forms: Either the issuer is not allowed to redeem the issue before a specified date, or the issuer is not permitted to call the issue until the stock price has increased by a predetermined percentage price above the conversion price at issuance.

An *exchangeable bond* is an issue that can be exchanged for the common stock of a corporation other than the issuer of the bond. For example, Bell Atlantic Corp. issued 5.75% coupon exchangeable bonds in February 1998 that can be exchanged for shares in Telecom Corp. of New Zealand. There are a handful of issues that are exchangeable into more than one security.

One significant innovation in the convertible bond market was the "Liquid Yield Option Note" (LYON) developed by Merrill Lynch Capital Markets in 1985. A LYON is a zero-coupon, convertible, callable, and putable bond.

Techniques for analyzing convertible and exchangeable bonds are described in Chapters 59 and 60.

Medium-Term Notes

Medium-term notes are highly flexible debt instruments that can be easily structured in response to changing market conditions and investor tastes. "Medium term" is a misnomer because these securities have ranged in maturity from nine months to 30 years and longer. Since the latter part of the 1980s, medium-term notes have become an increasingly important financing vehicle for corporations and federal agencies. Typically, medium-term notes are noncallable, unsecured, senior debt securities with fixed-coupon rates that carry an investment-grade credit rating. They generally differ from other bond offerings in their primary distribution process, as will be discussed in Chapter 14. *Structured medium-term notes,* or simply *structured notes,* are debt instruments linked to a derivative position. For example, structured notes are usually created with an underlying swap transaction. This "hedging swap" allows the issuer to create securities with interesting risk/return features demanded by bond investors.

Warrants

A *warrant* is an option a firm issues that permits the owner to buy from the firm a certain number of shares of common stock at a specified price. It is not uncommon for publicly held corporations to issue warrants with new bonds.

A valuable aspect of a warrant is its rather long life: Most warrants are in effect for at least two years from issuance, and some are perpetual.[6] Another key

6. This long life contrasts sharply with the short life during which many exchange-traded call options on common stock, similar to warrants, are exercisable.

feature of the warrant is the *exercise price,* the price at which the warrant holder can buy stock from the corporation. This price is normally set at about 15% above the market price of common stock at the time the bond, and thus the warrant, is issued. Frequently, the exercise price will rise through time, according to the schedule in the bond's indenture. Another important characteristic of the warrant is its detachability. *Detachable warrants* are often actively traded on the American Stock Exchange. Other warrants can be exercised only by the bondholder, and these are called *nondetachable warrants.* The chief benefit to the investor is the financial leverage the warrant provides.

PREFERRED STOCK

Preferred stock is a class of stock, not a debt instrument, but it shares characteristics of both common stock and debt. Like the holder of common stock, the preferred stockholder is entitled to dividends. Unlike those on common stock, however, preferred stock dividends are a specified percentage of par or face value.[7] The percentage is called the *dividend rate;* it need not be fixed but may float over the life of the issue.

Failure to make preferred stock dividend payments cannot force the issuer into bankruptcy. Should the issuer not make the preferred stock dividend payment, usually paid quarterly, one of two things can happen, depending on the terms of the issue. First, the dividend payment can accrue until it is fully paid. Preferred stock with this feature is called *cumulative preferred stock.* Second, if a dividend payment is missed and the security holder must forgo the payment, the preferred stock is said to be *noncumulative preferred stock.* Failure to make dividend payments may result in imposition of certain restrictions on management. For example, if dividend payments are in arrears, preferred stockholders might be granted voting rights.

Unlike debt, payments made to preferred stockholders are treated as a distribution of earnings. This means that they are not tax deductible to the corporation under the current tax code. (Interest payments, on the other hand, are tax deductible.) Although the after-tax cost of funds is higher if a corporation issues preferred stock rather than borrowing, there is a factor that reduces the cost differential: A provision in the tax code exempts 70% of qualified dividends from federal income taxation if the recipient is a qualified corporation. For example, if Corporation A owns the preferred stock of Corporation B, for each $100 of dividends received by A, only $30 will be taxed at A's marginal tax rate. The purpose of this provision is to mitigate the effect of double taxation of corporate earnings. There are two implications of

7. Almost all preferred stock limits the security holder to the specified amount. Historically, there have been issues entitling the preferred stockholder to participate in earnings distribution beyond the specified amount (based on some formula). Preferred stock with this feature is referred to as *participating preferred stock.*

this tax treatment of preferred stock dividends. First, the major buyers of preferred stock are corporations seeking tax-advantaged investments. Second, the cost of preferred stock issuance is lower than it would be in the absence of the tax provision because the tax benefits are passed through to the issuer by the willingness of buyers to accept a lower dividend rate.

Preferred stock has some important similarities with debt, particularly in the case of cumulative preferred stock: (1) The payments to preferred stockholders promised by the issuer are fixed, and (2) preferred stockholders have priority over common stockholders with respect to dividend payments and distribution of assets in the case of bankruptcy. (The position of noncumulative preferred stock is considerably weaker than cumulative preferred stock.) It is because of this second feature that preferred stock is called a *senior security.* It is senior to common stock. On a balance sheet, preferred stock is classified as equity.

Preferred stock may be issued without a maturity date. This is called *perpetual preferred stock.* Almost all preferred stock has a sinking-fund provision, and some preferred stock is convertible into common stock. A trademark product of Morgan Stanley is the Preferred Equity Redemption Cumulative Stock (PERCS). This is a preferred stock with a mandatory conversion at maturity.

Historically, utilities have been the major issuers of preferred stock, making up more than half of each year's issuance. Since 1985, major issuers have been in the financial industry—finance companies, banks, thrifts, and insurance companies.

There are three types of preferred stock: (1) fixed-rate preferred stock, (2) adjustable-rate preferred stock, and (3) auction and remarketed preferred stock. The dividend rate on an adjustable-rate preferred stock (ARPS) is reset quarterly and based on a predetermined spread from the highest of three points on the Treasury yield curve. Most ARPS are perpetual, with a floor and ceiling imposed on the dividend rate of most issues. For auction preferred stock (APS), the dividend rate is reset periodically, as with ARPS, but the dividend rate is established through an auction process. In the case of remarketed preferred stock (RP), the dividend rate is determined periodically by a remarketing agent who resets the dividend rate so that any preferred stock can be tendered at par and be resold (remarketed) at the original offering price. An investor has the choice of dividend resets every 7 days or every 49 days.

RESIDENTIAL MORTGAGE-BACKED SECURITIES

A residential *mortgage-backed security* (MBS) is an instrument whose cash flow depends on the cash flows of an underlying pool of mortgages. There are three types of mortgage-backed securities: (1) mortgage pass-through securities, (2) collateralized mortgage obligations, and (3) stripped mortgage-backed securities. This chapter provides an overview of these securities. A detailed discussion of the structure and analysis of these securities is presented in Chapters 22–25 of this book.

Mortgage Cash Flows

Because the cash flow for these securities depends on the cash flow from the underlying pool of mortgages, the first thing to define is a *mortgage.* A mortgage is a pledge of real estate to secure the loan originated for the purchase of that real estate. The mortgage gives the lender (*mortgagee*) the right to foreclose on the loan and seize the property in order to ensure that the loan is paid off if the borrower (*mortgagor*) fails to make the contracted payments. The types of real estate properties that can be mortgaged are divided into two broad categories: residential and nonresidential (i.e., commercial and farm properties). The mortgage loan specifies the interest rate of the loan, the frequency of payment, and the number of years to maturity. Each monthly mortgage payment consists of the monthly interest, a scheduled amount in excess of the monthly interest that is applied to reduce the outstanding loan balance (this is called the *scheduled repayment of principal*), and any payments in excess of the mortgage payment. The latter payments are called *prepayments.*

In effect, the lender has granted the homeowner the right to prepay (or "call") all or part of the mortgage balance at any time. Homeowners prepay their mortgages for one of several reasons. First, they prepay the entire mortgage when they sell their home. Homes are sold for many reasons, among them a change of employment that requires moving or the purchase of a more expensive home. Second, if mortgage rates drop substantially after the mortgage loan was obtained, it may be beneficial for the homeowner to refinance the loan (even after paying all refinancing costs) at the lower interest rate. Third, if homeowners cannot meet their mortgage obligations, their property is repossessed and sold. The proceeds from the sale are used to pay off the mortgage loan. Finally, if the property is destroyed by fire or another insured catastrophe occurs, the insurance proceeds are used to pay off the mortgage.

Mortgage Pass-Through Securities

A *mortgage pass-through security* (or simply *pass-through*) is created when one or more holders of mortgages form a collection (pool) of mortgages and sell shares or participation certificates in the pool. A pool may consist of several thousand mortgages or only a few mortgages. The cash flow of a pass-through depends on the cash flow of the underlying mortgages, which, as just explained, consists of monthly mortgage payments representing interest, the scheduled repayment of principal, and any prepayments. Payments are made to security holders each month.

There are three major types of pass-through securities, guaranteed by the following organizations: Government National Mortgage Association ("Ginnie Mae"), Federal Home Loan Mortgage Corporation ("Freddie Mac"), and Federal National Mortgage Association ("Fannie Mae"). The last two are government-sponsored entities. The Government National Mortgage Association is a federal government agency within the Department of Housing and Urban Development. The securities associated with these three entities are known as *agency pass-through securities.* There are also *nonagency pass-through securities,* issued by thrifts, commercial banks, and private conduits that are not backed by any agency.

Collateralized Mortgage Obligations

The *collateralized mortgage obligation* (*CMO*) structure was developed to broaden the appeal of mortgage-backed products to traditional fixed income investors. A CMO is a security backed by a pool of pass-throughs or a pool of mortgage loans. CMOs are structured so that there are several classes of bondholders with varying maturities. The different bond classes are called *tranches.* The rules for the distribution of the principal payments and the interest from the underlying collateral among the tranches are specified in the prospectus. By redirecting the cash flow (i.e., principal payments and interest) from the underlying collateral, issuers have created classes of bonds that have different degrees of prepayment and interest rate risk and are thereby more attractive to institutional investors to satisfy asset/liability objectives than a pass-through.

Numerous innovations in structuring CMOs have created classes of bonds with one or more of the following characteristics: (1) greater stability of cash flow over a wide range of prepayment speeds, (2) better matching of floating-rate liabilities, (3) substantial upside potential in a declining interest-rate environment but less downside risk in a rising interest-rate environment, or (4) properties that allow them to be used for hedging mortgage-related products.

The various types of bonds include sequential-pay bonds, planned amortization class (PAC) bonds, accrual (or Z) bonds, floating-rate bonds, inverse floating-rate bonds, targeted amortization class (TAC) bonds, support bonds, and very accurately determined maturity (VADM) bonds.

Stripped Mortgage-Backed Securities

A pass-through divides the cash flow from the underlying collateral on a pro rata basis to the security holders. *Stripped mortgage-backed securities,* introduced by Fannie Mae in 1986, are created by altering the distribution of principal and interest from a pro rata distribution to an *unequal* distribution.

Why are stripped mortgage-backed securities created? It is sufficient to say at this juncture that the risk/return characteristics of these instruments make them attractive for the purpose of hedging a portfolio of pass-throughs and mortgage loans.

There are two types of stripped MBSs: synthetic-coupon pass-throughs and interest-only/principal-only securities. The first generation of stripped mortgage-backed securities consisted of the synthetic-coupon pass-throughs because the unequal distribution of coupon and principal resulted in a synthetic coupon rate that was different from the underlying collateral. In early 1987, stripped MBSs began to be issued in which all the interest is allocated to one class (the interest-only, or IO, class) and all the principal to the other class (the principal-only, or PO, class). The IO class receives no principal payments, and the PO class receives no interest.

COMMERCIAL MORTGAGE-BACKED SECURITIES

Commercial mortgage-backed securities (CMBSs) are backed by a pool of commercial mortgage loans on income-producing property—multifamily properties (i.e., apartment buildings), office buildings, industrial properties (including warehouses), shopping centers, hotels, and health care facilities (i.e., senior housing care facilities). The basic building block of the CMBS transaction is a commercial loan that was originated either to finance a commercial purchase or to refinance a prior mortgage obligation. There are two major types of CMBS deal structures that have been of interest to bond investors, multiproperty single borrowers and multiproperty conduits. The fastest-growing segment of the CMBS is conduit-originated transactions. *Conduits* are commercial-lending entities that are established for the sole purpose of generating collateral to securitize.

Unlike residential mortgage loans, where the lender relies on the ability of the borrower to repay and has recourse to the borrower if the payment terms are not satisfied, commercial mortgage loans are nonrecourse loans. This means that the lender can only look to the income-producing property backing the loan for interest and principal repayment. If there is a default, the lender looks to the proceeds from the sale of the property for repayment and has no recourse to the borrower for any unpaid balance. Basically, this means that the lender must view each property as a stand-alone business and evaluate each property using measures that have been found useful in assessing credit risk.

ASSET-BACKED SECURITIES

Asset-backed securities are securities collateralized by assets that are not mortgage loans. In structuring an asset-backed security, issuers have drawn from the structures used in the mortgage-backed securities market. Asset-backed securities have been structured as pass-throughs and as structures with multiple bond classes called *pay-throughs,* which are similar to CMOs. Credit enhancement is provided by letters of credit, overcollateralization, or senior/subordination.

Three common types of asset-backed securities are those backed by credit card receivables, home equity loans, and automobile loans. Chapters 27–29 cover these securities. There are also asset-backed securities supported by a pool of manufactured homes, Small Business Administration (SBA) loans, student loans, boat loans, equipment leases, recreational vehicle loans, senior bank loans, and possibly, the future royalties of your favorite entertainer.

A *collateralized debt obligation* (CDO) is an asset-backed security backed by a diversified pool of one or more of the following types of debt obligations: U.S. domestic investment-grade and high-yield corporate bonds, emerging market bonds, residential mortgage-backed securities, commercial mortgage-backed securities, asset-backed securities, real estate investment trusts debt, U.S. domestic bank loans, special situation loans and distressed debt, foreign bank loans, or other CDOs. CDOs are classified as either cash CDOs or synthetic CDOs. A *cash* CDO is backed by a pool of cash market debt instruments and is discussed in Chapter 30, along with the motivation for their creation. A *synthetic* CDO is a CDO where the investor has economic exposure to a pool of debt instrument, but this exposure is realized via credit derivative instruments rather than the purchase of the cash market instruments. Synthetic CDOs are discussed in Chapter 31.

SUMMARY

This chapter has provided an overview of the types of fixed income securities and has explored the key features of these securities. It is our hope that this chapter will equip the reader with a general knowledge of the instruments and provide a conceptual and terminological background for the chapters that will investigate in more detail the features of these securities and the associated risks and returns.

CHAPTER

TWO

RISKS ASSOCIATED WITH INVESTING IN FIXED INCOME SECURITIES

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The return obtained from a fixed income security from the day it is purchased to the day it is sold can be divided into two parts: (1) the market value of the security when it is eventually sold and (2) the cash flows received from the security over the time period that it is held, plus any additional income from reinvestment of the cash flow. Several environmental factors affect one or both of these two parts. We can define the risk in any security as a measure of the impact of these market factors on the return characteristics of the security.

The different types of risk that an investor in fixed income securities is exposed to are as follows:

- Market, or interest-rate, risk
- Reinvestment risk
- Timing, or call, risk
- Credit risk
- Yield-curve, or maturity, risk
- Inflation, or purchasing-power, risk
- Liquidity risk
- Exchange-rate, or currency, risk
- Volatility risk
- Political or legal risk

- Event risk
- Sector risk

Each risk is described in this chapter. They will become more clear as the securities are described in other chapters of this book.

MARKET, OR INTEREST-RATE, RISK

The price of a typical fixed income security moves in the opposite direction of the change in interest rates: As interest rates rise (fall), the price of a fixed income security will fall (rise).[1] This property is illustrated in Chapter 9. For an investor who plans to hold a fixed income security to maturity, the change in its price before maturity is not of concern; however, for an investor who may have to sell the fixed income security before the maturity date, an increase in interest rates will mean the realization of a capital loss. This risk is referred to as *market risk,* or *interest-rate risk,* which is by far the biggest risk faced by an investor in the fixed income market.

It is customary to represent the market by the yield levels on Treasury securities. Most other yields are compared to the Treasury levels and are quoted as spreads off appropriate Treasury yields. To the extent that the yields of all fixed income securities are interrelated, their prices respond to changes in Treasury rates. As discussed in Chapter 9, the actual magnitude of the price response for any security depends on various characteristics of the security, such as coupon, maturity, and the options embedded in the security (e.g., call and put provisions).

To control interest-rate risk, it is necessary to quantify it. The most commonly used measure of interest-rate risk is *duration.* Duration is the approximate percentage change in the price of a bond or bond portfolio due to a 100 basis point change in yields. This measure and how it is computed is explained in Chapter 9.

REINVESTMENT RISK

As explained in Chapter 5, the cash flows received from a security are usually (or are assumed to be) reinvested. The additional income from such reinvestment, sometimes called *interest-on-interest,* depends on the prevailing interest-rate levels at the time of reinvestment, as well as on the reinvestment strategy. The variability in the returns from reinvestment from a given strategy due to changes in market rates is called *reinvestment risk.* The risk here is that the interest

1. There are certain fixed income instruments whose price changes in the same direction as interest rates. Examples are put options and interest-only mortgage-backed securities.

rate at which interim cash flows can be reinvested will fall. Reinvestment risk is greater for longer holding periods. It is also greater for securities with large, early cash flows such as high-coupon bonds. This risk is analyzed in more detail in Chapter 5.

It should be noted that interest-rate risk and reinvestment risk oppose each other. For example, interest-rate risk is the risk that interest rates will rise, thereby reducing the price of a fixed income security. In contrast, reinvestment risk is the risk that interest rates will fall. A strategy based on these two offsetting risks is called "immunization" and is the topic of Chapter 47.

TIMING, OR CALL, RISK

As explained in Chapter 1, bonds may contain a provision that allows the issuer to retire, or "call," all or part of the issue before the maturity date. The issuer usually retains this right to refinance the bond in the future if market interest rates decline below the coupon rate.

From the investor's perspective, there are three disadvantages of the call provision. First, the cash-flow pattern of a callable bond is not known with certainty. Second, because the issuer may call the bonds when interest rates have dropped, the investor is exposed to reinvestment risk. That is, the investor will have to reinvest the proceeds received when the bond is called at lower interest rates. Finally, the capital appreciation potential of a bond will be reduced because the price of a callable bond may not rise much above the price at which the issuer may call the bond.

Agency, corporate, and municipal bonds may have embedded in them the option on the part of the borrower to call, or terminate, the issue before the stated maturity date. All mortgage-backed securities have this option. Even though the investor is usually compensated for taking the risk of call by means of a lower price or a higher yield, it is not easy to determine if this compensation is sufficient. In any case, the returns from a bond with call risk can be dramatically different from those obtained from a noncallable bond. The magnitude of this risk depends on the various parameters of the call, as well as on market conditions. Timing risk is so pervasive in fixed income portfolio management that many market participants consider it second only to interest-rate risk in importance.

In the case of mortgage-backed securities, the cash flow depends on prepayments of principal made by the homeowners in the pool of mortgages that serves as collateral for the security. The timing risk in this case is called *prepayment risk.* It includes *contraction risk*—the risk that homeowners will prepay all or part of their mortgage when mortgage interest rates decline. If interest rates rise, however, investors would benefit from prepayments. The risk that prepayments will slow down when mortgage interest rates rise is called *extension risk.* Thus, timing risk in the case of mortgage-backed securities is called *prepayment risk,* which includes contraction risk and extension risk.

CREDIT RISK

The *credit risk* of a bond includes

1. The risk that the issuer will default on its obligation (default risk).
2. The risk that the bond's value will decline and/or the bond's price performance will be worse than that of other bonds against which the investor is compared because either (a) the market requires a higher spread due to a perceived increase in the risk that the issuer will default or (b) companies that assign ratings to bonds will lower a bond's rating.

The first risk is referred to as *default risk*. The second risk is labeled based on the reason for the adverse or inferior performance. The risk attributable to an increase in the spread or, more specifically, the credit spread demanded by the market is referred to as *credit spread risk*; the risk attributable to a lowering of the credit rating (i.e., a downgrading) is referred to as *downgrade risk*.

A *credit rating* is a formal opinion given by a specialized company of the default risk faced by investing in a particular issue of debt securities. The specialized companies that provide credit ratings are referred to as "rating agencies." The three nationally recognized rating agencies in the United States are Moody's Investors Service, Standard & Poor's Corporation, and Fitch Ratings. The symbols used by these rating agencies and a summary description of each rating are given in Chapter 13.

Once a credit rating is assigned to a debt obligation, a rating agency monitors the credit quality of the issuer and can reassign a different credit rating to its bonds. An "upgrade" occurs when there is an improvement in the credit quality of an issue; a "downgrade" occurs when there is a deterioration in the credit quality of an issue. As noted earlier, downgrade risk is the risk that an issue will be downgraded.

Typically, before an issue's rating is changed, the rating agency will announce in advance that it is reviewing the issue with the potential for upgrade or downgrade. The issue in such cases is said to be on "rating watch" or "credit watch." In the announcement, the rating agency will state the direction of the potential change in rating—upgrade or downgrade. Typically, a decision will be made within three months.

In addition, rating agencies will issue rating outlooks. A *rating outlook* is a projection of whether an issue in the long term (from six months to two years) is likely to be upgraded, downgraded, or maintain its current rating. Rating agencies designate a rating outlook as either positive (i.e., likely to be upgraded), negative (i.e., likely to be downgraded), or stable (i.e., likely to be no change in the rating).

Gauging Default Risk and Downgrade Risk

The information available to investors from rating agencies about credit risk are (1) ratings, (2) rating watches or credit watches, and (3) rating outlooks. A study by Moody's found that for corporate bonds, its ratings combined with its rating watches and rating outlook status provide a better gauge for default risk than using the ratings alone.[2] Moreover, periodic studies by the rating agencies provide information to investors about credit risk.

Below we describe how the information provided by rating agencies can be used to gauge two forms of credit risk: default risk and downgrade risk.

For long-term debt obligations, a credit rating is a forward-looking assessment of (1) the probability of default and (2) the relative magnitude of the loss should a default occur. For short-term debt obligations (i.e., obligations with initial maturities of one year or less), a credit rating is a forward-looking assessment of the probability of default. Consequently, credit ratings are the rating agencies' assessments of the default risk associated with a bond issue.

Periodic studies by rating agencies provide information about two aspects of default risk—default rates and default loss rates. First, rating agencies study and make available to investors the percentage of bonds of a given rating at the beginning of a period that have defaulted at the end of the period. This percentage is referred to as the *default rate*. A *default loss rate* is a measure of the magnitude of the potential of the loss should a default occur.

Rating transition tables published periodically by rating agencies also provide information. A rating transition table shows the percentage of issues of each rating at the beginning of a period that were downgraded or upgraded by the end of the time period. Consequently, by looking at the percentage of downgrades for a given rating, an estimate can be obtained of the probability of a downgrade, and this can serve as a measure of downgrade risk.

YIELD-CURVE, OR MATURITY, RISK

In many situations, a bond of a given maturity is used as an alternative to another bond of a different maturity. An adjustment is made to account for the differential interest-rate risks in the two bonds. However, this adjustment makes an assumption about how the interest rates (i.e., yields) at different maturities will move.[3] To the extent that the yield movements deviate from this assumption, there is *yield-curve,* or *maturity, risk.*

In general, yield-curve risk is more important in hedging situations than in pure investment decisions. For example, if a trader is hedging a position, or if a pension fund or an insurance company is acquiring assets so as to enable it to meet a given liability, then yield-curve risk should be examined carefully. However, if a pension fund has decided to invest in the intermediate-term sector, then the fine distinctions in maturity are less important.

2. David T. Hamilton and Richard Cantor, "Rating Transitions and Defaults Conditional on Watchlist, Outlook and Rating History," Moody's Investors Service, February 2004.

3. Usually, a parallel-shift assumption is made. That is, we assume that the yields at different maturities move by equal amounts.

Another situation where yield-curve risk should be considered is in the analysis of bond-swap transactions, where the potential incremental returns are dependent entirely on the parallel-shift (or other equally arbitrary) assumption for the yield curve.

INFLATION, OR PURCHASING POWER, RISK

Inflation risk, or *purchasing power risk,* arises because of the variation in the value of cash flows from a security due to inflation, as measured in terms of purchasing power. For example, if an investor purchases a five-year bond in which he or she can realize a coupon rate of 7%, but the rate of inflation is 8%, then the purchasing power of the cash flow has declined. For all but inflation-adjusted securities, and adjustable- or floating-rate bonds, an investor is exposed to inflation risk because the interest rate the issuer promises to make is fixed for the life of the security. To the extent that interest rates reflect the expected inflation rate, floating-rate bonds have a lower level of inflation risk.

LIQUIDITY RISK

Liquidity risk is the risk that the investor will have to sell a bond below its true value where the true value is indicated by a recent transaction. The primary measure of liquidity is the size of the spread between the bid price and the ask price quoted by a dealer. The wider the bid-ask spread, the greater is the liquidity risk.

A liquid market generally can be defined by "small bid-ask spreads which do not materially increase for large transactions."[4] How to define the bid-ask spread in a multiple-dealer market is subject to interpretation. For example, consider the bid-ask spread for four dealers. Each quote is for 92 plus the number of 32nds shown:

	Dealer			
	1	**2**	**3**	**4**
Bid price	1	1	2	2
Ask price	4	3	4	5

The bid-ask spread for each dealer (in 32nds) is

	Dealer			
	1	**2**	**3**	**4**
Bid-ask spread	3	2	2	3

4. Robert I. Gerber, "A User's Guide to Buy-Side Bond Trading," Chapter 16 in Frank J. Fabozzi (ed.), *Managing Fixed Income Portfolios* (New Hope, PA: Frank J. Fabozzi, 1997), p. 278.

The bid-ask spread as computed above is measured relative to a dealer. The best bid-ask spread is two 32nds for Dealers 2 and 3.

From the perspective of the *market overall,* the bid-ask spread can be computed by looking at the best bid price (high price at which one of the dealers is willing to buy the security) and the lowest ask price (lowest offer price at which one of the dealers is willing to sell the security). This liquidity measure is called the *market bid-ask spread.* For the four dealers, the highest bid price is 92 plus two 32nds and the lowest ask price is 92 plus three 32nds. Thus the market bid-ask spread is one 32nd.

For investors who plan to hold a bond until maturity and need not mark a position to market, liquidity risk is not a major concern. An institutional investor who plans to hold an issue to maturity but is periodically marked to market is concerned with liquidity risk. By marking a position to market, it is meant that the security is revalued in the portfolio based on its current market price. For example, mutual funds are required to mark to market at the end of each day the holdings that are in their portfolio in order to compute the net asset value (NAV). While other institutional investors may not mark to market as frequently as mutual funds, they are marked to market when reports are periodically sent to clients or the board of directors or trustees.

Where are the prices obtained to mark a position to market? Typically, a portfolio manager will solicit indicative bids from several dealers and then use some process to determine the bid price used to mark the position. The less liquid the issue, the greater the variation there will be in the bid prices obtained from dealers. With an issue that has little liquidity, the price may have to be determined by a pricing service rather than by dealers. Moreover, lack of dealer indicative bids and concern with models used by pricing services may lead the manager to occasionally override a bid (subject to internal approval beyond the control of the manager).

EXCHANGE-RATE, OR CURRENCY, RISK

A non-dollar-denominated bond (i.e., a bond whose payments occur in a foreign currency) has unknown U.S. dollar cash flows. The dollar cash flows are dependent on the foreign-exchange rate at the time the payments are received. For example, suppose that an investor purchases a bond whose payments are in Japanese yen. If the yen depreciates relative to the U.S. dollar, then fewer dollars will be received. The risk of this occurring is referred to as *exchange-rate risk,* or *currency risk.* Of course, should the yen appreciate relative to the U.S. dollar, the investor will benefit by receiving more dollars.

In addition to the change in the exchange rate, an investor is exposed to the interest-rate, or market, risk in the local market. For example, if a U.S. investor purchases German government bonds denominated in euros, the proceeds received from the sale of that bond prior to maturity will depend on the level of interest rates in the German bond market, in addition to the exchange rate.

VOLATILITY RISK

As will be explained in later chapters, the price of a bond with an embedded option depends on the level of interest rates and factors that influence the value of the embedded option. One of the factors is the expected volatility of interest rates. Specifically, the value of an option rises when expected interest-rate volatility increases. In the case of a callable bond or mortgage-backed security, because the investor has granted an option to the borrower, the price of the security falls because the investor has given away a more valuable option. The risk that a change in volatility will adversely affect the price of a security is called *volatility risk.*

POLITICAL OR LEGAL RISK

Sometimes the government can declare withholding or other additional taxes on a bond or declare a tax-exempt bond taxable. In addition, a regulatory authority can conclude that a given security is unsuitable for investment entities that it regulates. These actions can adversely affect the value of the security. Similarly, it is also possible that a legal or regulatory action affects the value of a security positively. The possibility of any political or legal actions adversely affecting the value of a security is known as *political* or *legal risk.*

To illustrate political or legal risk, consider investors who purchase tax-exempt municipal securities. They are exposed to two types of political risk that can be more appropriately called *tax risk*. The first type of tax risk is that the federal income tax rate will be reduced. The higher the marginal tax rate, the greater is the value of the tax-exempt nature of a municipal security. As the marginal tax rates decline, the price of a tax-exempt municipal security will decline. For example, proposals for a flat tax with a low tax rate significantly reduced the potential tax advantage of owning municipal bonds. As a result, tax-exempt municipal bonds began trading at lower prices. The second type of tax risk is that a municipal bond issued as tax exempt eventually will be declared taxable by the Internal Revenue Service (IRS). This may occur because many municipal (revenue) bonds have elaborate security structures that could be subject to future adverse congressional actions and IRS interpretations. As a result of the loss of the tax exemption, the municipal bond will decline in value in order to provide a yield comparable to similar taxable bonds. For example, in June of 1980, the Battery Park City Authority sold $97.315 million in construction loan notes. At the time of issuance, the legal counsel thought that the interest on the note would be exempt from federal income taxation. In November of 1980, however, the IRS held that interest on these notes was not exempt, resulting in a lower price for the notes. The issue was not resolved until September 1981 when the Authority and the IRS signed a formal agreement resolving the matter so as to make the interest on the notes tax exempt.

EVENT RISK

Occasionally, the ability of an issuer to make interest and principal payments is seriously and unexpectedly changed by (1) a natural or industrial accident or (2) a takeover or corporate restructuring. These risks are referred to as *event risk.* The cancellation of plans to build a nuclear power plant illustrates the first type of event in relation to the utility industry.

An example of the second type of event risk is the takeover in 1988 of RJR Nabisco for $25 billion via a financing technique known as a *leveraged buyout* (LBO). In such a transaction, the new company incurred a substantial amount of debt to finance the acquisition of the firm. Because the corporation was required to service a substantially larger amount of debt, its quality rating was reduced to non-investment-grade quality. As a result, the change in yield spread to a benchmark Treasury, demanded by investors because of the LBO announcement, increased from about 100 to 350 basis points.

There are also spillover effects of event risk on other firms. For example, if there is a nuclear accident, this will affect all utilities producing nuclear power.

SECTOR RISK

Bonds in different sectors of the market respond differently to environmental changes because of a combination of some or all of the preceding risks, as well as others. Examples include discount versus premium coupon bonds, industrial versus utility bonds, and corporate versus mortgage-backed bonds. The possibility of adverse differential movement of specific sectors of the market is called *sector risk.*

OTHER RISKS

The various risks of investing in the fixed income markets reviewed in this chapter do not represent the entire range of risks. In the marketplace, it is customary to combine almost all risks other than market risk (interest-rate risk) and refer to it as *basis risk.*

SUMMARY

In this chapter we have described 12 risks associated with investing in fixed income securities. Not all securities or investment strategies expose the investor to all the risks we have discussed. As the instruments and portfolio management strategies are described in more detail throughout this book, these risks will be explained further.

CHAPTER

THREE

THE PRIMARY AND SECONDARY BOND MARKETS

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Financial markets can be categorized as those dealing with financial claims that are newly issued, called the *primary market,* and those for exchanging financial claims previously issued, called the *secondary market,* or the *market for seasoned securities*. In this chapter we will discuss the primary and secondary markets for bonds.

PRIMARY MARKET

The primary market involves the distribution to investors of newly issued securities by the central government, its agencies, municipal governments, and corporations. Investment bankers work with issuers to distribute newly issued securities.

Regulation of the Primary Market

The Securities Act of 1933 governs the issuance of securities. The act requires that a registration statement be filed with the Securities and Exchange Commission (SEC) by the issuer of a security. The type of information contained in the registration statement is the nature of the business of the issuer, key provisions or features of the security, the nature of the investment risks associated with the security, and the background of management. Financial statements must be included in the registration statement, and they must be certified by an independent public accountant.

The registration is actually divided into two parts. Part I is the prospectus. It is this part that is typically distributed to the public as an offering of the securities. Part II contains supplemental information, which is not distributed to the public as part of the offering but is available from the SEC on request.

The act provides for penalties in the form of fines and/or imprisonment if the information provided is inaccurate or material information is omitted. Moreover, investors who purchase the security are entitled to sue the issuer to recover damages if they incur a loss as a result of the misleading information. The underwriter also may be sued if it can be demonstrated that the underwriter did not conduct a reasonable investigation of the information reported by the issuer. One of the most important duties of an underwriter is to perform due diligence.

The filing of a registration statement with the SEC does not mean that the security can be offered to the public. The registration statement must be reviewed and approved by the SEC's Division of Corporate Finance before a public offering can be made. Typically, the staff of this division will find a problem with the registration statement. The staff then sends a "letter of comments" or "deficiency letter" to the issuer explaining the problem it has encountered. The issuer must remedy any problem by filing an amendment to the registration statement. If the staff is satisfied, the SEC will issue an order declaring that the registration statement is "effective," and the underwriter can solicit sales. The approval of the SEC, however, does not mean that the securities have investment merit or are priced properly or that the information is accurate. It merely means that the appropriate information appears to have been disclosed.

In 1982, the SEC approved Rule 415, which permits certain issuers to file a single registration document indicating that they intend to sell a certain amount of a certain class of securities at one or more times within the next two years. The issuer qualifies for Rule 415 registration if the securities are investment grade and/or the securities of the issuer historically have filed registration statements and those securities comply with minimum flotation requirements. Rule 415 is popularly referred to as the "shelf registration rule" because the securities can be viewed as sitting on a "shelf" and can be taken off that shelf and sold to the public without obtaining additional SEC approval. In essence, the filing of a single registration document allows the issuer to come to market quickly because the sale of the security has been preapproved by the SEC. Prior to establishment of Rule 415, there was a lengthy period required before a security could be sold to the public. As a result, in a fast-moving market, issuers could not come to market quickly with an offering to take advantage of what they perceived to be attractive financing opportunities. For example, if a corporation felt that interest rates were low and wanted to issue a bond, it had to file a registration statement and could not issue the bond until the registration statement became effective. The corporation was then taking the chance that during the waiting period interest rates would rise, making the bond offering more costly.

Traditional Process for Underwriting Bonds

The traditional process in the United States for issuing new securities involves investment bankers performing one or more of the following three functions: (1) advising the issuer on the terms and the timing of the offering, (2) buying the securities from the issuer, and (3) selling the issue to the public. The advisor role may require investment bankers to design a security structure that is more palatable to investors than a particular traditional instrument.

In the sale of new securities, investment bankers need not undertake the second function—buying the securities from the issuer. An investment banker may merely act as an advisor and/or distributor of the new security. The function of buying the securities from the issuer is called *underwriting*. When an investment banking firm buys the securities from the issuer and accepts the risk of selling the securities to investors at a lower price, it is referred to as an "underwriter." When the investment banking firm agrees to buy the securities from the issuer at a set price, the underwriting arrangement is referred to as a "firm commitment." In contrast, in a "best-efforts arrangement," the investment banking firm agrees only to use its expertise to sell the securities—it does not buy the entire issue from the issuer.

The fee earned from underwriting a security is the difference between the price paid to the issuer and the price at which the investment bank reoffers the security to the public. This difference is called the *gross spread,* or the *underwriter discount*.

The typical underwritten transaction involves so much risk of capital loss that a single investment banking firm undertaking it alone would be exposed to the danger of losing a significant portion of its capital. To share this risk, an investment banking firm forms a *syndicate of firms* to underwrite the issue. The gross spread is then divided among the lead underwriter(s) and the other firms in the underwriting syndicate. The lead underwriter manages the deal (or "runs the books" for the deal). In many cases, there may be more than one lead underwriter so that the lead underwriters are said to colead or comanage the deal.

To realize the gross spread, the entire securities issue must be sold to the public at the planned reoffering price. This usually requires a great deal of marketing muscle. Investment banking firms have an investor client base (retail and institutional) to which they attempt to sell the securities. To increase the potential investor base, the lead underwriter will put together a *selling group*. This group includes the underwriting syndicate plus other firms that are not in the syndicate. Members of the selling group can buy the security at a concession price—a price less than the reoffering price. The gross spread is thereby divided among the lead underwriter, members of the underwriting syndicate, and members of the selling group.

A successful underwriting of a security requires that the underwriter have a strong sales force. The sales force provides feedback on advance interest in the security, and the traders (also called *market makers*) provide input in pricing the security as well. It would be a mistake to think that once the bonds are all sold, the investment banking firm's ties with the deal are ended. Those who bought the bonds will look to the investment banking firm to make a market in the issue. This means that the investment banking firm must be willing to take a principal position in secondary market transactions.

Variations in the Bond Underwriting Process

Not all bonds are underwritten using the traditional syndicate process we have described. Variations in the United States, the Euromarkets, and foreign markets include the bought deal, the auction process, and continuous offerings of medium-term notes.

Bought Deal

The mechanics of a bought deal are as follows: The lead manager or a group of managers offers a potential issuer of bonds a firm bid to purchase a specified amount of the bonds with a certain interest (coupon) rate and maturity. The issuer is given a day or so (maybe even only a few hours) to accept or reject the bid. If the bid is accepted, the underwriting firm has "bought the deal." It can, in turn, sell the bonds to other investment banking firms for distribution to their clients and/or distribute the bonds to its clients. Typically, the underwriting firm that buys the deal will have presold most of the issue to its institutional clients.

There are several reasons why some underwriting firms find the bought deal attractive. While SEC Rule 415 gives certain issuers timing flexibility to take advantage of windows of opportunity in the global marketplace, it requires that underwriting firms be prepared to respond on short notice to commit funds to a deal. This fact favors the bought deal because it gives the underwriting firm very little time to line up a syndicate. A consequence of accepting bought deals, however, is that underwriting firms need to expand their capital so that they can commit greater amounts of funds to such deals.

The risk of capital loss in a bought deal may not be as great as it first appears. There are some deals that are so straightforward that a large underwriting firm may have enough institutional investor interest to keep the risks of distributing the issue at the reoffering price quite small. Moreover, in the case of bonds, hedging strategies using the interest-rate risk control tools can reduce or eliminate the risk of realizing a loss of selling the bonds at a price below the reoffering price.

Auction Process

Another variation for underwriting bonds is the auction process. In this method, the issuer announces the terms of the issue, and interested parties submit bids for the entire issue. The auction form is mandated for certain bond offerings of regulated public utilities and many municipal debt obligations. It is more commonly called a *competitive-bidding underwriting*. For example, suppose that a public utility wishes to issue $200 million in bonds. Various underwriters will form syndicates and bid on the issue. The syndicate that bids the lowest yield (i.e., the lowest cost to the issuer) wins the entire $200 million bond issue and then reoffers it to the public.

In a variant of the process, the bidders indicate the price they are willing to pay and the amount they are willing to buy. The bond issue is then allocated to bidders from the highest bid price (lowest yield) to the lower ones (higher yield) until the entire issue is allocated. For example, suppose that an issuer is offering $500 million of a bond issue and nine bidders submit the following yield bids:

Bidder	Amount (in millions)	Bid
A	$150	5.1%
B	110	5.2
C	90	5.2
D	100	5.3
E	75	5.4
F	25	5.4
G	80	5.5
H	70	5.6
I	85	5.7

The first four bidders—A, B, C, and D—will be allocated the amount for which they bid because they submitted the lowest-yield bids. In total, they will receive $450 million of the $500 million to be issued. This leaves $50 million to be allocated to the next-lowest bidders. Both E and F submitted the next-lowest yield bid, 5.4%. In total, they bid for $100 million. Since the total they bid for exceeds the remaining $50 million, they will receive an amount proportionate to the amount for which they bid. Specifically, E will be allocated three-quarters ($75 million divided by $100 million) of the $50 million, or $37.5 million, and F will be allocated one-quarter ($25 million divided by $100 million) of the $50 million, or $12.5 million.

The next question concerns the yield that all the six winning bidders—A, B, C, D, E, and F—will have to pay for the amount of the issue allocated to them. One way in which a competitive bidding can occur is that all bidders pay the highest winning yield bid (or, equivalently, the lowest winning price). In our example, all bidders would buy the amount allocated to them at 5.4%. This type of auction is called a *single-price auction*, or a *Dutch auction*. Another way is for each bidder to pay whatever each one bid. This type of auction is called a *multiple-price auction*. In the United States, both procedures have been used in the auctioning of U.S. Treasury securities.

Using an auction allows corporate issuers to place newly issued debt obligations directly with institutional investors rather than follow the indirect path of using an underwriting firm. Internet auctions of municipal originations to underwriters began during 1997. One method of issuing municipal securities (i.e., securities issued by state and local governments and their authorities) is via a competitive-bidding process.

Investment bankers' response to the practice of direct purchase of publicly registered securities is that, as intermediaries, they add value by searching their institutional client base, which increases the likelihood that the issuer will incur the lowest cost, after adjusting for the underwriting fees. By dealing with just a few institutional investors, investment bankers argue, issuers cannot be sure of obtaining funds at the lowest cost. In addition, investment bankers say that they often play another important role: They make a secondary market in the securities they issue. This market improves the perceived liquidity of the issue and, as a result, reduces the cost to issuers. The question of whether or not investment bankers can obtain lower-cost funding (after accounting for underwriting fees) for issuers, by comparison with the cost of funding from a direct offering, is an interesting empirical question.

Continuous Offering of Medium-Term Notes

A *medium-term note* (MTN) is a corporate debt instrument with the unique characteristic that notes are offered continuously to investors by an agent of the issuer.[1] Investors can select from several maturity ranges: 9 months to 1 year, more than 1 year to 18 months, more than 18 months to 2 years, and so on up to 30 years. Medium-term notes are registered with the SEC under Rule 415 (the shelf registration rule), which gives a corporation the maximum flexibility for issuing securities on a continuous basis.

The term *medium-term note* to describe this corporate debt instrument is misleading. Traditionally, the terms *note* and *medium term* were used to refer to debt issues with a maturity greater than one year but less than 15 years. Certainly this is not a characteristic of MTNs, because they have been sold with maturities from 9 months to 30 years, and even longer. For example, in July 1993, Walt Disney Corporation issued a security with a 100-year maturity off its medium-term note shelf registration.

MTNs differ from corporate bonds in the manner in which they are distributed to investors when they are sold initially. Although some investment-grade corporate bond issues are sold on a best-efforts basis, typically they are underwritten by investment bankers. MTNs traditionally have been distributed on a best-efforts basis by either an investment banking firm or other broker-dealers acting as agents. Another difference between corporate bonds and MTNs when they are offered is that MTNs are usually sold in relatively small amounts on a continuous or an intermittent basis, whereas corporate bonds are sold in large, discrete offerings.

A corporation that wants an MTN program will file a shelf registration with the SEC for the offering of securities. While the SEC registration for MTN offerings is between $100 and $1 billion, once the total is sold, the issuer can file another shelf registration. The registration will include a list of the investment banking firms, usually two to four, that the corporation has arranged to act as agents to distribute the MTNs.

The issuer then posts rates over a range of maturities: for example, 9 months to 1 year, 1 year to 18 months, 18 months to 2 years, and annually thereafter. Usually, an issuer will post rates as a spread over a Treasury security of comparable

1. Medium-term notes are described in Chapter 14.

maturity. Rates will not be posted for maturity ranges that the issuer does not desire to sell. The agents will then make the offering rate schedule available to their investor base interested in MTNs. An investor who is interested in the offering will contact the agent. In turn, the agent contacts the issuer to confirm the terms of the transaction. Since the maturity range in the offering rate schedule does not specify a specific maturity date, the investor can choose the final maturity subject to approval by the issuer. The minimum size that an investor can purchase of an MTN offering typically ranges from $1 million to $25 million.

The rate offering schedule can be changed at any time by the issuer either in response to changing market conditions or because the issuer has raised the desired amount of funds at a given maturity. In the latter case, the issuer can either not post a rate for that maturity range or lower the rate.

Reverse Inquiry

Rule 415 has had a very different effect on bonds than stocks. New issues of stocks are typically large issues and become a commingled part of the previous issue (have the same dividend and maturity). New issues of bonds, however, become distinct issues (different coupon, different maturity) and may be large or small issues. Rule 415 permits a corporation to obtain approval for a large issue and then subsequently allows small amounts actually to be issued when funds are needed or issuing conditions are appropriate. Each individual issue will be separate; that is, each may have a different coupon or maturity. These issues are called *tranches*. This Rule 415–related issuing procedure is more effective for bonds than stocks.

The issuing process for single large issues of bonds is similar to new issues of stocks. However, the issuing of small tranches, which may occur for bonds but not stocks, may be quite different. Investment banks usually have a capital market desk near their corporate bond trading desks. The participants on these desks (often called *bankers*) are in continual contact with institutional investors who may be investors for bonds they "have on the shelf." The bankers can tailor the bonds they have on the shelf to the needs of the institutional investor and issue bonds from the shelf intended just for this single investor. The process of the banker learning the needs of the investor and tailoring an issue just for the investor is called *reverse inquiry*.

Private Placement Market

In addition to underwriting securities for distribution to the public, securities may be placed with a limited number of institutional investors such as insurance companies, investment companies, and pension funds. *Private placement,* as this process is known, differs from the public offering of securities that we have described so far. Life insurance companies are the major investors in private placements.

Public and private offerings of securities differ in terms of the regulatory requirements that the issuer must satisfy. The Securities Act of 1933 and the

Securities Exchange Act of 1934 require that all securities offered to the general public must be registered with the SEC, unless there is a specific exemption.

The securities acts allow three exemptions from federal registration. First, intrastate offerings—that is, securities sold only within a state—are exempt. Second, there is a small-offering exemption (Regulation A). Specifically, if the offering is for $1 million or less, the securities need not be registered. Finally, Section 4(2) of the 1933 act exempts from registration "transactions by an issuer not involving any public offering." At the same time, the 1933 act does not provide specific guidelines to identify what is a private offering or placement.

In 1982, the SEC adopted Regulation D, which sets forth the guidelines that determine if an issue is qualified for exemption from registration. The guidelines require that, in general, the securities cannot be offered through any form of general advertising or general solicitation that would prevail for public offerings. Most important, the guidelines restrict the sale of securities to "sophisticated" investors. Such "accredited" investors are defined as those who (1) have the capability to evaluate (or who can afford to employ an advisor to evaluate) the risk and return characteristics of the securities and (2) have the resources to bear the economic risks. These investors are called *qualified institutional buyers* (QIBs).

The exemption of an offering does not mean that the issuer need not disclose information to potential investors. In fact, the issuer must still furnish the same information deemed material by the SEC. The issuer supplies this information in a private placement memorandum, as opposed to a prospectus for a public offering. The distinction between the private placement memorandum and the prospectus is that the former does not include information deemed by the SEC "nonmaterial" if such information is required in a prospectus. Moreover, unlike a prospectus, the private placement memorandum is not subject to SEC review.

Investment banking firms assist in the private placement of securities in several ways. They work with the issuer and potential investors on the design and pricing of the security. Often it has been in the private placement market that investment bankers first design new security structures. Field testing of many of the innovative securities that we describe in this book occurred in the private placement market.

The investment bankers may be involved with lining up the investors as well as designing the issue. Or, if the issuer has already identified the investors, the investment banker may serve only in an advisory capacity. An investment banker also can participate in the transaction on a best-efforts underwriting arrangement.

Overall, institutional investors investing in private placements receive a higher yield (usually expressed as a spread to a Treasury security of a similar maturity) to compensate for less liquidity. In general, private placements are at the lower end of the credit-risk spectrum, that is, triple B and below; there are few private placements rated A and above.

There is one additional advantage of private placements, however. In a single large issue of a corporate bond, there may be hundreds of investors, and the terms of the issues are set by the issuer (and their investment banker), and the investor can then "take it or leave it." Similarly, if there is a financial problem with the issuer that violates the terms of the prospectus, typically the overall procedures to resolve the problem are specified and followed. With a private placement, however, there may be a small number of investors—for example, 8 to 10 and they may cooperate to negotiate some of the terms or covenants with the issuer. Similarly, if the issuer violates one or more of the covenants, the consortium of investors can flexibly negotiate their response with the issuer. Skillful private placement investors can benefit from their flexibility at both times relative to the inflexible approach of public issues.

Rule 144A

In the United States, one restriction imposed on buyers of privately placed securities is that they may not be resold for two years after acquisition. Thus there is no liquidity in the market for that time period. Buyers of privately placed securities must be compensated for the lack of liquidity, which raises the cost to the issuer of the securities.

In April 1990, however, SEC Rule 144A became effective. This rule eliminates the two-year holding period by permitting large institutions to trade securities acquired in a private placement among themselves without having to register those securities with the SEC.

Private placements are now classified as Rule 144A offerings or non-Rule 144A offerings. The latter are more commonly referred to as "traditional private placements." Rule 144A offerings are underwritten by investment bankers.

Rule 144A encourages non-U.S. corporations to issue securities in the U.S. private placement market for two reasons. First, it will attract new large institutional investors into the market that were unwilling previously to buy private placements because of the requirement to hold the securities for two years. Such an increase in the number of institutional investors may encourage non-U.S. entities to issue securities. Second, foreign entities were unwilling to raise funds in the United States prior to establishment of Rule 144A because they had to register their securities and furnish the necessary disclosure set forth by U.S. securities laws. Private placement requires less disclosure. Rule 144A also improves liquidity, reducing the cost of raising funds.

SECONDARY MARKETS

It is in the secondary market that bonds that have been issued previously are traded. In the secondary market, an issuer may obtain regular information about the value of the bonds it has issued. The periodic trading of a bond issue reveals to the issuer the consensus price that the bond commands in an open market. Thus issuers can observe the prices of their bonds and the implied interest rates investors expect and demand from them. Such information helps issuers to assess how well they are using the funds acquired from earlier primary market activities, and it also indicates how receptive investors would be to new offerings. Another service that the secondary market offers issuers is the opportunity for the original buyer of a bond to reverse the investment by selling it for cash. Unless investors are confident that they can shift from one financial asset to another as they may feel necessary, they naturally would be reluctant to buy any bonds. Such reluctance would harm potential issuers in one of two ways: Either issuers would be unable to sell new bonds at all, or they would have to pay a higher rate of return because investors would increase the discount rate in compensation for expected illiquidity of the bonds.

Bond investors receive several benefits from a secondary market. Such a market obviously offers them liquidity for their bonds, as well as information about the fair or consensus value of bonds. Furthermore, secondary markets bring together many interested parties and thereby reduce the costs of searching for likely buyers and sellers of bonds. Moreover, by accommodating many trades, secondary markets keep the cost of transactions low. By keeping the costs of both searching and transacting low, secondary markets encourage investors to purchase bonds.

In the United States, secondary trading of common stock occurs in a number of trading locations. Many shares are traded on major national stock exchanges (the largest of which is the New York Stock Exchange) and regional stock exchanges, which are organized and somewhat regulated markets in specific geographic locations. Additional significant trading in stock takes place on the so-called over-the-counter (OTC) market, which is a geographically dispersed group of traders linked to one another via telecommunication systems. The dominant OTC market for stocks in the United States is the Nasdaq.

With respect to bonds, some are traded on exchanges—the NYSE sponsors a small bond-trading facility, mainly for small orders. But most trading in bonds in the United States and throughout the world occurs in the OTC market.

In addition, for stocks, there are two other types of secondary markets: *electronic communication networks* and *crossing networks*. Electronic communication networks (ECNs) are privately owned broker-dealers that operate as market participants within the Nasdaq system. They display quotes that reflect actual orders and provide institutions and Nasdaq market makers with an anonymous way to enter orders.[2] Crossing networks are systems developed to allow institutional investors to cross orders—that is, match buyers and sellers directly—typically via computer. These networks are batch processes that aggregate orders for execution at prespecified times. Crossing networks provide anonymity and are specifically designed to minimize trading costs.

2. Essentially, an ECN is a limit-order book that is widely disseminated and open for continuous trading to subscribers who may enter and access orders displayed on the ECN.

Brokers

A typical investor may not be skilled in the art of the deal or completely informed about every facet of trading in the asset. Clearly, most investors, even in smoothly functioning markets need professional assistance. Investors need someone to receive and keep track of their orders for buying or selling, to find other parties wishing to sell or buy, to negotiate for good prices, to serve as a focal point for trading, and to execute the orders. The broker performs all these functions. Obviously, these functions are more important for the complicated trades, such as the small or large trades, than for simple transactions or those of typical size.

A *broker* is an entity that acts on behalf of an investor who wishes to execute orders. In economic and legal terms, a broker is said to be an "agent" of the investor. It is important to realize that the brokerage activity does not require the broker to buy and sell or hold in inventory the bond that is the subject of the trade. (Such activity is termed *taking a position in the bond,* and it is the role of the dealer, another important financial market participant discussed below.) Rather, the broker receives, transmits, and executes investors' orders with other investors. The broker receives an explicit commission for these services, and the commission is a transaction cost of the securities markets. If the broker also provides other services, such as research, record keeping, or advising, investors may pay additional charges.

Dealers as Market Makers

In secondary markets, there can be a temporary imbalance in the number of buy and sell orders that investors may place for any bond at any one time. Such unmatched or unbalanced flow causes two problems. One is that the bond's price may change abruptly, even if there has been no shift in either supply or demand for the bond. Another problem is that buyers may have to pay higher than market-clearing prices (or sellers accept lower ones) if they want to make their trade immediately.

Because of such imbalances, there is the need for a dealer or market maker who stands ready and willing to buy a bond issue for its own account (to add to an inventory of a bond issue) or sell from its own account (to reduce the inventory of a bond issue). At a given time, dealers are willing to buy a bond issue at a price (the bid price) that is less than what they are willing to sell the same bond issue for (the ask price).

Dealers are viewed as the suppliers of immediacy to the market.[3] The bid-ask spread can be viewed in turn as the price charged by dealers for supplying immediacy together with short-run price stability (continuity or smoothness) in the presence of short-term order imbalances. There is another role that dealers play in the bond market: providing reliable price information to market participants.

3. George Stigler, "Public Regulation of Securities Markets," *Journal of Business* (April 1964), pp. 117–134; and Harold Demsetz, "The Cost of Transacting," *Quarterly Journal of Economics* (October 1968), pp. 35–36.

The price-stabilization role follows from what may happen to the price of a particular transaction in the absence of any intervention when there is a temporary imbalance of orders. By taking the opposite side of a trade when there are no other orders, the dealer prevents the price from materially diverging from the price at which a recent trade was consummated. Investors are concerned not only with immediacy but also with being able to trade at prices that are reasonable, given prevailing conditions in the market.

What factors determine the price dealers should charge for the services they provide? Or equivalently, what factors determine the bid-ask spread? One of the most important is the order-processing cost incurred by dealers. Dealers also have to be compensated for bearing risk. A dealer's position may involve carrying inventory of a security (a long position) or selling a security that is not in inventory (a short position). There are three types of risks associated with maintaining a long or short position in a given security. First, there is the uncertainty about the future price of the security. A dealer who has a net long position in the security is concerned that the price will decline in the future; a dealer who is in a net short position is concerned that the price will rise. The second type of risk has to do with the expected time it will take the dealer to unwind a position and its uncertainty. And this, in turn, depends primarily on the thickness of the market for the security. Finally, while a dealer may have access to better information about order flows than the general public, there are some trades where the dealer takes the risk of trading with someone who has better information. This results in the better-informed trader obtaining a better price at the expense of the dealer. Consequently, a dealer in establishing the bid-ask spread for a trade will assess whether or not the trader might have better information.

Trading Operations

The secondary markets in bonds are quite different from those in stocks. As discussed earlier, most secondary stock trades are conducted on centralized stock exchanges (NYSE, Amex, or Nasdaq, although the Nasdaq is actually a dealer network). The secondary fixed income markets, however, are not centralized exchanges but are OTC markets, which are a network of noncentralized (often called *fragmented*) dealers, each of which provide "bids" and "offers" (in general, "quotes") for each of the issues in which they participate. Thus an investor's buy or sell is conducted with an individual dealer at their quoted price, which does not emanate from any centralized organization such as an exchange.[4]

4. Some corporate bonds, however, are listed on the NYSE (traded in NYSE's so-called bond room). While the NYSE market for corporate bonds always has been a minor part of the market, it continues to decline. From 1990 to 2002, the listed issues have declined by more than 40% to 1,323, a period during which corporate bond issuance increased significantly. In the secondary market, of the $15 billion to $20 billion of corporate bonds that trade daily, on average only

Owing to these major differences between stock and bond secondary trading, other differences result:

- There are public prices, that is, trade prices that the public can observe, for stocks but not for bonds. There is a "tape" containing trade prices for stocks (available at the bottom of many financial TV channels), but there are no such tapes that contain trade prices for fixed income instruments. Thus, because of the OTC market for bonds, there is a lack of prices or quote transparency. While large institutions have access to the quotes from bond dealers, small investors do not. This lack of pricing transparency is changing, however. During early 2004, the Municipal Securities Rulemaking Board, the regulatory organization for municipal bonds, began providing pricing information within minutes for bonds issued by state and local governments. For corporate bonds, the National Association of Securities Dealers (NASD) provides pricing data through its Trade Reporting and Compliance Engine (also known as "Trace"). During April 2004, the NASD approved a plan to increase the number of bonds whose prices are published through Trace to more than 23,000 (from 4,600).[5] Despite these improvements, the level of price transparency in the bond markets is inadequate.
- There is a single, widely used posttrade mechanism for "clearing and settling" the trades for stocks but not for fixed income instruments.[6] The steps for the fixed income mechanism, which are discussed in more detail below, are
    - Agree on the specific issue, trade price, and quantity (and thus the value of the securities traded) (this step is called *clearance*).
    - Transfer of the funds equal to this value from the account of the buyer to the account of the seller.
    - Transfer of the agreed amounts of securities from the account of the seller to the account of the buyer (the last two steps are called *settlement*).

Straight-through processing (STP) refers to the objective of accomplishing the posttrade functions (the functions after the trade is agreed on) in an automatic, even paperless manner. The transition to STP has been ongoing for several years

$9 million traded each day during 2003 on the NYSE. While this market is small, it does provide transparency of quotes and a transaction vehicle for small investors. (Christine Richard, "As NYSE-Listed Bonds Dwindle, Small Investors Get Edged Out," *Wall Street Journal,* (May 17, 2004), p. C6.)

5. Aaron Luchetti, "NASD to Expand List of Bond-Pricing Data," *Wall Street Journal* (April 23, 2004), p. C2.
6. One result of this difference is that there is a common clearinghouse for common stocks (the Depository Trust Company, or DTC), but none for bonds.

and is the current goal of the securities industry. Achieving this STP goal depends, to some extent, on electronic fixed income trading, which is discussed below.

Saying that firm A "made a trade" of securities with firm B sounds simple. In practice, "making a trade" is a very involved process. This section describes this process. There are four parts to the process:

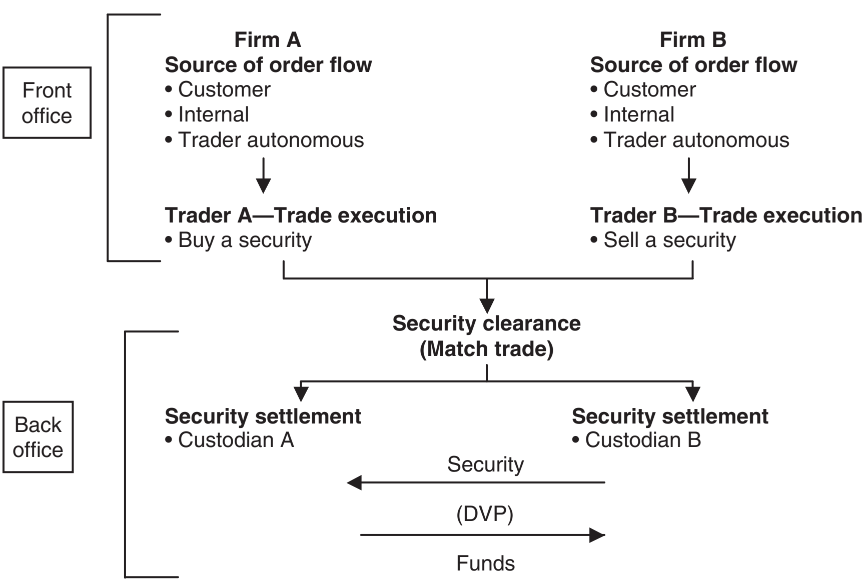
1. Sources of order flow:
   a. Customer (external) order flow
   b. House/proprietary (internal) order flow
   c. Trader autonomous order flow (could be proprietary trader)
2. Trade or execution of order flow
3. Clearance of trade
4. Settlement of trade

The first two steps are said to occur in the "front office." The last two steps are said to take place in the "back office." The functions of the back office are also called *operations* and are also referred to as *posttrade functions*. Two decades ago, the back office was mainly manual and clerical. Back office functions, however, have become much more computer- and system-oriented, as will be considered below.

Consider these four functions in the context of Exhibit 3–1, wherein firm A buys a security from firm B. Order flow can be of three different types. The

EXHIBIT 3–1

Aspects of Trade



order flow can be developed from the firm's sales force, which develops either institutional or retail orders. It also can represent the firm's own order flow from its own portfolio managers. For example, an insurance company's trading desk can execute trades from its internal portfolio managers. Finally, the trader may have autonomy to initiate his own trades for the firm, often called the *house*. These are often called *proprietary trades*.

When the trader acquires the order, he simply executes the trade. For example, trader A may buy $1 million par value of General Motors (GM) with an 8.375% coupon and a maturity on July 15, 2033, at a price of 103.952 (which represents a yield of 8.021%, which is 267 basis points over the 30-year Treasury), and trader B may sell the same. The preceding says that trader A simply executes the trade. It is not always simple to do so. First, trader A must identify a trader who wants to sell this specific issue. Second, traders A and B must agree on a price, in this case 103.952. Buying traders and selling traders may "locate the other side of the trade" through their own dealer network or through brokers who are in contact with many dealers. These functions complete the front office functions.

Consider next the back office or posttrade functions. The first step is trade matching, or *clearance*. Clearance refers to the comparison of the details of a trade between dealers or brokers before completion or settlement of a trade (settlement is discussed next). In the preceding example, perhaps trader A thought that he bought at 103.952 and trader B thought that she sold at 104.952. Or perhaps, trader A thought that he bought GMs of 01/15/2033 and trader B thought that she sold the 6.75% GEs of 03/15/2032. Or perhaps trader A thought that he bought $10 million and trader B thought that she sold $12 million. The "details" of the trade—specific issue (issuer, coupon, and maturity) and amount—have to be agreed on before the trade can be completed. This is the clearance function.

To complete the trade, the agreed-on amount of securities must flow from the seller to the buyer, and the corresponding amount of funds must flow from the buyer to the seller. The trading firms do not maintain their funds and securities internally but in a bank, which keeps their funds and securities "in custody"; these are called *custodian banks*. In earlier years, securities had a physical existence. Now, almost all securities are kept in computer memory and are called *book entry*. Each trading firm has a relationship with its own custodian bank. To avert fraud and insolvency, the funds and the securities flow between the two custodian banks (if different) or different accounts of the same custodian bank (if the same) simultaneously. This simultaneous reverse flow of funds and securities is called *delivery versus payment* (DVP).

A critical element of the clearance/settlement process is the number of days between the trade date T and the settlement date. This is called the "$T + X$ period," where X is the number of days between trade date and settlement date. For several decades, the standard was $T + 5$ days. During the mid-1990s, however, the settlement period was reduced to $T + 3$, with a goal of $T + 1$. Currently, the $T + 1$ goal has been abandoned and, $T + 3$ is the status quo.

EXHIBIT 3–2

Securities Industry Association Definitions of STP

How Investment Managers View STP:
The buy-side firms interviewed for this paper were provided with a concise definition of SIA's STP program definition:

"*. . . the seamless integration of systems and processes to automate the trade process from end-to-end-trade execution, confirmation and settlement—without the need for manual intervention or the re-keying of data*."

The Current SIA Definition Is as Follows:
"*The STP scope of the industry is from Notice of Execution (NOE) through to settlement for institutional trading. For retail and corporate actions, the STP scope is broader. For individual firms, STP is also defined more broadly, and encompasses the streamlining of the operational infrastructure—front-, middle-, and back-office of all industry participants (broker/dealers, investment managers, custodians, and clearance/settlement utilities)*."

Source: Securities Industry Association, STP Buy-Side Committee, "Buy-Side Straight-Through Processing White Paper," December 2003, final version.

As indicated, traditionally the settlement process has been very manual and clerical-intensive. However, the increased use of computers and systems has streamlined the process. The current goal is STP, which refers to a seamless, paperless process of clearing and settlement.

The Securities Industry Association (SIA)[7] is an industry trade group that represents brokers and dealers that sell taxable securities. It attempts to affect favorable regulation and legislation for the securities industry and educates its members and the public. The SIA's Web site is very useful for a discussion of various STP issues.[8] The SIA definitions of STP are given in Exhibit 3–2.

Most firms soon will conduct their back office processing on an STP basis with the $T + 3$ settlement norm. As indicated below, many client-dealer fixed income electronic trading platforms now facilitate STP.

Electronic Bond Trading

Traditionally, bond trading has been based on broker-dealer trading desks, which take principal positions to fill customer buy and sell orders. In recent years, however, there has been an evolution away from traditional bond trading toward electronic trading. This evolution toward electronic trading is likely to continue.

There are several related reasons for the transition to the electronic trading of bonds. Because the bond business has been a principal rather than an agency

7. www.sia.com.
8. See www.sia.com/stp/html/industry_reports.html/#white.

business, the capital of the market makers is critical. Whereas the amount of capital of the broker-dealers has increased during the last several years, the amount of capital of U.S. institutional investors (pension funds, mutual funds, insurance companies, and commercial banks) and international customers has increased much more, and the size of the orders has increased significantly. As a result, making markets in bonds has become more risky for market makers. In addition, the increase in the volatility of bond markets has increased the capital required of bond broker-dealers. Finally, the profitability of bond market making has declined because many of the products have become more commodity-like and their bid-offer spreads have decreased.

The combination of the increased risk and the decreased profitability of bond market making has induced the major market markers to deemphasize this business in the allocation of capital. Broker-dealer firms have determined that it is more efficient to employ their capital in other activities, such as underwriting, asset management, and other agency-type brokerage businesses than in principal-type market-making businesses. As a result, the liquidity of the traditionally principal-oriented bond markets has declined, and this decline in liquidity has opened the way for other market-making mechanisms.

This retreat by traditional market-making firms opened the door for electronic trading. In fact, as indicated below, the same Wall Street firms that have been the major market makers in bonds also have been the supporters of electronic trading in bonds.

Electronic trading in bonds has helped to fill this developing vacuum and has provided liquidity to the bond markets. The growth of electronic trading necessarily will continue. Among the overall advantages of electronic trading are (1) providing liquidity to the markets, (2) price discovery (particularly for less liquid markets), (3) use of new technologies, and (4) trading and portfolio management efficiencies. As an example of the last advantage, portfolio managers can load their buy/sell orders in a Web site, trade from these orders, and then clear these orders.

Electronic Fixed Income Transactions Systems

There are five types of electronic fixed income transactions systems: (1) auction systems, (2) cross-matching systems, (3) interdealer systems, (4) multidealer systems, and (5) single-dealer systems.

Auction Systems. These systems permit participants to conduct electronic auctions of securities offerings for both new issues in the primary markets and secondary market offerings. The seller or issuer provides a description of the security being sold, the type of auction, and how the buyer can submit bids. The identity of the bidders and their bids are anonymous in some cases and open in others. Auction systems are not used commonly.

Cross-Matching Systems. These systems bring dealers and institutional investors together in electronic trading networks that provide real-time or periodic cross-matching sessions. Buy and sell orders are executed automatically when contra-side orders are entered at the same price or when the posted price is "hit" or "lifted."

Interdealer Systems. These systems permit dealers to execute transactions electronically with other dealers via the anonymous services of "brokers' brokers." Clients are not involved in these systems.

Multidealer Systems. These systems, also called *client-to-dealer systems,* provide customers with consolidated orders from two or more dealers that give the customers the ability to execute from among multiple quotes. These systems often display to customers the best bid or offer price of those posted by all dealers. The participating dealer usually acts as the principal in the transaction.

Single-Dealer Systems. These systems permit investors to execute transactions directly with the specific dealer desired; this dealer acts as a principal in the transaction. Access to the dealer by the investor increasingly has been through the Internet. These systems simply replace telephone contact between a single dealer and a customer with Internet contact.

There are several systems in each of these five categories of electronic fixed income trading systems. Exhibit 3–3 provides a summary of the five main participants that fall into either cross-matching systems, interdealer systems, or multidealer systems.

Overview of Electronic Fixed Income Trading

Traditionally, fixed income trading has been an OTC market conducted via telephone. However, recently, there has been a strong trend in the replacement of the telephone by electronic trading in the fixed income OTC market.

In a short period of time, the U.S. electronic fixed income trading market has undergone dramatic changes. During 2000 and 2001, the financial services industry became obsessed with electronic bond trading, with many new firms entering the marketplace. By 2002, however, the market excitement about fixed income electronic trading was based on unrealistic expectations of volume and system capability.

Thus this irrational market enthusiasm was followed by a significant, rapid market decline in 2002, when several electronic fixed income platforms without clients and volume went out of business in a short period of time. Even the highly publicized and well-funded BondBook, which was supported by large bond dealers, ceased operations.

Electronic trading platforms in the United States then continued to mature and consolidate in 2003 as online execution of fixed income transactions became virtually commonplace. Subsequently, by 2004, after several failures and consolidations, expectations became more consistent with realistic trading volumes.

EXHIBIT 3–3

Summary of Five Electronic Fixed Income Trading Systems

System	System Type	Major Products	Owner/ Investor	U.S. Products
Broker Tec/ ICAP	Interdealer	Off-the-run U.S. Treasury market	ICAP plc.	Treasuries; Agencies; MBS
E Speed	Interdealer	Benchmark (liquid) U.S. Treasury market	Developed within Cantor Fitzgerald; went public in December 1999	Treasuries; Agencies; Municipals
Market Axess	Cross-matching; Multidealer (disclosed counterparty)	Corporate bonds	Consortium of global dealers	Corporates
MuniCenter	Interdealer-cross-matching (anonomous counterparty)	Municipal bonds	Consortium of U.S. dealers	Municipals; Corporates
Trade Web	Multidealer (disclosed counterparty)	Liquid U.S. Treasuries and MBS	Thomson Financial (bought from consortium of 27 global dealers in April 2004)	Treasuries; Agencies; MBS; Corporates

Notes:

Broker Tec/ICAP (www.icap.com)

- Interdealer broker
- Headquartered in Jersey City, NJ; office in London (ICAP's headquarters)
- Broker Tec launched in June 2000
  - o 14 Large dealers as shareholders
- Acquired by ICAP plc in May 2003
  - o ICAP is leading global interdealer brokerage firm
- Focus on global government fixed income markets
- While eSpeed may be the leader in liquid U.S. Treasury benchmarks, ICAP is the leader in most of the other markets, especially in the European fixed income markets (including Sovereigns and Supranationals)

eSpeed (www.espeed.com)

- Interdealer broker
- Located in New York, NY
- Developed within Cantor Fitzgerald
- Went public in December 1999

(Continued on next page)

(Continued)

- Focus on U.S. Treasury products
- Leader in liquid U.S. Treasuries (benchmarks)
- Also trades in Euro Sovereigns, Japanese government bonds (JGBs), Canadian government bonds, repos, and MBS.
- Trading platforms in front-to-back office, offering everything from front-end applications to back office clearing and settlement functions, thus providing the basis for STP.

Market Axess (www.marketaxess.com)

- Multidealer system
- Located in New York, NY
- Owned by 19 participating dealers
- Market leader in electronic trading of credit instruments and investment-grade and high-yield corporates
  - o Keeps real-time data on 4,000 corporate bonds
- Also offers European high-grade corporates and emerging-market bonds
- Targets qualified institutional buyers (QIBs) as clients
- Offers straight-through processing (STP)

The MuniCenter (www.MuniCenter.com)

- Interdealer and multidealer system
- Located in New York, NY
- Established in July 2000; owned by group of large dealers
- Dominant in electronic trading of U.S. municipal bonds
- Provides access to municipal bonds to its clients on its Web site

TradeWeb (www.tradeweb.com)

- Multidealer system
- Located in Jersey City, NJ
- Formed in 1997
- Owned by consortium of global dealers; bought by Thomson Financial in April 2002
- Has 27 participating dealers, which provides significant liquidity
- Over 1,500 buy-side firms as clients
- Main product is U.S. Treasuries
  - o Also U.S. agencies, TBA-MBS, corporates, Euro Sovereign commercial paper, Euro CP, Gilts, and Pfandbriefe
- Also provides posttrade processing to permit clients to achieve real-time STP

Sources: "eCommerce in the Fixed-Income Markets, the 2002 Review of Electronic Transaction Systems," The Bond Market Association, November 2003 (www.bondmarkets.com); Sang Lee and Jodi Burns, "eBond Trading 2004: Going Beyond Trade Execution," Celent Communications.

Currently, market optimism is based on realistic client expectations and tangible trade volume. And the systems that are surviving and prospering are going beyond simple trade execution and into providing real-time market data and posttrade processing services

The continued growth in the use of online trading platforms has resulted in a well-established core group of systems. Surviving platform vendors have continued to improve their product offerings, which, in turn, have enhanced the use of online trading for dealers and customers.

Electronic trading is now responsible for approximately 30% of all fixed income secondary trading. This fraction will continue to grow as it has in the equity markets. However, electronic trading will not mark the end of traditional, that is, telephone, trading, particularly for illiquid products.

In equilibrium, there are likely to be a small number of interdealer fixed income electronic platforms, perhaps two. And there also will be a small number of platforms in the client-to-dealer market, although most likely more than two. The surviving client-to-dealer networks may be specialists in specific fixed income issues (e.g., municipals), or they may span the market sectors.

Electronic trading was initiated for efficient trade execution. However, it has expanded to other related posttrading functions, most importantly providing market data (thus improving price transparency) and providing posttrading processing services, which typically are complicated and manually intensive (thus facilitating STP).

It is now clear that the electronic fixed income market is here for the long haul, and the real competition appears to be just beginning among a few market leaders. Electronic fixed income trading is well on its way from being a headline to being a work horse.

SUMMARY

The primary market involves the distribution to investors of newly issued bonds. Investment bankers perform one or more of three functions: (1) advising the issuer on the terms and the timing of the bond offering, (2) buying the bonds from the issuer (the underwriting function), and (3) distributing the bonds to investors. The SEC is responsible for regulating the issuance of new securities, with the major provisions set forth in the Securities Act of 1933. The act requires that the issuer file a registration statement for approval by the SEC. Rule 415, the shelf registration rule, permits certain issuers to file a single registration document indicating that they intend to sell a certain amount of a certain class of securities at one or more times within the next two years.

Variations in the bond underwriting process include the bought deal, the auction process, and continuous offering of medium-term notes. A private placement is different from the public offering of securities in terms of the regulatory requirements that must be satisfied by the issuer. If an issue qualifies as a private placement, it is exempt from the more complex registration requirements imposed on public offerings. Rule 144A has contributed to the growth of the private placement market by improving the liquidity of securities issued in this market.

A secondary market for bonds is one where existing or outstanding bonds are traded among investors. A secondary market serves several needs of the firm or governmental unit that issues securities in the primary market. The secondary market provides the issuer with regular information about the value of its outstanding bonds, and it encourages investors to buy bonds from issuers because it offers them an ongoing opportunity for liquidating their positions. Investors also get services from the secondary market: The market supplies them with liquidity and prices for the bonds they are holding or want to buy, and the market brings interested investors together, thereby reducing the costs of searching for other parties and of making trades.

Brokers aid investors by collecting and transmitting orders to the market, by bringing willing buyers and sellers together, by negotiating prices, and by executing orders. Dealers in the bond market perform two functions: (1) they provide the opportunity for investors to trade immediately rather than waiting for the arrival of sufficient orders on the other side of the trade (immediacy), and they do this while maintaining short-run price stability (continuity), and (2) they offer price information to market participants (transparency). Dealers buy for their own account and maintain inventories of bonds, and their profits come from selling bonds at higher prices than the prices at which they purchased them.

Electronic bond trading has improved the liquidity of the bond market because the commitment to bond trading by dealers has not kept pace with the liquidity needs of institutional investors. The two major types of electronic trading systems are the interdealer and the dealer-to-customer systems (single- and multiple-dealer systems). In addition to these dealer systems, there are auction systems that permit their participants to conduct electronic auctions of securities offerings for both new issues in the primary markets and secondary offerings.

Electronic fixed income trading systems provide not only efficient trading opportunities but also improved price transparency and more efficient posttrade services, including straight-through processing (STP).

CHAPTER
FOUR

BOND MARKET INDEXES

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The value of nonmunicipal bonds outstanding in the United States at over $8 trillion is fairly close to the combined value of equity in the United States, and a similar comparison holds for world capital markets, where the value of fixed income securities is typically similar to the total value of equity. The only instance where this capital comparison does not hold is in some emerging-market countries, where the bond markets have not yet developed. Given the economic importance of fixed income markets, it is difficult to understand why there has not been greater concern and analysis of bond market indexes. Part of the reason for this lack of analysis of bond market indexes is the relatively short history of these indexes. Specifically, in contrast to stock market indexes that have been in existence for over 100 years, total rate-of-return bond indexes were not developed until the 1970s, and those created in the 1970s were limited to U.S. investment-grade bonds. For example, indexes for U.S. high-yield bonds, where the market has grown to over $500 billion, were not established until the mid-1980s, which is also when international government bond indexes were created.

There are four parts to this chapter. The first section considers the major uses for bond market indexes. The second section is concerned with the difficulty of building and maintaining a bond market index compared with the requirements for a stock market index. The third section contains a description of the indexes available in three major categories. Finally, we present the risk/return characteristics of the alternative bond market sectors and examine the correlations among the alternative indexes.

USES OF BOND INDEXES

An analysis of bond market indexes is important and timely for several reasons. First, the bond portfolios of both pension funds and individuals have grown substantially in recent years; sales of fixed income mutual funds have exceeded equity mutual fund sales in a number of years. With the increase in the number and size of bond portfolios, investors and portfolio managers increasingly have come to rely on bond indexes *as benchmarks for measuring performance* and, in the case of those managing portfolios on a performance-fee basis, for determining compensation. There are numerous indexes of differing construction that purport to measure the aggregate bond market and the major sectors of the market (government, corporate, and mortgages). An obvious concern is the choice of an appropriate index that will provide an accurate benchmark of bond market behavior.

Second, benchmarks for *bond index funds* have become increasingly popular because those who monitor the performance of bond portfolios have discovered that, similar to equity managers, most bond portfolio managers have not been able to outperform the aggregate bond market. The amount of money invested in bond index funds grew from $3 billion in 1984 to over $300 billion in 2003. Given the total size and growth of the bond market, it is estimated that bond index funds could grow to $500 billion by the end of this first decade of the twenty-first century.

The behavior of a particular bond index is critical to fixed income managers who attempt to replicate its performance in an index fund. Clearly, if all indexes move together, one would be indifferent to the choice of a particular index. We examine the return correlations between the various indexes and their risk/return characteristics. The analysis of long-term risk/return and correlations is important because index numbers may differ markedly over short periods of time and yet still exhibit similar long-run movements.

Portfolio managers of a bond index fund need to rebalance their assets to replicate the composition, maturity, and duration of the bond market. As shown in Reilly, Kao, and Wright,[1] the composition of the bond market changed dramatically during the 1980s, and there have been continuing changes during the 1990s and early 2000s. It is possible to use the indexes to document the intertemporal changes in the makeup, maturity, and duration of the bond market that have influenced its risk and return characteristics.

Third, because of the size and importance of the bond market, there has been and will continue to be substantial fixed income research; the bond market indexes can provide accurate and timely measurement of the risk/return characteristics of these assets and the characteristics of the market, as noted earlier. For example, the time-series properties of equity index returns have been examined extensively, but these same tests were not applied to bond market returns. Our investigation indicated significant autocorrelation in bond market index returns,

1. Frank K. Reilly, Wenchi Kao, and David J. Wright, "Alternative Bond Market Indexes," *Financial Analysts Journal* 48, no. 3 (May–June 1992), pp. 44–58.

which were explained by examining the intertemporal behavior of U.S. Treasury securities with different maturities.[2]

BUILDING AND MAINTAINING A BOND INDEX

To construct a *stock market index,* you have to select a sample of stocks, decide how to weight each component, and select a computational method. Once you have done this, adjustment for stock splits typically is automatic, and the pricing of the securities is fairly easy because most of the sample stocks are listed on a major stock exchange or actively traded in the over-the-counter (OTC) market. Mergers or significant changes in the performance of the firms in an index may necessitate a change in the index components. Other than such events, a stock could continue in an index for decades. (On average, the Dow Jones Industrial Average has about one change per year.)

In contrast, the creation, computation, and maintenance of a bond market index is more difficult for several reasons. First, *the universe of bonds is broader and more diverse than that of stocks*. It includes U.S. Treasury issues, agency series, municipal bonds, and a wide variety of corporate bonds spanning several segments (industrials, utilities, financials) and ranging from high-quality, AAA-rated bonds to bonds in default. Furthermore, within each group, issues differ by coupon and maturity, as well as by sinking funds and call features. As a result of this diversity, an aggregate bond market series can be subdivided into numerous subindexes; the Merrill Lynch series, for example, contains over 150 subindexes.

Second, *the universe of bonds changes constantly*. A firm typically will have one common stock issue outstanding, which may vary in size over time as the result of additional share sales or repurchases. In contrast, a major corporation will have several bond issues outstanding at any point in time, and the characteristics of the issues will change constantly because of maturities, sinking funds, and call features. This constant fluctuation in the universe of bonds outstanding also makes it more difficult to determine the market value of bonds outstanding, which is a necessary input when computing market-value-weighted rates of return.

Third, *the volatility of bond prices varies across issues and over time*. As indicated in Chapter 5, bond price volatility is influenced by the *duration* and *convexity* of the bond. These factors change constantly because they are affected by the maturity, coupon, market yield, and call features of the bond. Also, market yields have become more volatile, which, in turn, has an effect on the value of embedded call options and makes it more difficult to estimate the duration, convexity, and implied volatility of an individual bond issue or an aggregate bond series.

2. *Ibid*.

Finally, *there can be significant problems in the pricing of individual bond issues*. Individual bond issues generally are not as liquid as stocks. While most stock issues are listed on exchanges or traded on an active OTC market with an electronic quotation system (NASDAQ), most bonds (especially corporates) have historically been traded on a fragmented OTC market. Notably, this problem will be alleviated in the future when there is expanded trading on electronic platforms.[3]

DESCRIPTION OF ALTERNATIVE BOND INDEXES

This section contains three subsections to reflect three major sectors of the global bond market: (1) U.S. investment-grade bonds (including Treasury bonds), (2) U.S. high-yield bonds, and (3) international government bonds. We examine the overall constraints and computational procedures employed for the indexes in these three sectors.

Several characteristics are critical in judging or comparing bond indexes. First is the *sample of securities,* including the number of bonds as well as specific requirements for including the bonds in the sample, such as maturity and size of issue. It is also important to know what issues have been excluded from the index. Second is the *weighting of returns* for individual issues. Specifically, are the returns market-value weighted or equally weighted? Third, users of indexes need to consider the *quality of the price data* used in the computation. Are the bond prices used to compute rates of return based on actual market transactions, as they almost always are for stock indexes? Alternatively, are the prices provided by bond traders based on recent actual transactions or are they the traders' current "best estimate"? Finally, are they based on *matrix pricing,* which involves a computer model that estimates a price using current and historical relationships? Fourth, what *reinvestment assumption* does the rate of return calculation use for interim cash flows?

U.S. Investment-Grade Bond Indexes

Four firms publish ongoing rate-of-return investment-grade bond market indexes. Three of them publish a comprehensive set of indexes that span the universe of U.S. bonds: Lehman Bros. (LB), Merrill Lynch (ML), and Salomon Smith Barney (SSB). The fourth firm, Ryan Labs (RL), concentrates on a long series for the Treasury bond sector.

Exhibit 4–1 summarizes the major characteristics of the indexes created and maintained by these firms. Three of the four firms (LB, ML, and SSB)

3. Electronic bond trading and trading platforms are discussed in Chapter 3.

EXHIBIT 4–1

Summary of Bondmarket Indexes

Name of Index	Number of Issues	Maturity	Size of Issues	Weighting	Pricing	Reinvestment Assumption	Subindexes Available
U.S. Investment-Grade Bond Indexes							
Lehman Brothers Aggregate	6,700+	Over 1 year	Over $200 million	Market value	Trader priced	No	Government, gov./credit, corporate, mortgage-backed, asset-backed
Merrill Lynch Composite	5,500+	Over 1 year	Over $150 million	Market value	Trader priced (externally)	At one-month LIBID rate	Government, gov./corp., corporate mortgage pass-through
Ryan Treasury Composite	118	Over 1 year	All Treasury	Market value and equal	Market priced	In specific bonds	Treasury
Salomon Smith Barney BIG	5,000+	Over 1 year	Over $50 million	Market value	Trader priced	In one-month T-bill	Broad inv. grade, Treas.-agency, corporate, mortgage
U.S. High-Yield Bond Indexes							
Credit Suisse First Boston	500+	All maturities	Over $100 million	Market value	Trader priced	Yes	Composite and by rating
Lehman Brothers	1,600+	Over 1 year	Over $150 million	Market value	Trader priced	No	Composite and by rating
Merrill Lynch	1,900+	Over 1 year	Over $100 million	Market value	Trader priced (externally)	At one-month LIBID rate	Composite and by rating
Salomon Smith Barney	300+	Over 7 years	Over $50 million	Market value	Trader priced	Yes	Composite and by rating
Global Government Bond Indexes							
Lehman Brothers	800+	Over 1 year	Over $300 million	Market value	Trader priced	No	Composite and 23 countries, local and U.S. dollars
Merrill Lynch	600+	Over 1 year	Approx. $1 billion U.S.	Market value	Trader priced	Yes	Composite and 20 countries, local and U.S. dollars
J. P. Morgan	500+	Over 1 year	Over $200 million	Market value	Trader priced	In index	Composite and 13 countries, local and U.S. dollars
Salomon Smith Barney	525	Over 1 year	Over $250 million	Market value	Trader priced	Yes at local short-term rate	Composite and 14 countries, local and U.S. dollars

Sources: Frank K. Reilly, Wenchi Kao, and David J. Wright, "Alternative Bond Market Indexes," *Financial Analysts Journal* 48, no. 3 (May–June 1992); Frank K. Reilly and David J. Wright, "An Analysis of High Yield Bond Benchmarks," *Journal of Fixed Income* 3, no. 4 (March 1994); and Frank K. Reilly and David J. Wright, "Global Bond Markets: An Analysis of Performance and Benchmarks," mimeo (March 1994).

include numerous bonds (over 5,000), and there is substantial diversity in a sample that can include Treasuries, corporates (credits), mortgage-backed, and asset-backed securities. In contrast, the RL series is limited to Treasury bonds and has a sample size that has varied over time based on the Treasury issues outstanding (i.e., from 26 to 118 issues). All the indexes require bonds to have maturities of at least one year. The required minimum size of an issue varies from $50 million (SSB) to $200 million (LB), whereas the Treasury issues used by RL are substantially larger. All the series include only investment-grade bonds (rated BBB or better) and exclude convertible bonds and floating-rate bonds. The three broad-based indexes by LB, ML, and SSB also exclude government flower bonds, whereas RL has included these bonds in its index because flower bonds were a significant factor in the government bond market during the 1950s.

The two major alternatives for weighting are *relative market value* of the issues outstanding and *equal weighting* (also referred to as *unweighted*). The justification for market-value weighting is that it reflects the relative economic importance of the issue and is a logical weighting for an investor with no preferences regarding asset allocation. Although this theoretical argument is reasonable, it is important to recognize that in the real world it is difficult to keep track of the outstanding bonds, given the possibility of calls, sinking funds, and redemptions. The alternative of equal weighting is reasonable for an investor who has no prior assumptions regarding the relative importance of individual issues. Also, equal weighting is consistent if one is assuming the random selection of issues. Finally, an equally weighted index is easier to compute, and the results are unambiguous because it is not necessary to worry about outstanding market value owing to calls and so on. The three large-sample indexes are value-weighted, whereas RL has created both a value-weighted and an equal-weighted series (for comparability, we use the value-weighted series).

As noted, one of the major problems with computing returns for a bond index is that continuous transaction prices are not available for most bonds. RL can get recent transaction prices for its Treasury issues, whereas SSB gets all prices from its traders. As noted, these trader prices may be based on a recent actual transaction, the trader's current bid price, or what the trader would bid if he made a market in the bond. Both LB and ML use a combination of trader pricing (ML from an external source) and matrix prices based on a computer model. It is contended that most of the individual issues are priced by traders, so most of the value of each index is based on trader prices.

The indexes also treat interim cash flows differently. RL assumes that cash flows are immediately reinvested in the bonds that generated the cash flows, SSB assumes that flows are reinvested at the one-month T-bill rate, ML assumes reinvestment at the one-month London interbank bid (LIBID) rate, whereas LB does not assume any reinvestment of funds. Obviously, immediate reinvestment in the same bond is the most aggressive assumption, whereas no reinvestment is the most conservative.

U.S. High-Yield Bond Indexes

There are two notable points about high-yield (HY) bond indexes. First, they have a shorter history than the investment-grade bond indexes. This is not surprising because, as shown in several studies, this market only became a recognizable factor in 1977, and its major growth began in about 1982.[4] Therefore, the fact that HY bond indexes began in about 1984 is reasonable.

Second, earlier we noted the general difficulty of creating and maintaining bond indexes because of the constant changes in the size and characteristics of the sample and the significant pricing problems. The fact is that these difficulties are magnified when dealing with the HY bond market because it experiences more extensive sample changes owing to defaults and more frequent redemptions. In addition, the illiquidity and bond pricing problems in the HY bond market are a quantum leap above those faced in the government and investment-grade corporate bond markets.

As shown in Exhibit 4–1, four investment firms have created HY bond indexes Credit Suisse First Boston [CSFB], Lehman Brothers [LB], Merrill Lynch [ML], and Salomon Smith Barney [SSB]).[5] The investment firms also have created indexes for rating categories within the HY bond universe: BB, B, and CCC bonds.

The summary of characteristics in Exhibit 4–1 indicates that there are substantial differences among the HY bond indexes. This contrasts with relatively small differences in the characteristics of investment-grade bond indexes. The number of issues in the alternative HY bond indexes varies from about 300 HY bonds in the SSB series to 1,900 bonds in the ML series. Some of the differences in sample size can be traced to the maturity constraints of the particular index. The large number of bonds in the ML series can be explained in part by its maturity guideline, which includes all HY bonds with a maturity over one year compared with a seven-year maturity requirement for the SSB series.

The minimum issue size is also important because SSB has a minimum issue size requirement of $50 million compared with $100 million (FB and ML) and $150 million (LB).

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4. Edward I. Altman, "Revisiting the High-Yield Bond Market: Mature but Never Dull," *Journal of Applied Corporate Finance* 13, no. 1 (Spring 2000), pp. 64–74; Rayner Cheung, Joseph C. Bencivenga, and Frank J. Fabozzi, "Original-Issue High-Yield Bonds: Historical Return and Default Experiences 1977–1989," *Journal of Fixed Income* 2, no. 2 (September 1992), pp. 58–76; Martin S. Fridson, "The State of the High-Yield Bond Market: Overshooting or Return to Normalcy?" *Journal of Applied Corporate Finance* 7, no. 1 (Spring 1994), pp. 85–97; Frank K. Reilly and David J. Wright, "Unique Risk-Return Characteristics of High–Yield Bonds" *Journal of Fixed Income* 11, no. 2 (September 2001), pp. 65–82.
5. Drexel Burnham also created a HY bond index before its demise in 1989. Blume and Keim created such an index but subsequently substituted an SSB series. There is also an index of high-yield bond mutual funds created by Lipper Analytical.

Notably, there are significant differences in how the alternative indexes handle defaulted issues. The treatment varies, from dropping issues the day they default (ML) to retaining them for an unlimited period subject to size and other constraints (FB and LB). In contrast, there is no difference in return weighting; that is, all the indexes use market-value weighting.

All the bonds in the HY bond indexes are trader priced except for ML, which uses matrix pricing for a few of its illiquid issues. The difficulty with trader pricing is that when bond issues do not trade, the price provided is a trader's best estimate of what the price "should be." Matrix pricing is likewise a problem because each issue has unique characteristics that may not be considered by the computer program. Obviously, this means that it is possible to get significantly different prices from alternative traders or matrix pricing programs.

All the indexes except LB assume the reinvestment of interim cash flows, but at different rates—that is, the individual bond rate, the one-month LIBID rate, or a T-bill rate. Finally, the average maturity and the duration for the indexes are consistent with the constraints on the index: FB, LB, and ML have one-year minimums and lower durations, whereas SSB with a seven-year minimum is at the high end.

In summary, there are significant differences in the characteristics of the alternative HY bond indexes in terms of the samples and pricing. One would expect these differences to have a significant impact on the risk/return performance and the correlations among indexes.[6]

Global Government Bond Market Indexes

Similar to the HY bond indexes, these global-based indexes are relatively new (beginning in 1985) because there was limited interest in these markets prior to the 1980s. The summary description in Exhibit 4–1 indicates numerous similarities among the indexes by the four investment firms (J. P. Morgan [JPM], Lehman Brothers [LB], Merrill Lynch [ML], and Salomon Smith Barney [SSB]), with the exception of minimum size, which varies from $200 million (JPM) to $1 billion (ML). In turn, this issue-size constraint has an impact on the sample sizes, which ranges from JPM at 500 to LB with over 800 bonds. The indexes are the same regarding market value weighting and trader pricing. All of them except LB assume the reinvestment of cash flows with small differences in the reinvested security. The final difference is the number of countries included, which varies from 13 (JPM) to 23 (LB).

6. For a detailed analysis of the alternative HY bond indexes, see Frank K. Reilly and David J. Wright, "An Analysis of High-Yield Bond Benchmarks," *Journal of Fixed Income* 3, no. 4 (March 1994), pp. 6–25.

RISK/RETURN CHARACTERISTICS

The presentation of the risk/return results is divided into two subsections. The first subsection presents and discusses the results for the U.S. indexes, including government and investment-grade bonds, as well as HY bonds. The second subsection provides a similar presentation for global bond indexes, including both domestic and U.S. dollar returns.

U.S. Investment-Grade and HY Bonds

The arithmetic and geometric average annual rates of return and risk measures are contained in Exhibit 4–2 for the period beginning in 1986, when the data are available for almost all the series except the Altman defaulted bond series, which began in 1987. We show the LB index for U.S. investment-grade bonds because it has shown that all the investment-grade bond series are very highly correlated.[7] The SB broad investment-grade (BIG) index is provided because of its popularity.

When viewing the results in Exhibit 4–2 and Exhibit 4–3, one is struck by two factors. The first is the generally high level of mean returns over this 18-year period, wherein the investment-grade bonds experienced average annual returns of between 8% and 9% and the HY bonds attained returns of almost 10%.

The second observation is that the relationship between return and risk (measured as the annualized standard deviation of returns) generally was consistent with expectations. The investment-grade bond indexes typically had lower returns and risk, whereas the HY bond indexes had higher returns and risk measures. The major deviations were the high-risk segments (CCC-rated bonds and defaulted bonds), which experienced returns clearly below HY debt but risk substantially above all other assets.[8] The BB-rated bonds experienced abnormally positive results because they experienced returns above other HY bonds but experienced risk similar to investment-grade debt.

Global Government Bonds

These results will be considered in two parts, involving results in local currency and in U.S. dollars. The results in Exhibits 4–2 and 4–4 show significant consistency between the risk and returns in local currency. Within Europe, Germany experienced the lowest return relative to the United Kingdom, which had a much higher return (10% for the United Kingdom versus about 7% for Germany), but

7. Reilly, Kao, and Wright, *op cit*.
8. For a detailed analysis of defaulted-debt securities, see Frank K. Reilly, David J. Wright, and Edward I. Altman, "Including Defaulted Debt in the Capital Markets Asset Spectrum," *Journal of Fixed Income* 8, no. 3 (December 1998), pp. 33–48.

EXHIBIT 4–2

Rates of Return, Risk, and Annual Range for U.S. and Global Bond Indexes (1986–2003)

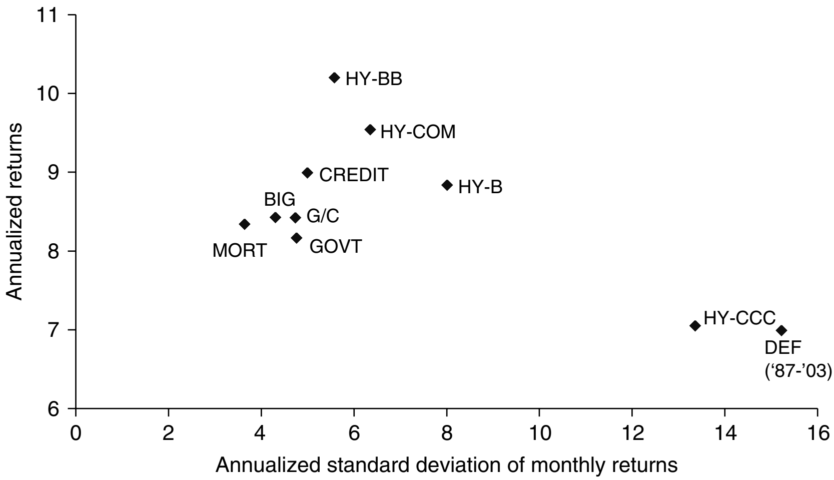
	Geometric Mean Annual Return	Arithemetic Mean Annual Return	Annualized Standard Deviation of Monthly Returns	Coefficient of Variation*	Minimum Annual Return	Maximum Annual Return
U.S. Bond Indexes						
Lehman Bros. Govt./Credit	8.42	8.59	4.74	0.55	–3.51	19.24
Lehman Bros. Government	8.17	8.33	4.76	0.57	–3.38	18.34
Lehman Bros. Credit	9.00	9.18	5.00	0.54	–3.93	22.25
Lehman Bros. Mortgage Backed Securities	8.34	8.45	3.64	0.43	–1.61	16.80
Lehman Bros. Aggregate	8.39	8.54	4.30	0.50	–2.92	18.47
Salomon Bros. Broad Invest. (Grade (B.I.G.)	8.43	8.57	4.30	0.50	–2.85	18.55
Merrill Lynch High Yield Master (composite)	9.54	10.04	6.35	0.63	–4.34	34.58
Lehman Bros. High Yield BB Grade	10.20	10.50	5.58	0.53	–1.80	25.03
Lehman Bros. High Yield B Grade	8.84	9.51	8.01	0.84	–9.18	43.28
Lehman Bros. High Yield CCC Grade	7.05	9.73	13.36	1.37	–22.64	83.16
Altman Default Index ('87–'03)	6.99	10.89	15.22	1.40	–33.08	84.93
Moody's Bankrupt Bond Index	9.41	19.08	207.46	10.87	–40.64	219.25
Merrill Lynch Global Government Bond Indexes in $U.S. and the Ryan Labs U.S. Treasury Composite						
ML Gobal with U.S.	9.24	9.52	6.91	0.73	–4.52	22.96
ML Gobal without U.S.	10.20	10.86	10.20	0.94	–5.57	35.88
ML Canada	10.02	10.42	8.46	0.81	–9.77	29.17

ML France	11.21	12.07	11.45	0.95	–17.17	33.83
ML Germany	9.53	10.50	12.04	1.15	–16.48	37.52
ML Japan	9.13	10.14	13.66	1.35	–14.21	40.05
ML U.K.	11.31	12.04	12.60	1.05	–4.27	46.31
Ryan Labs Treasury Composite-U.S.	8.14	8.31	4.95	0.60	–3.32	18.59
Merrill Lynch Global Government Bond Indexes in Local Currency						
ML Canada	9.54	9.72	5.67	0.58	–4.33	21.28
ML France	8.97	9.15	4.16	0.45	–4.37	20.21
ML Germany	6.80	6.91	3.18	0.46	–2.10	16.03
ML Japan	5.37	5.49	4.43	0.81	–2.92	13.45
ML U.K.	9.99	10.23	6.41	0.63	–5.65	21.20

*Coefficient of variation = annualized standard deviation/arithmetic mean annual return.

EXHIBIT 4–3

Geometric Mean Return versus the Standard Deviation of U.S. Bond Index Returns (1986–2003)



the United Kingdom also experienced higher risk (almost 6.4% for the United Kingdom versus about 3% for Germany). The only country that deviated from the main security market line was Japan, which experienced midrange risk but relatively low return (about 5.4%).

EXHIBIT 4–4

Geometric Mean Return versus the Standard Deviation of Country Government Bond Index Returns in Local Currency (1986–2003)

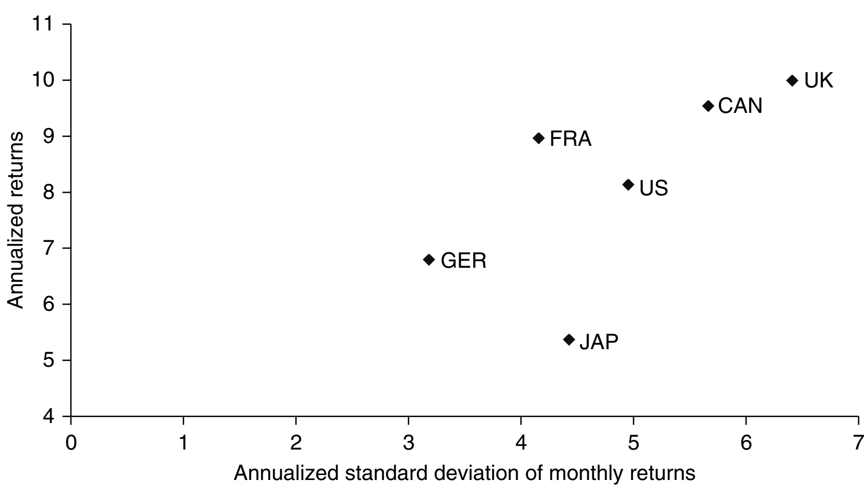
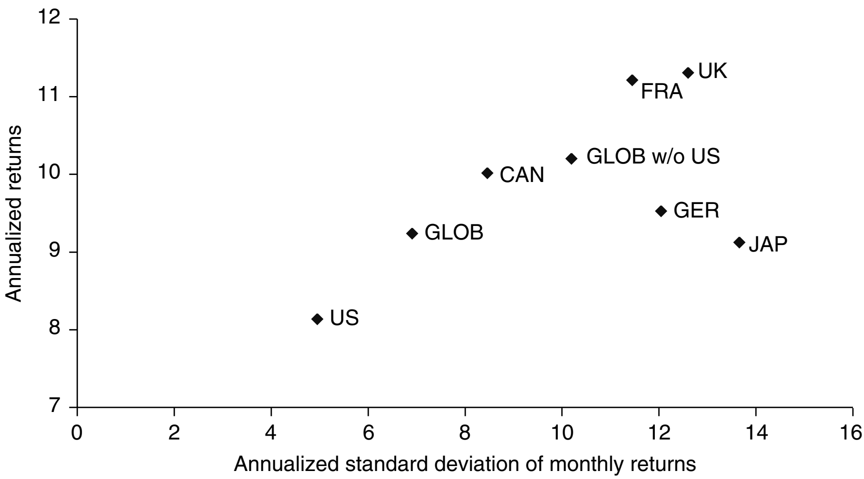


EXHIBIT 4–5

Geometric Mean Return versus the Standard Deviation of Global and Country Government Bond Index Returns in U.S. Dollars (1986–2003)



The return/risk results in U.S. dollars are shown in Exhibits 4–2 and 4–5. The graph in Exhibit 4–5 makes it clear that the results change substantially with the conversion to U.S. dollars. Specifically, the United States is clearly the low risk/return market, followed by Canada, whereas France and the United Kingdom experienced higher returns (8% to 10% for the United States and Canada versus over 11% for France and the United Kingdom) and larger risk (5% to 8.5% for United States and Canada versus 11.45% to 12.6% for the others). Both Germany and Japan were below the consensus line with risk similar to France and the United Kingdom but returns about 2% lower.

In addition to the individual countries, there is a global index with and without the United States. Both these indexes were close to the average line.

CORRELATION RELATIONSHIPS

The correlations likewise are presented in two parts: U.S. bond market results and global bond market results.

U.S. Investment-Grade and HY Bonds

The correlation results in Exhibit 4–6 confirm some expectations about relationships among sectors of the bond market but also provide some unique results. The expected relationships are those among the five investment-grade bond indexes. Because all these are investment grade, it implies that there is a small

EXHIBIT 4–6

Correlation Coefficients of the U.S. Bond Index Monthly Returns (1986–2003)

	LB Govt./ Credit	LB Govt.	LB Credit	LB Mort.	LB Aggr.	SB B.I.G.	ML HY Master	LB HY-BB	LB HY-B	LB HY-CCC	Altman Default	Moody's Bankrupt
LB Govt./Credit	1.000											
LB Govt.	0.990*	1.000										
LB Credit	0.966*	0.922*	1.000									
LB Mort.	0.884*	0.873*	0.868*	1.000								
LB Aggr.	0.992*	0.983*	0.960*	0.934*	1.000							
SB B.I.G.	0.991*	0.982*	0.957*	0.931*	0.998*	1.000						
ML HY Master	0.286*	0.185*	0.449*	0.269*	0.286*	0.287*	1.000					
LB HY BB	0.409*	0.311*	0.560*	0.381*	0.410*	0.411*	0.907*	1.000				
LB HY B	0.225*	0.132	0.379*	0.228*	0.230*	0.229*	0.955*	0.846*	1.000			
LB HY CCC	0.083	0.002	0.226*	0.095	0.087	0.088	0.855*	0.719*	0.852*	1.000		
Altman Default ('87–'03)	–0.087	–0.159*	0.041	–0.108	–0.100	–0.099	0.610*	0.477*	0.601*	0.622*	1.000	
Moody's Bankrupt	0.071	0.061	0.090	0.070	0.072	0.069	0.107	0.055	0.089	0.117	0.119	1.000

*Significant at the 5% level.

probability of default, so the major factor influencing returns is interest-rate changes based on the Treasury yield curve. Therefore, since these index returns have a common determinant, they are very highly correlated. Specifically, the correlations among the LB indexes range from about 0.87 to 0.99, with the results for the mortgage bond sector at the low end because of the impact of embedded call options on mortgage bonds. The correlations with the SSB BIG index is similar even with the higher average maturity of the bonds in this index.

The HY bond results show two distinct patterns. First, the correlations among the HY indexes are quite high, ranging from 0.72 to 0.96. In contrast, the correlations among investment-grade bonds and HY bonds have a greater range and are significantly lower, generally ranging from about 0.00 to 0.56. Not surprisingly, the highest correlations are between BB-rated bonds and investment-grade bonds, whereas the lowest correlations (typically insignificant) are between investment-grade bonds and CCC-rated bonds.

The correlations of defaulted debt with other segments were diverse but not unexpected. The correlations between defaulted debt and investment-grade debt generally were negative but not significant. In contrast, the correlations among defaulted debt and various HY bonds were larger positive values, and all were significant.

Global Government Bond Correlations

Again the discussion is in two parts, to consider the local currency and U.S. dollar results. Exhibit 4–7 contains correlations among returns in local currencies. The correlations of Canada with all European countries indicate a similar relationship (about 0.50), with Japan at 0.29, and the U.S.–Canada correlation was about 0.73. In turn, France had a strong correlation with Germany (0.81)—its major trading partner in Europe—and 0.61 with the United Kingdom. Japan had correlations with the European countries between 0.28 and 0.37 and a correlation with the United States of only 0.31, even though Japan and the United States conduct significant trade.

Exhibit 4–8 contains correlations among returns in U.S. dollars. The results differ from local currency results and normal expectations. Typically, correlations decline when one goes from local currency to U.S. currency because of the effect of random exchange-rate changes, which reduce the relationships. As expected, this decline in correlations occurred among these countries and the United States, and it also happened for all correlations with Canada. In contrast, the correlations among the European countries and for these countries with Japan consistently experienced large *increases* when returns were in U.S. dollars, and all the correlations with the global indexes increased substantially. For example, the correlations between France and Germany went from about 0.81 to about 0.96. This implies that during this period, the exchange-rate correlations were quite high and became a cause for stronger return correlations. In addition, the

EXHIBIT 4–7

Correlation Coefficients among Monthly Global Government Bond Index Returns in Local Currency (1986–2003)

	RL U.S.	ML Canada	ML France	ML Germany	ML Japan	ML U.K.	ML Global w/o U.S.	MLGlobal with U.S.
RL U.S.	1.000							
ML Canada	0.731	1.000						
ML France	0.564	0.466	1.000					
ML Germany	0.591	0.493	0.806	1.000				
ML Japan	0.308	0.292	0.284	0.373	1.000			
ML U.K.	0.535	0.537	0.614	0.660	0.328	1.000		
ML Global w/o U.S.	0.374	0.306	0.270	0.398	0.433	0.352	1.000	
ML Global with U.S.	0.614	0.475	0.385	0.500	0.445	0.439	0.954	1.000

Note: All the correlation coefficients are significant at the 5% level. The ML Global returns are expressed in U.S. dollars.

EXHIBIT 4–8

Correlation Coefficients among Monthly Global Government Bond Index Returns in U.S. Dollars (1986–2003)

	RL U.S.	ML Canada	ML France	ML Germany	ML Japan	ML U.K.	ML Global w/o U.S.	ML Global with U.S.
RL U.S.	1.000							
ML Canada	0.534*	1.000						
ML France	0.402*	0.244*	1.000					
ML Germany	0.361*	0.226*	0.963*	1.000				
ML Japan	0.189*	0.129	0.551*	0.576*	1.000			
ML U.K.	0.395*	0.306*	0.658*	0.653*	0.484*	1.000		
ML Global w/o U.S.	0.374*	0.301*	0.864*	0.873*	0.850*	0.850*	1.000	
ML Global with U.S.	0.614*	0.419*	0.856*	0.849*	0.771*	0.771*	0.954*	1.000

*Significant at the 5% level.

European Union currency was initiated on January 1, 1999, which had an impact on the recent results.

SUMMARY

Bond market indexes are a relatively new but important factor to those who analyze bonds or manage bond portfolios. They have several significant uses, including acting as performance benchmarks, as a benchmark for investors who want to invest through index funds, and as a means to determine fixed income asset risk/return characteristics and correlations as inputs into the asset allocation decision. Therefore, although bond indexes are very difficult to create and maintain, they are worth the effort.

A brief analysis of the risk/return characteristics of alternative bond series indicated that most of the series had results in line with expectations. The outliers were the very risky securities (CCC bonds and defaulted bonds), which underperformed, and low-risk HY bonds (BB-rated), which outperformed. The global bond results were heavily affected by the currency effect. Local currency results were consistent, except for Japan, which was below the market line. The U.S. dollar results were quite consistent in terms of risk and return, with most countries showing benefits from the weak dollar. The global index results were in line with most country results.

The analysis of correlations for U.S. bond indexes confirmed prior studies showing that there are very high correlations among bond series within either the investment-grade or the HY bond sector (typically between 0.86 and 0.99). In contrast, there are significantly lower correlations between investment-grade and HY bonds. (The correlations were typically between 0.20 and 0.40.) Defaulted debt had no correlation with investment-grade debt but fairly significant correlation with HY debt.

The correlations among the global indexes in local currencies typically showed fairly low relationships with other countries (about 0.50), except United States–Canada and France-Germany (between 0.73 and 0.81). The correlations changed when we considered returns in U.S. dollars. Specifically, all the correlations with the United States declined, whereas many of the correlations among non-U.S. countries increased owing to the weak U.S. dollar during this period, which affected these countries simultaneously—and the introduction of European Union currency.

Two final points. First, the significance of many of the empirical results of risk/return and correlations is limited because of the relatively short 18-year time period. Second, while these results do not have the long history one would want, the important point is that it is currently possible to do serious analysis of the bond market because there are a number of very well constructed and diverse bond indexes available, as described herein. Such an analysis of the bond market and its components is critical for investors and portfolio managers making asset allocation and portfolio-performance decisions.

PART
TWO

BASIC ANALYTICS

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CHAPTER

FIVE

BOND PRICING, YIELD MEASURES, AND TOTAL RETURN

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In this chapter the pricing of fixed income securities and the various measures of computing return (or yield) from holding a fixed income security will be explained and illustrated. The chapter is organized as follows: In the first section, we apply the present-value analysis[1] to explain how a bond's price is determined. Then we turn to yield measures, first focusing on conventional yield measures for a fixed-rate bond (yield-to-maturity and yield-to-call in the case of a callable bond) and a floating-rate bond. After highlighting the deficiencies of the conventional yield measures, a better measure of return—total return—is then presented.

BOND PRICING

The price of any financial instrument is equal to the present value of the expected cash flow. The interest rate or discount rate used to compute the present value depends on the yield offered on comparable securities in the market. In this chapter we shall explain how to compute the price of a noncallable bond. The pricing of callable bonds is explained in Chapter 37.

Determining the Cash Flow

The first step in determining the price of a bond is to determine its cash flow. The cash flow of an option-free bond (i.e., noncallable/nonputable bond) consists of (1) periodic coupon interest payments to the maturity date and (2) the par (or maturity)

1. The time value of money is reviewed in the Appendix to this book.

value at maturity. Although the periodic coupon payments can be made over any time interval (weekly, monthly, quarterly, semiannually, or annually), most bonds issued in the United States pay coupon interest semiannually. In our illustrations, we shall assume that the coupon interest is paid semiannually. Also, to simplify the analysis, we shall assume that the next coupon payment for the bond will be made exactly six months from now. Later in this section we explain how to price a bond when the next coupon payment is less than six months from now.

In practice, determining the cash flow of a bond is not simple, even if we ignore the possibility of default. The only case in which the cash flow is known with certainty is for fixed-rate, option-free bonds. For callable bonds, the cash flow depends on whether the issuer elects to call the issue. In the case of a putable bond, it depends on whether the bondholder elects to put the issue. In either case, the date that the option will be exercised is not known. Thus the cash flow is uncertain. For mortgage-backed and asset-backed securities, the cash flow depends on prepayments. The amount and timing of future prepayments are not known, and therefore, the cash flow is uncertain. When the coupon rate is floating rather than fixed, the cash flow depends on the future value of the reference rate. The techniques discussed in Part 5 have been developed to cope with the uncertainty of cash flows. In this chapter, the basic elements of bond pricing where the cash flow is assumed to be known are presented.

The cash flow for an option-free bond consists of an annuity (i.e., the fixed coupon interest paid every 6 months) and the par or maturity value. For example, a 20-year bond with a 9% (4.5% per 6 months) coupon rate and a par or maturity value of $1,000 has the following cash flows:

$$\text{Semiannual coupon interest} = \$1{,}000 \times 0.045$$
$$= \$45$$
$$\text{Maturity value} = \$1{,}000$$

Therefore, there are 40 semiannual cash flows of $45, and a $1,000 cash flow 40 six-month periods from now.

Notice the treatment of the par value. It is *not* treated as if it will be received 20 years from now. Instead, it is treated on a consistent basis with the coupon payments, which are semiannual.

Determining the Required Yield

The interest rate that an investor wants from investing in a bond is called the *required yield.* The required yield is determined by investigating the yields offered on comparable bonds in the market. By comparable, we mean option-free bonds of the same credit quality and the same maturity.[2]

2. In Chapter 9, we introduce a measure of interest-rate risk known as *duration*. Instead of talking in terms of a bond with the same maturity as being comparable, we can recast the analysis in terms of the same duration.

The required yield typically is specified as an annual interest rate. When the cash flows are semiannual, the convention is to use one-half the annual interest rate as the periodic interest rate with which to discount the cash flows. As explained in the Appendix to this book, a periodic interest rate that is one-half the annual yield will produce an effective annual yield that is greater than the annual interest rate.

Although one yield is used to calculate the present value of all cash flows, there are theoretical arguments for using a different yield to discount the cash flow for each period. Essentially, the theoretical argument is that each cash flow can be viewed as a zero-coupon bond, and therefore, the cash flow of a bond can be viewed as a package of zero-coupon bonds. The appropriate yield for each cash flow then would be based on the theoretical rate on a zero-coupon bond with a maturity equal to the time that the cash flow will be received. For purposes of this chapter, however, we shall use only one yield to discount all cash flows. In later chapters, this issue is reexamined.

Determining the Price

Given the cash flows of a bond and the required yield, we have all the necessary data to price the bond. The price of a bond is equal to the present value of the cash flows, and it can be determined by adding (1) the present value of the semiannual coupon payments and (2) the present value of the par or maturity value.

Because the semiannual coupon payments are equivalent to an ordinary annuity, the present value of the coupon payments and maturity value can be calculated from the following formula:[3]

$$c\left[\frac{1-\left[\frac{1}{(1+i)^n}\right]}{i}\right]+\frac{M}{(1+i)^n}$$

where

c = semiannual coupon payment ($)
n = number of periods (number of years times 2)
i = periodic interest rate (required yield divided by 2) (in decimal)
M = maturity value

Illustration 1. Compute the price of a 9% coupon bond with 20 years to maturity and a par value of $1,000 if the required yield is 12%.

3. The first term in the formula is the same as the formula for the present value of an ordinary annuity for n periods given in the Appendix to this book. Instead of using A to represent the annuity, we have used c, the semiannual coupon payment.

The cash flows for this bond are as follows: (1) 40 semiannual coupon payments of \$45 and (2) \$1,000 40 six-month periods from now. The semiannual or periodic interest rate is 6%.

The present value of the 40 semiannual coupon payments of \$45 discounted at 6% is \$677.08, as shown below:

$$c = \$45$$
$$n = 40$$
$$i = 0.06$$
$$\$45\left\{\frac{1-\left[\frac{1}{(1.06)^{40}}\right]}{0.06}\right\}$$
$$= \$45\left[\frac{1-\left(\frac{1}{10.28572}\right)}{0.06}\right]$$
$$= \$45\left(\frac{1-0.097222}{0.06}\right)$$
$$= \$45(15.04630)$$
$$= \$677.08$$

The present value of the par or maturity value *40 six-month periods* from now discounted at 6% is \$97.22, as shown below:

$$M = \$1,000$$
$$n = 0.40$$
$$i = 0.06$$
$$\$1,000\left[\frac{1}{(1.06)^{40}}\right]$$
$$= \$1,000\left(\frac{1}{10.28572}\right)$$
$$= \$1,000(0.097222)$$
$$= \$97.22$$

The price of the bond is then equal to the sum of the two present values:

Present value of coupon payments	\$677.08
Present value of par (maturity) value	97.22
Price	\$774.30

Illustration 2. Compute the price of the bond in Illustration 1 assuming that the required yield is 7%.

The cash flows are unchanged, but the periodic interest rate is now 3.5% (7%/2).

The present value of the 40 semiannual coupon payments of $45 discounted at 3.5% is $960.98, as shown below:

$$c = \$45$$
$$n = 40$$
$$i = 0.035$$

$$\$45\left\{\frac{1-\left[\frac{1}{(1.035)^{40}}\right]}{0.035}\right\}$$

$$= \$45\left[\frac{1-\left(\frac{1}{3.95926}\right)}{0.035}\right]$$

$$= \$45\left(\frac{1-0.252572}{0.035}\right)$$

$$= \$45(21.35509)$$
$$= \$960.98$$

The present value of the par or maturity value of $1,000 *40 six-month periods from now* discounted at 3.5% is $252.57, as shown below:

$$M = \$1,000$$
$$n = 40$$
$$= 0.035$$

$$\$1,000\left[\frac{1}{(1.035)^{40}}\right]$$

$$= \$1,000\left(\frac{1}{3.95926}\right)$$

$$= \$1,000(0.252572)$$
$$= \$252.57$$

The price of the bond is then equal to the sum of the two present values:

Present value of coupon payments	$960.98
Present value of par (maturity) value	252.57
Price	$1,213.55

EXHIBIT 5–1

Price/Yield Relationship for a 20-Year, 9% Coupon Bond

Required Yield	Price of Bond
5%	$1,502.05
6	1,346.72
7	1,213.55
8	1,098.96
9	1,000.00
10	914.21
11	839.54
12	774.30
13	717.09
14	666.71

Relationship between Required Yield and Price at a Given Time

The price of an option-free bond changes in the direction opposite to the change in the required yield. The reason is that the price of the bond is the present value of the cash flows. As the required yield increases, the present value of the cash flows decreases; hence the price decreases. The opposite is true when the required yield decreases: The present value of the cash flows increases, and therefore, the price of the bond increases.

We can see this by comparing the price of the 20-year, 9% coupon bond that we priced in Illustrations 1 and 2. When the required yield is 12%, the price of the bond is $774.30. If, instead, the required yield is 7%, the price of the bond is $1,213.55. Exhibit 5–1 shows the price of the 20-year, 9% coupon bond for required yields from 5% to 14%.

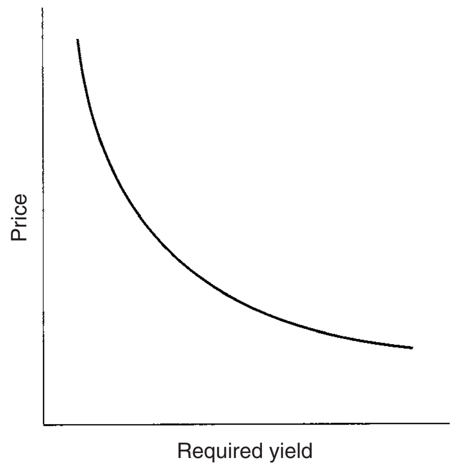
If we graphed the price/yield relationship for any option-free bond, we would find that it has the "bowed" shape shown in Exhibit 5–2. This shape is referred to as *convex*. The convexity of the price/yield relationship has important implications for the investment properties of a bond. We've devoted Chapter 9 to examining this relationship more closely.

The Relationship among Coupon Rate, Required Yield, and Price

For a bond issue at a given point in time, the coupon rate and the term-to-maturity are fixed. Consequently, as yields in the marketplace change, the only variable that an investor can change to compensate for the new yield required in the market is

EXHIBIT 5–2

Price/Yield Relationship



the price of the bond. As we saw in the preceding section, as the required yield increases (decreases), the price of the bond decreases (increases).

Generally, when a bond is issued, the coupon rate is set at approximately the prevailing yield in the market.[4] The price of the bond then will be approximately equal to its par value. For example, in Exhibit 5–1, we see that when the required yield is equal to the coupon rate, the price of the bond is its par value. Consequently, we have the following properties:

When the coupon rate equals the required yield, the price equals the par value.

When the price equals the par value, the coupon rate equals the required yield.

When yields in the marketplace rise above the coupon rate *at a given time,* the price of the bond has to adjust so that the investor can realize some additional interest. This adjustment is accomplished by having the bond's price fall below the par value. The difference between the par value and the price is a capital gain and represents a form of interest to the investor to compensate for the coupon rate being lower than the required yield. When a bond sells below its par value, it is said to be selling at a *discount* We can see this in Exhibit 5–1. When the required yield is greater than the coupon rate of 9%, the price of the bond is always less than the par value. Consequently, we have the following properties:

When the coupon rate is less than the required yield, the price is less than the par value.

When the price is less than the par value, the coupon rate is less than the required yield.

4. The exception is an original-issue discount bond such as a zero-coupon bond.

Finally, when the required yield in the market is below the coupon rate, the price of the bond must be above its par value. This occurs because investors who could purchase the bond at par would be getting a coupon rate in excess of what the market requires. As a result, investors would bid up the price of the bond because its yield is attractive. It will be bid up to a price that offers the required yield in the market. A bond whose price is above its par value is said to be selling at a *premium*. Exhibit 5–1 shows that for a required yield less than the coupon rate of 9%, the price of the bond is greater than its par value. Consequently, we have the following properties:

> *When the coupon rate is greater than the required yield, the price is greater than the par value.*
>
> *When the price is greater than the par value, the coupon rate is greater than the required yield.*

Time Path of a Bond

If the required yield is unchanged between the time the bond is purchased and the maturity date, what will happen to the price of the bond? For a bond selling at par value, the coupon rate is equal to the required yield. As the bond moves closer to maturity, the bond will continue to sell at par value. Thus, for a bond selling at par, its price will remain at par as the bond moves toward the maturity date.

The price of a bond will *not* remain constant for a bond selling at a premium or a discount. For all discount bonds, the following is true: As the bond moves toward maturity, its price will increase if *the required yield* does not change. This can be seen in Exhibit 5–3, which shows the price of the 20-year, 9% coupon bond as it moves toward maturity, assuming that the required yield remains at 12%. For a bond selling at a premium, the price of the bond declines as it moves toward maturity. This can also be seen in Exhibit 5–3, which shows the time path of the 20-year, 9% coupon bond selling to yield 7%.

Reasons for the Change in the Price of a Bond

The price of a bond will change because of one or more of the following reasons:

- *A change in the level of interest rates in the economy.* For example, if interest rates in the economy increase (fall) because of Fed policy, the price of a bond will decrease (increase).
- *A change in the price of the bond selling at a price other than par as it moves toward maturity without any change in the required yield.* As we demonstrated, over time a discount bond's price increases if yields do not change; a premium bond's price declines over time if yields do not change.

EXHIBIT 5–3

Time Paths of 20-Year, 9% Coupon Discount and Premium Bonds

Years Remaining to Maturity	Price of Discount Bond*	Price of Premium Bond†
20	$774.30	$1,213.55
18	780.68	1,202.90
16	788.74	1,190.89
14	798.91	1,176.67
12	811.75	1,160.59
10	827.95	1,142.13
8	848.42	1,120.95
6	874.24	1,096.63
4	906.85	1,068.74
2	948.02	1,036.73
1	972.50	1,019.00
0	1,000.00	1,000.00

*Selling to yield 12%.
†Selling to yield 7%.

- *For non-Treasury bonds, a change in the required yield due to changes in the spread to Treasuries.* If the Treasury rate does not change but the spread to Treasuries changes (narrows or widens), non-Treasury bond prices will change.
- *A change in the perceived credit quality of the issuer.* Assuming that interest rates in the economy and yield spreads between non-Treasuries and Treasuries do not change, the price of a non-Treasury bond will increase (decrease) if its perceived credit quality has improved (deteriorated).
- *For bonds with embedded options (e.g., callable bonds, putable bonds, and convertible bonds), the price of the bond will change as the factors that affect the value of the embedded options change.*

Pricing a Zero-Coupon Bond

So far we have determined the price of coupon-bearing bonds. Some bonds do not make any periodic coupon payments. Instead, the investor realizes interest by the difference between the maturity value and the purchase price.

The pricing of a zero-coupon bond is no different from the pricing of a coupon bond: Its price is the present value of the expected cash flows. In the case of a zero-coupon bond, the only cash flow is the maturity value. Therefore, the price of a zero-coupon bond is simply the present value of the maturity value. The number of periods used to discount the maturity value is double the number of years to maturity. This treatment is consistent with the manner in which the maturity value of a coupon bond is handled.

Illustration 3. The price of a zero-coupon bond that matures in 10 years and has a maturity value of $1,000 if the required yield is 8.6% is equal to the present value of $1,000 20 periods from now discounted at 4.3%. That is,

$$\$1{,}000\left[\frac{1}{(1.043)^{20}}\right] = \$430.83$$

Determining the Price When the Settlement Date Falls between Coupon Periods

In our illustrations we assumed that the next coupon payment is six months away. This means that settlement occurs on the day after a coupon date. Typically, an investor will purchase a bond between coupon dates so that the next coupon payment is less than six months away. To compute the price, we have to answer the following three questions:

- How many days are there until the next coupon payment?
- How should we determine the present value of cash flows received over fractional periods?
- How much must the buyer compensate the seller for the coupon interest earned by the seller for the fraction of the period that the bond was held?

The first question is the day-count question. The second is the compounding question. The last question asks how accrued interest is determined. Below we address these questions.

Day Count

Market conventions for each type of bond dictate the answer to the first question: The number of days until the next coupon payment.

For Treasury coupon securities, a nonleap year is assumed to have 365 days. The number of days between settlement and the next coupon payment is therefore the actual number of days between the two dates. The day count convention for a coupon-bearing Treasury security is said to be "actual/actual," which means the actual number of days in a month and the actual number of days in the coupon period. For example, consider a Treasury bond whose last coupon payment was on March 1; the next coupon would be six months later on September 1. Suppose that this bond is purchased with a settlement date of July 17. The actual number of days between July 17 (the settlement date) and September 1 (the date of the next coupon payment) is 46 days (the actual number of days in the coupon period is 184), as shown below:

July 17 to July 31	14 days
August	31 days
September 1	1 day
	46 days

In contrast to the actual/actual day count convention for coupon-bearing Treasury securities, for corporate and municipal bonds and agency securities, the day count convention is "30/360." That is, each month is assumed to have 30 days and each year 360 days. For example, suppose that the security in our previous example is not a coupon-bearing Treasury security but instead either a coupon-bearing corporate bond, municipal bond, or agency security. The number of days between July 17 and September 1 is shown below:

Remainder of July	13 days
August	30 days
September 1	1 day
	44 days

Compounding

Once the number of days between the settlement date and the next coupon date is determined, the present value formula must be modified because the cash flows will not be received six months (one full period) from now. The Street convention is to compute the price is as follows:

1. Determine the number of days in the coupon period.
2. Compute the following ratio:

$$w = \frac{\text{number of days between settlement and next coupon payment}}{\text{number of days in the coupon period}}$$

   For a corporate bond, a municipal bond, and an agency security, the number of days in the coupon period will be 180 because a year is assumed to have 360 days. For a coupon-bearing Treasury security, the number of days is the actual number of days. The number of days in the coupon period is called the *basis*.
3. For a bond with n coupon payments remaining to maturity, the price is

$$p = \frac{c}{(1+i)^{w}} + \frac{c}{(1+i)^{1+w}} + \frac{c}{(1+i)^{2+w}} + \cdots + \frac{c}{(1+i)^{n-1+w}} + \frac{M}{(1+i)^{n-1+w}}$$

where

p = price ($)
c = semiannual coupon payment ($)
M = maturity value
n = number of coupon payments remaining
i = periodic interest rate (required yield divided by 2) (in decimal)

The period (exponent) in the formula for determining the present value can be expressed generally as $t - 1 + w$. For example, for the first cash flow, the period is $1 - 1 + w$, or simply w. For the second cash flow, it is $2 - 1 + w$, or simply $1 + w$. If the bond has 20 coupon payments remaining, the last period is $20 - 1 + w$, or simply $19 + w$.

Illustration 4. Suppose that a corporate bond with a coupon rate of 10% maturing March 1, 2012 is purchased with a settlement date of July 17, 2006. What would the price of this bond be if it is priced to yield 6.5%?

The next coupon payment will be made on September 1, 2006. Because the bond is a corporate bond, based on a 30/360 day-count convention, there are 44 days between the settlement date and the next coupon date. The number of days in the coupon period is 180. Therefore,

$$w = \frac{44}{180} = 0.24444$$

The number of coupon payments remaining, n, is 12. The semiannual interest rate is 3.25% (6.5%/2).

The calculation based on the formula for the price is given in Exhibit 5–4. The price of this corporate bond would be $120.0281 per $100 par value. The price calculated in this way is called the *full price* or *dirty price* because it reflects the portion of the coupon interest that the buyer will receive but that the seller has earned.

Accrued Interest and the Clean Price

The buyer must compensate the seller for the portion of the next coupon interest payment the seller has earned but will not receive from the issuer because the issuer will send the next coupon payment to the buyer. This amount is called *accrued interest* and depends on the number of days from the last coupon payment to the settlement date.[5] The accrued interest is computed as follows:

$$\text{AI} = c\left(\frac{\text{number of days from last coupon payment to settlement date}}{\text{number of days in coupon period}}\right)$$

5. Accrued interest is not computed for all bonds. No accrued interest is computed for bonds in default or income bonds. A bond that trades without accrued interest is said to be traded "flat."

EXHIBIT 5–4

Price Calculation When a Bond Is Purchased between Coupon Payments

Period	Cash Flow per $100 of Par	Present Value of $1 at 3.25%	Present Value of Cash Flow
0.24444	$ 5.000	$0.992212	$4.961060
1.24444	5.000	0.960980	4.804902
2.24444	5.000	0.930731	4.653658
3.24444	5.000	0.901435	4.507175
4.24444	5.000	0.873060	4.365303
5.24444	5.000	0.845579	4.227896
6.24444	5.000	0.818963	4.094815
7.24444	5.000	0.793184	3.965922
8.24444	5.000	0.768217	3.841087
9.24444	5.000	0.744036	3.720181
10.24444	5.000	0.720616	3.603081
11.24444	105.000	0.697933	73.283000
		Total	$120.028100

where

AI = accrued interest ($)
c = semiannual coupon payment ($)

Illustration 5. Let's continue with the hypothetical corporate bond in Illustration 4. Because the number of days between settlement (July 17, 2006) and the next coupon payment (September 1, 2006) is 44 days and the number of days in the coupon period is 180, the number of days from the last coupon payment date (March 1, 2006) to the settlement date is 136 (180 – 44). The accrued interest per $100 of par value is

$$\text{AI} = \$5\left(\frac{136}{180}\right) = \$3.777778$$

The full or dirty price includes the accrued interest that the seller is entitled to receive. For example, in the calculation of the full price in Exhibit 5–4, the next coupon payment of $5 is included as part of the cash flow. The *clean price* or *flat price* is the full price of the bond minus the accrued interest.

The price that the buyer pays the seller is the full price. It is important to note that in calculation of the full price, the next coupon payment is a discounted value, but in calculation of accrued interest, it is an undiscounted value. Because of this market practice, if a bond is selling at par and the settlement date is not a coupon date, the yield will be slightly less than the coupon rate. Only when the settlement date and coupon date coincide is the yield equal to the coupon rate for a bond selling at par.

In the U.S. market, the convention is to quote a bond's clean or flat price. The buyer, however, pays the seller the full price. In some non-U.S. markets, the full price is quoted.

CONVENTIONAL YIELD MEASURES

In the preceding section we explained how to compute the price of a bond given the required yield. In this section we'll show how various yield measures for a bond are calculated given its price. First let's look at the sources of potential return from holding a bond.

An investor who purchases a bond can expect to receive a *dollar* return from one or more of the following sources:

- The coupon interest payments made by the issuer
- Any capital gain (or capital loss—negative dollar return) when the bond matures, is called, or is sold
- Income from reinvestment of the coupon interest payments

This last source of dollar return is referred to as *interest-on-interest.*

Three yield measures are commonly cited by market participants to measure the potential return from investing in a bond—current yield, yield-to-maturity, and yield-to-call. These yield measures are expressed as a *percent* return rather than as a dollar return. However, any yield measure should consider each of the three potential sources of return just cited. Below we discuss these three yield measures and assess whether they consider the three sources of potential return.

Current Yield

The current yield relates the *annual* coupon interest to the market price. The formula for the current yield is

$$\text{Current yield} = \frac{\text{annual dollar coupon interest}}{\text{price}}$$

Illustration 6. The current yield for an 18-year, 6% coupon bond selling for \$700.89 per \$1,000 par value is 8.56%, as shown below:

$$\begin{aligned}\text{Annual dollar coupon interest} &= \$1{,}000 \times 0.06\\ &= \$60\end{aligned}$$

$$\text{Current yield} = \frac{\$60}{\$700.89} = 0.0856, \text{ or } 8.56\%$$

The current yield considers only the coupon interest and no other source of return that will affect an investor's return. For example, in Illustration 6, no consideration is given to the capital gain that the investor will realize when the bond matures. No recognition is given to a capital loss that the investor will realize when a bond selling at a premium matures. In addition, interest-on-interest from reinvesting coupon payments is ignored.

Yield-to-Maturity

The yield or internal rate of return on any investment is the interest rate that will make the present value of the cash flows equal to the price (or initial investment). The yield-to-maturity is computed in the same way as the yield; the cash flows are those which the investor would realize by holding the bond to maturity. For a semiannual-pay bond, doubling the interest rate or discount rate gives the yield-to-maturity.

The calculation of a yield involves a trial-and-error procedure.[6] Practitioners usually use calculators or software to obtain a bond's yield-to-maturity. The following illustration shows how to compute the yield-to-maturity for a bond.

Illustration 7. In Illustration 6 we computed the current yield for an 18-year, 6% coupon bond selling for $700.89. The maturity value for this bond is $1,000. The yield-to-maturity for this bond is 9.5%, as shown in Exhibit 5–5. Cash flows for the bond are

- 36 coupon payments of $30 every six months
- $1,000 36 six-month periods from now

Different interest rates must be tried until one is found that makes the present value of the cash flows equal to the price of $700.89. Because the coupon rate on the bond is 6% and the bond is selling at a discount, the yield must be greater than 6%. Exhibit 5–5 shows the present value of the cash flows of the bond for semiannual interest rates from 3.25% to 4.75% (corresponding to annual interest rates from 6.5% to 9.50%). As can be seen, when a 4.75% interest rate is used, the present value of the cash flows is $700.89. Therefore, the yield-to-maturity is 9.50% (4.75% × 2).

The yield-to-maturity considers the coupon income and any capital gain or loss that the investor will realize by *holding the bond to maturity.* The yield-to- maturity also considers the timing of the cash flows. It does consider interest-on-interest; *however, it assumes that the coupon payments can be reinvested at an interest rate equal to the yield-to-maturity.* Thus, if the yield-to-maturity for a bond is 9.5%, to earn that yield, the coupon payments must be reinvested at an interest rate equal to 9.5%. The following example clearly demonstrates this.

6. See the Appendix to this book.

EXHIBIT 5–5

Computation of Yield-to-Maturity for an 18-Year, 6% Coupon Bond Selling at $700.89

Objective: Find, by trial and error, the semiannual interest rate that will make the present value of the following cash flows equal to $700.89:

36 coupon payments of $30 every six months
$1,000 36 six-month periods from now

Annual Interest Rate	Semi-annual Rate	Present Value of 36 Payments of $30*	Present Value of $1,000 10 Periods from Now†	Present Value of Cash Flows
6.50%	3.25%	$631.20	$316.20	$947.40
7.00	3.50	608.71	289.83	898.54
7.50	3.75	587.42	265.72	853.14
8.00	4.00	567.25	243.67	810.92
8.50	4.25	548.12	223.49	771.61
9.00	4.50	529.98	205.03	735.01
9.50	4.75	512.76	188.13	700.89

$$*30\left\{\frac{1-\left[\frac{1}{(1+\text{ semiannual interest rate})^{36}}\right]}{\text{semiannual interest rate}}\right\}$$

$$^{\dagger}\$1{,}000\left[\frac{1}{(1+\text{ semiannual interest rate})^{36}}\right]$$

Suppose that an investor has $700.89 and places the funds in a certificate of deposit (CD) that pays 4.75% every six months for 18 years, or 9.5% per year. At the end of 18 years, the $700.89 investment will grow to $3,726. Instead, suppose that the investor buys a 6%, 18-year bond selling for $700.89. This is the same as the price of our bond in Illustration 7. The yield-to-maturity for this bond is 9.5%. The investor would expect that at the end of 18 years, the total dollars from the investment will be $3,726.

Let's look at what he will receive. There will be 36 semiannual interest payments of $30, which will total $1,080. When the bond matures, the investor will receive $1,000. Thus the total dollars that he will receive is $2,080 if he holds the bond to maturity, but this is $1,646 less than the $3,726 necessary to produce a yield of 9.5% (4.75% semiannually). How is this deficiency supposed to be made up? If the investor reinvests the coupon payments at a semiannual interest rate of 4.75% (or a 9.5% annual rate), it is a simple exercise to demonstrate that the interest earned on the coupon payments will be $1,646. Consequently, of the $3,025 total dollar return ($3,726 − $700.89) necessary to produce a yield of 9.5%, about 54% ($1,646 divided by $3,025) must be generated by reinvesting the coupon payments.

Clearly, the investor will realize the yield-to-maturity stated at the time of purchase only if (1) the coupon payments can be reinvested at the yield-to-maturity and (2) if the bond is held to maturity. With respect to the first assumption, the risk that an investor faces is that future reinvestment rates will be less than the yield-to-maturity at the time the bond is purchased. This risk is referred to as *reinvestment risk*. If the bond is not held to maturity, the price at which the bond may have to be sold is less than its purchase price, resulting in a return that is less than the yield-to-maturity. The risk that a bond will have to be sold at a loss because interest rates rise is referred to as *interest rate risk*.

Reinvestment Risk

There are two characteristics of a bond that determine the degree of reinvestment risk. First, for a given yield-to-maturity and a given coupon rate, the longer the maturity, the more the bond's total dollar return is dependent on the interest-on-interest to realize the yield-to-maturity at the time of purchase. That is, the greater the reinvestment risk. The implication is that the yield-to-maturity measure for long-term coupon bonds tells little about the potential yield that an investor may realize if the bond is held to maturity. In high-interest-rate environments, the interest-on-interest component for long-term bonds may be as high as 80% of the bond's potential total dollar return.

The second characteristic that determines the degree of reinvestment risk is the coupon rate. For a given maturity and a given yield-to-maturity, the higher the coupon rate, the more dependent the bond's total dollar return will be on the reinvestment of the coupon payments in order to produce the yield-to-maturity at the time of purchase. This means that holding maturity and yield-to-maturity constant, premium bonds will be more dependent on interest-on-interest than bonds selling at par. For zero-coupon bonds, none of the bond's total dollar return is dependent on interest-on-interest; a zero-coupon bond carries no reinvestment risk if held to maturity.

Interest-Rate Risk

As we explained in the preceding section, a bond's price moves in the direction opposite to the change in interest rates. As interest rates rise (fall), the price of a bond will fall (rise). For an investor who plans to hold a bond to maturity, the change in the bond's price before maturity is of no concern; however, for an investor who may have to sell the bond prior to the maturity date, an increase in interest rates after the bond is purchased will mean the realization of a capital loss. Not all bonds have the same degree of interest-rate risk. In Chapter 9, the characteristics of a bond that determine its interest-rate risk will be discussed.

Given the assumptions underlying yield-to-maturity, we can now demonstrate that yield-to-maturity has limited value in assessing the potential return of bonds. Suppose that an investor who has a five-year investment horizon is considering the following four option-free bonds:

Bond	Coupon Rate	Maturity	Yield-to-Maturity
W	5%	3 years	9.0%
X	6	20	8.6
Y	11	15	9.2
Z	8	5	8.0

Assuming that all four bonds are of the same credit quality, which one is the most attractive to this investor? An investor who selects bond Y because it offers the highest yield-to-maturity is failing to recognize that the bond must be sold after five years, and the selling price of the bond will depend on the yield required in the market for 10-year, 11% coupon bonds at that time. Hence there could be a capital gain or capital loss that will make the return higher or lower than the yield-to-maturity promised now. Moreover, the higher coupon rate on bond Y relative to the other three bonds means that more of this bond's return will be dependent on the reinvestment of coupon interest payments.

Bond W offers the second highest yield-to-maturity. On the surface, it seems to be particularly attractive because it eliminates the problem faced by purchasing bond Y of realizing a possible capital loss when the bond must be sold before the maturity date. In addition, the reinvestment risk seems to be less than for the other three bonds because the coupon rate is the lowest. However, the investor would not be eliminating the reinvestment risk because after three years she must reinvest the proceeds received at maturity for two more years. The return that the investor will realize will depend on interest rates three years from now, when the investor must roll over the proceeds received from the maturing bond.

Which is the best bond? The yield-to-maturity doesn't seem to help us identify the best bond. The answer depends on the expectations of the investor. Specifically, it depends on the interest rate at which the coupon interest payments can be reinvested until the end of the investor's investment horizon. Also, for bonds with a maturity longer than the investment horizon, it depends on the investor's expectations about interest rates at the end of the investment horizon. Consequently, any of these bonds can be the best investment vehicle based on some reinvestment rate and some future interest rate at the end of the investment horizon. In the next section we present an alternative return measure for assessing the potential performance of a bond.

Yield-to-Maturity for a Zero-Coupon Bond

When there is only one cash flow, it is much easier to compute the yield on an investment. A zero-coupon bond is characterized by a single cash flow resulting from an investment. Consequently, the following formula can be applied to compute the yield-to-maturity for a zero-coupon bond:

$$y = (\text{future value per dollar invested})^{1/n} - 1$$

where

$$y = \text{one-half the yield-to-maturity}$$

$$\text{Future value per dollar invested} = \frac{\text{maturity value}}{\text{price}}$$

Once again, doubling y gives the yield-to-maturity. *Remember that the number of periods used in the formula is double the number of years.*

Illustration 8. The yield-to-maturity for a zero-coupon bond selling for \$274.78 with a maturity value of \$1,000, maturing in 15 years, is 8.8%, as computed below:

$$n = 15 \times 2 = 30$$

$$\text{Future value per dollar invested} = \frac{\$1,000.00}{\$274.78} = 3.639275$$

$$\begin{aligned} y &= (3.639275)^{1/30} - 1 \\ &= (3.639275)^{0.033333} - 1 \\ &= 1.044 - 1 \\ &= 0.044, \text{ or } 4.4\% \end{aligned}$$

Doubling 4.4% gives the yield-to-maturity of 8.8%.

Relationship among Coupon Rate, Current Yield, and Yield-to-Maturity

The following relationship should be recognized between the coupon rate, current yield, and yield-to-maturity:

Bond Selling at	Relationship
Par	Coupon rate = current yield = yield-to-maturity
Discount	Coupon rate < current yield < yield-to-maturity
Premium	Coupon rate > current yield > yield-to-maturity

Problem with the Annualizing Procedure

Multiplying a semiannual interest rate by 2 will give an underestimate of the effective annual yield. The proper way to annualize the semiannual yield is by applying the following formula:

$$\text{Effective annual yield} = (1 + \text{periodic interest rate})^k - 1$$

where

$$k = \text{number of payments per year}$$

For a semiannual-pay bond, the formula can be modified as follows:

$$\text{Effective annual yield} = (1 + \text{semiannual interest rate})^2 - 1$$

or

$$\text{Effective annual yield} = (1 + y)^2 - 1$$

For example, in Illustration 7, the semiannual interest rate is 4.75%, and the effective annual yield is 9.73%, as shown below:

$$\begin{aligned}\text{Effective annual yield} &= (1.0475)^2 - 1 \\ &= 1.0973 - 1 \\ &= 0.0973, \text{ or } 9.73\%\end{aligned}$$

Although the proper way for annualizing a semiannual interest rate is given in the preceding formula, the convention adopted in the bond market is to double the semiannual interest rate. The yield-to-maturity computed in this manner—doubling the semiannual yield—is called a *bond-equivalent yield.* In fact, this convention is carried over to yield calculations for other types of fixed income securities.

Yield-to-Call

For a callable bond, investors also compute another yield (or internal rate of return) measure, the *yield-to-call*. The cash flows for computing the yield-to-call are those which would result if the issue were called on some assumed call date. Two commonly used call dates are the *first call date* and the *first par call date*. The yield-to-call is the interest rate that will make the present value of the cash flows if the bond is held to the assumed call date equal to the price of the bond (i.e., the full price).

Illustration 9. In Illustrations 6 and 7, we computed the current yield and yield-to-maturity for an 18-year, 6% coupon bond selling for $700.89. Suppose that this bond is first callable in five years at $1,030. The cash flows for this bond if it is called in five years are

- 10 coupon payments of $30 every six months
- $1,030 in 10 six-month periods from now

The interest rate we seek is one that will make the present value of the cash flows equal to $700.89. From Exhibit 5–6, it can be seen that when the interest rate is 7.6%, the present value of the cash flows is $700.11, which is close enough

EXHIBIT 5–6

Computation of Yield-to-Call for an 18-Year, 6% Coupon Bond Callable in 5 Years at $1,030, Selling at $700.89

Objective: Find, by trial and error, the semiannual interest rate that will make the present value of the following cash flows equal to $700.89:

10 coupon payments of $30 every six months
$1,030 10 six-month periods from now

Annual Interest Rate	Semi-annual Rate	Present Value of 10 Payments of $30*	Present Value of $1,030 10 Periods from Now†	Present Value of Cash Flows
11.20%	5.60%	$225.05	$597.31	$822.36
11.70	5.85	222.38	585.35	805.73
12.20	6.10	219.76	569.75	789.51
12.70	6.35	217.19	556.50	773.69
13.20	6.60	214.66	543.58	758.24
13.70	6.85	212.18	531.00	743.18
14.20	7.10	209.74	518.73	728.47
14.70	7.35	207.34	506.78	714.12
15.20	7.60	204.99	495.12	700.11

$$^{*}\$30\left\{\frac{1-\left[\dfrac{1}{(1+\text{semiannual interest rate})^{10}}\right]}{\text{semiannual interest rate}}\right\}$$

$$^{\dagger}\$1{,}030\left[\frac{1}{(1+\text{semiannual interest rate})^{10}}\right]$$

to $700.89 for our purposes. Therefore, the yield-to-call on a bond-equivalent basis is 15.2% (double the periodic interest rate of 7.6%).

According to the conventional approach, conservative investors will compute the yield-to-call and yield-to-maturity for a callable bond selling at a premium, selecting the lower of the two as a measure of potential return. It is the smaller of the two yield measures that investors would use to evaluate the yield for a bond. Some investors calculate not just the yield to the first call date and yield to first par call date but the yield to all possible call dates. Because most bonds can be called at any time after the first call date, the approach has been to compute the yield to every coupon anniversary date following the first call date. Then all calculated yields-to-call and the yield-to-maturity are compared. The lowest of these yields is called the *yield-to-worst*. The conventional approach would have us believe that this yield is the appropriate one a conservative investor should use.

Let's take a closer look at the yield-to-call as a measure of the potential return of a callable bond. The yield-to-call does consider all three sources of potential return from owning a bond. However, as in the case of the yield-to-maturity, it assumes that all cash flows can be reinvested at the computed yield—in this case, the yield-to-call—until the assumed call date. As we noted earlier in this chapter, this assumption may be inappropriate. Moreover, the yield-to-call assumes that (1) the investor will hold the bond to the assumed call date and (2) the issuer will call the bond on that date.

The assumptions underlying the yield-to-call are often unrealistic. They do not take into account how an investor will reinvest the proceeds if the issue is called. For example, consider two bonds, M and N. Suppose that the yield-to-maturity for bond M, a five-year noncallable bond, is 10%, whereas for bond N the yield-to-call, assuming that the bond will be called in three years, is 10.5%. Which bond is better for an investor with a five-year investment horizon? It's not possible to tell from the yields cited. If the investor intends to hold the bond for five years and the issuer calls the bond after three years, the total dollars that will be available at the end of five years will depend on the interest rate that can be earned from reinvesting funds from the call date to the end of the investment horizon.

More will be said about the analysis of callable bonds in Chapter 37.

Yield (Internal Rate of Return) for a Portfolio

The yield for a portfolio of bonds is not simply the average or weighted average of the yield-to-maturity of the individual bond issues. It is computed by determining the cash flows for the portfolio and then finding the interest rate that will make the present value of the cash flows equal to the market value of the portfolio.[7] As with any yield measure, it suffers from the same assumptions.

Illustration 10. Consider the following three-bond portfolio:[8]

Bond	Coupon Rate	Maturity	Par Value	Price Value	Yield-to-Maturity
A	7.0%	5 years	$ 10,000,000	$ 9,209,000	9.0%
B	10.5	7	20,000,000	20,000,000	10.5
C	6.0	3	30,000,000	28,050,000	8.5

The portfolio's total market value is $57,259,000. The cash flow for each bond in the portfolio and for the whole portfolio is as follows:

7. Chapter 9 discusses the concept of duration. A good approximation to the yield for a portfolio can be obtained by using duration to weight the yield-to-maturity of the individual bonds in the portfolio.
8. To simplify the illustration, it is assumed that the coupon payment date is the same for each bond.

Period Cash Flow Received	Bond A	Bond B	Bond C	Portfolio
1	$ 350,000	$ 1,050,000	$ 900,000	$ 2,300,000
2	350,000	1,050,000	900,000	2,300,000
3	350,000	1,050,000	900,000	2,300,000
4	350,000	1,050,000	900,000	2,300,000
5	350,000	1,050,000	900,000	2,300,000
6	350,000	1,050,000	30,900,000	32,300,000
7	350,000	1,050,000	—	1,400,000
8	350,000	1,050,000	—	1,400,000
9	350,000	1,050,000	—	1,400,000
10	10,350,000	1,050,000	—	11,400,000
11	—	1,050,000	—	1,050,000
12	—	1,050,000	—	1,050,000
13	—	1,050,000	—	1,050,000
14	—	21,050,000	—	21,050,000

To determine the yield (internal rate of return) for this three-bond portfolio, the interest rate that makes the present value of the cash flows shown in the last column of the table above equal to $57,259,000 (the total market value of the portfolio) must be found. If an interest rate of 4.77% is used, the present value of the cash flows will equal $57,259,000. Doubling 4.77% gives 9.54%, which is the yield on the portfolio on a bond-equivalent basis.

Yield Measure for Floating-Rate Securities

The coupon rate for a floating-rate security changes periodically based on some reference rate (such as LIBOR).[9] Because the value for the reference rate in the future is not known, it is not possible to determine the cash flows. This means that a yield-to-maturity cannot be calculated.

A conventional measure used to estimate the potential return for a floating-rate security is the security's *discount margin.* This measure estimates the average spread or margin over the reference rate that the investor can expect to earn over the life of the security. The procedure for calculating the discount margin is as follows:

1. Determine the cash flows assuming that the reference rate does not change over the life of the security.
2. Select a margin (spread).

9. Other spread measures are explained in Chapter 16.

3. Discount the cash flows found in step 1 by the current value of the reference rate plus the margin selected in step 2.
4. Compare the present value of the cash flows as calculated in step 3 to the price. If the present value is equal to the security's price, the discount margin is the margin assumed in step 2. If the present value is not equal to the security's price, go back to step 2 and try a different margin.

For a security selling at par, the discount margin is simply the spread over the reference rate.

Illustration 11. To illustrate the calculation, suppose that a six-year floating-rate security selling for 99.3098 pays a rate based on some reference rate index plus 80 basis points. The coupon rate is reset every six months. Assume that the current value for the reference rate is 10%. Exhibit 5–7 shows the calculation of

EXHIBIT 5–7

Calculation of the Discount Margin for a Floating-Rate Security

Floating-rate security: Maturity = 6 years
Coupon rate = reference rate + 80 basis points
Reset every six months

			Present Value of Cash Flow: Assumed Annual Yield Spread (in bp)				
Period	**Reference Rate**	**Cash Flow***	**80**	**84**	**88**	**96**	**100**
1	10%	5.4	5.1233	5.1224	5.1214	5.1195	5.1185
2	10	5.4	4.8609	4.8590	4.8572	4.8535	4.8516
3	10	5.4	4.6118	4.6092	4.6066	4.6013	4.5987
4	10	5.4	4.3755	4.3722	4.3689	4.3623	4.3590
5	10	5.4	4.1514	4.1474	4.1435	4.1356	4.1317
6	10	5.4	3.9387	3.9342	3.9297	3.9208	3.9163
7	10	5.4	3.7369	3.7319	3.7270	3.7171	3.7122
8	10	5.4	3.5454	3.5401	3.5347	3.5240	3.5186
9	10	5.4	3.3638	3.3580	3.3523	3.3409	3.3352
10	10	5.4	3.1914	3.1854	3.1794	3.1673	3.1613
11	10	5.4	3.0279	3.0216	3.0153	3.0028	2.9965
12	10	105.4	56.0729	55.9454	55.8182	55.5647	55.4385
Present value			100.0000	99.8269	99.6541	99.3098	99.138

*For periods 1–11: cash flow = 100 (reference rate + assumed margin) (0.5); for period 12: cash flow = 100 (reference rate + assumed margin) (0.5) + 100.

the discount margin for this security. The second column shows the current discounted value for the reference rate (10%). The third column sets forth the cash flows for the security. The cash flow for the first 11 periods is equal to one-half the current value for the reference rate (5%) plus the semiannual spread of 40 basis points multiplied by 100. In the twelfth six-month period, the cash flow is 5.4 plus the maturity value of 100. The top row of the last five columns shows the assumed margin. The rows below the assumed margin show the present value of each cash flow. The last row gives the total present value of the cash flows. For the five assumed yield spreads, the present value is equal to the price of the floating-rate security (99.3098) when the assumed margin is 96 basis points. Therefore, the discount margin on a semiannual basis is 48 basis points and 96 basis points on an annual basis. (Notice that the discount margin is 80 basis points, the same as the spread over the reference rate, when the security is selling at par.)

There are two drawbacks of the discount margin as a measure of the potential return from investing in a floating-rate security. First, this measure assumes that the reference rate will not change over the life of the security. Second, if the floating-rate security has a cap or floor, this is not taken into consideration. Techniques described in Chapter 37 can allow interest rate volatility to be considered and can handle caps or floors.

TOTAL RETURN ANALYSIS

If conventional yield measures such as the yield-to-maturity and yield-to-call offer little insight into the potential return of a bond, what measure of return can be used? The proper measure is one that considers all three sources of potential dollar return over the investment horizon. This requires that an investor first project the total future dollars over an investment horizon. The return is then the interest rate that will make the bond's price (full price) grow to the projected total future dollars at the end of the investment horizon. The yield computed in this way is known as the *total return,* also referred to as the *horizon return.* In this section we explain this measure and demonstrate how it can be applied in assessing the potential return from investing in a bond.

Calculating the Total Return

The total return requires that the investor specify

- An investment horizon
- A reinvestment rate
- A selling price for the bond at the end of the investment horizon (which depends on the assumed yield at which the bond will sell at the end of the investment horizon)

More formally, the steps for computing a total return over some investment horizon are as follows.

Step 1: Compute the total coupon payments plus the interest-on-interest based on an assumed reinvestment rate. The reinvestment rate is one-half the annual interest rate that the investor believes can be earned on the reinvestment of coupon interest payments.

The total coupon payments plus interest-on-interest can be calculated using the formula for the future value of an annuity (see the Appendix to this book) as shown:

$$\text{Coupon plus interest-on-interest} = \text{semiannual coupon}\left\{\frac{[(1+r)^h - 1)]}{r}\right\}$$

where

h = length of the investment horizon (in semiannual periods)
r = assumed semiannual reinvestment rate

Step 2: Determine the projected sale price at the end of the investment horizon. The projected sale price will depend on the projected yield on comparable bonds at the end of the investment horizon.

Step 3: Add the values computed in steps 1 and 2. The sum is the *total future dollars* that will be received from the investment given the assumed reinvestment rate and projected required yield at the end of the investment horizon.

Step 4: To obtain the semiannual total return, use the following formula[10]:

$$\left(\frac{\text{total future dollars}}{\text{purchase price of bond}}\right)^{1/h} - 1$$

Step 5: Because coupon interest is assumed to be paid semiannually, double the interest rate found in step 4. The resulting interest rate is the total return expressed on a bond-equivalent basis. Alternatively, the total return can be expressed on an effective annual interest rate basis by using the following formula:

$$(1 + \text{semiannual total return})^2 - 1$$

10. This formula is the same formula as given in the Appendix to this book for calculating the yield on an investment when there is only one cash flow and, as expected, for calculating the yield on a zero-coupon bond given earlier in this chapter.

Illustration 12. Suppose that an investor with a three-year investment horizon is considering purchasing a 20-year, 8% coupon bond for $828.40. The yield-to-maturity for this bond is 10%. The investor expects that he can reinvest the coupon interest payments at an annual interest rate of 6% and that at the end of the investment horizon the 17-year bond will be selling to offer a yield-to-maturity of 7%. The total return for this bond is computed in Exhibit 5–8.

Objections to the total return analysis cited by some portfolio managers are that it requires them to make assumptions about reinvestment rates and future yields and forces a portfolio manager to think in terms of an investment horizon. Unfortunately, some portfolio managers find comfort in meaningless measures such as the yield-to-maturity because it is not necessary to incorporate any expectations. As explained below, the total return framework enables the portfolio manager to analyze the performance of a bond based on different interest-rate scenarios for reinvestment rates and future market yields. By investigating multiple scenarios, the portfolio manager can see how sensitive the bond's performance is to each scenario. There is no need to assume that the reinvestment rate will be constant for the entire investment horizon.

For portfolio managers who want to use the market's expectations of short-term reinvestment rates and the yield on the bond at the end of the investment horizon, implied forward rates can be calculated from the yield curve. Implied forward rates are explained in Chapters 7 and 8, and are calculated based on arbitrage arguments. A total return computed using implied forward rates is called an *arbitrage-free total return.*

Scenario Analysis

Because the total return depends on the reinvestment rate and the yield at the end of the investment horizon, portfolio managers assess performance over a wide range of scenarios for these two variables. This approach is referred to as *scenario analysis.*

Illustration 13. Suppose that a portfolio manager is considering the purchase of bond A, a 20-year, 9% noncallable bond selling at $109.896 per $100 of par value. The yield-to-maturity for this bond is 8%. Assume also that the portfolio manager's investment horizon is three years and that the portfolio manager believes that the reinvestment rate can vary from 3% to 6.5% and that the yield at the end of the investment horizon can vary from 5% to 12%.

The top panel of Exhibit 5–9 shows the total future dollars at the end of three years under various scenarios. The bottom panel shows the total return (based on the effective annualizing of the six-month total return). The portfolio manager knows that the maximum and minimum total return for the scenarios analyzed will be 16.72% and –1.05%, respectively, and the scenarios under which each will be realized. If the portfolio manager faces three-year liabilities guaranteeing, say, 6%,

EXHIBIT 5–8

Illustration of Total Return Calculation

Assumptions:

Bond = 8% 20-year bond selling for $828.40 (yield-to-maturity is 10%)

Annual reinvestment rate = 6%

Investment horizon = 3 years

Yield for 17-year bonds at end of investment horizon = 7%

Step 1: Compute the total coupon payments plus the interest-on-interest assuming an annual reinvestment rate of 6%, or 3% every six months. The coupon payments are $40 every six months for three years or six periods (the investment horizon). The total coupon interest plus interest-on-interest is

$$\text{Coupon plus interest-on-interest} = \$40\left[\frac{(1.03)^6 - 1}{0.03}\right] = \$258.74$$

Step 2: The projected sale price at the end of 3 years, assuming that the required yield-to-maturity for 17-year bonds is 7%, is found by determining the present value of 34 coupon payments of $40 plus the present value of the maturity value of $1,000, discounted at 3.5%. The price can be shown to be $1,098.51.

Step 3: Adding the amount in steps 1 and 2 gives total future dollars of $1,357.25.

Step 4: Compute the following:

$$= \left(\frac{\$1,357.25}{828.40}\right)^{1/6} - 1$$

$$= (1.63840)^{0.16667} - 1$$

$$1.0858 - 1$$

$$= 0.0858, \text{ or } 8.58\%$$

Step 5: Doubling 8.58% gives a total return of 17.16% on a bond-equivalent basis. On an effective annual interest-rate basis, the total return is

$$(1.0858)^2 - 1$$

$$= 1.1790 - 1$$

$$= 0.1790$$

$$= 17.90\%$$

the major consideration is scenarios that will produce a three-year total return of less than 6%. These scenarios can be determined from Exhibit 5–9.

Illustration 14. Suppose that the same portfolio manager owns bond B, a 14-year noncallable bond with a coupon rate of 7.25% and a current price of $94.553 per $100 par value. The yield-to-maturity is 7.9%. Exhibit 5–10 reports the total

EXHIBIT 5–9

Scenario Analysis for Bond A

Bond A:	9% coupon, 20-year noncallable bond
Price:	$109.896
Yield-to-maturity:	8.00%
Investment horizon:	3 years

	Yield at End of Horizon							
	5.00%	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**	**11.00%**	**12.00%**
	Horizon Price							
	145.448	**131.698**	**119.701**	**109.206**	**100.000**	**91.9035**	**84.763**	**78.4478**

Reinvestment Rate	***Total Future Dollars*** 5.00%	6.00%	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%
3.0%	173.481	159.731	147.734	137.239	128.033	119.937	112.796	106.481
3.5	173.657	159.907	147.910	137.415	128.209	120.113	112.972	106.657
4.0	173.834	160.084	148.087	137.592	128.387	120.290	113.150	106.834
4.5	174.013	160.263	148.266	137.771	128.565	120.469	113.328	107.013
5.0	174.192	160.443	148.445	137.950	128.745	120.648	113.508	107.193
5.5	174.373	160.623	148.626	138.131	128.926	120.829	113.689	107.374
6.0	174.555	160.806	148.809	138.313	129.108	121.011	113.871	107.556
6.5	174.739	160.989	148.992	138.497	129.291	121.195	114.054	107.739

Reinvestment Rate	***Total Return (Effective Rate)*** 5.00%	6.00%	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%
3.0%	16.44	13.28	10.37	7.69	5.22	2.96	0.87	–1.05
3.5	16.48	13.32	10.41	7.73	5.27	3.01	0.92	–0.99
4.0	16.52	13.36	10.45	7.78	5.32	3.06	0.98	–0.94
4.5	15.56	13.40	10.50	7.83	5.37	3.11	1.03	–0.88
5.0	16.60	13.44	10.54	7.87	5.42	3.16	1.08	–0.83
5.5	16.64	13.49	10.59	7.92	5.47	3.21	1.14	–0.77
6.0	16.68	13.53	10.63	7.97	5.52	3.26	1.19	–0.72
6.5	16.72	13.57	10.68	8.02	5.57	3.32	1.25	–0.66

future dollars and total return over a three-year investment horizon under the same scenarios as Exhibit 5–9. A portfolio manager considering swapping from bond B to bond A would compare the relative performance of the two bonds as reported in Exhibits 5–9 and 5–10. Exhibit 5–11 shows the difference between the performance of the two bonds in basis points. This comparative analysis assumes that the two bonds are of the same investment quality and ignores the

EXHIBIT 5–10

Scenario Analysis for Bond B

Bond B:	7.25% coupon, 14-year noncallable bond
Price:	$94.553
Yield-to-maturity:	7.90%
Investment horizon:	3 years

	Yield at End of Horizon							
	5.00%	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**	**11.00%**	**12.00%**
	Horizon Price							
	118.861	**109.961**	**101.896**	**94.5808**	**87.9386**	**81.9009**	**76.4066**	**71.4012**

Reinvestment Rate	*Total Future Dollars*							
	5.00%	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**	**11.00%**	**12.00%**
3.0%	141.443	132.543	124.478	117.163	110.521	104.483	98.989	93.983
3.5	141.585	132.685	124.620	117.448	110.663	104.625	99.131	94.125
4.0	141.728	132.828	124.763	117.448	110.806	104.768	99.273	94.268
4.5	141.872	132.971	124.907	117.592	110.949	104.912	99.417	94.412
5.0	142.017	133.116	125.051	117.736	111.094	105.056	99.562	94.557
5.5	142.162	133.262	125.197	117.882	111.240	105.202	99.708	94.703
6.0	142.309	133.409	125.344	118.029	111.387	105.349	99.855	94.849
6.5	142.457	133.556	125.492	118.176	111.534	105.497	100.002	94.997

Reinvestment Rate	*Total Return (Effective Rate)*							
	5.00%	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**	**11.00%**	**12.00%**
3.0%	14.37	11.92	9.60	7.41	5.34	3.38	1.54	–0.20
3.5	14.41	11.96	9.64	7.45	5.38	3.43	1.59	–0.15
4.0	14.44	12.00	9.68	7.50	5.43	3.48	1.64	–0.10
4.5	14.48	12.04	9.72	7.54	5.48	3.53	1.69	–0.05
5.0	14.52	12.08	9.77	7.58	5.52	3.57	1.74	0.00
5.5	14.56	12.12	9.81	7.63	5.57	3.62	1.79	0.05
6.0	14.60	12.16	9.85	7.67	5.61	3.67	1.84	0.10
6.5	14.64	12.20	9.90	7.72	5.66	3.72	1.89	0.16

financial accounting and tax consequences associated with the disposal of bond B to acquire bond A.

Evaluating Potential Bond Swaps

Portfolio managers commonly swap an existing bond in a portfolio for another bond. Bond swaps can be categorized as pure yield pickup swaps, substitution

EXHIBIT 5–11

Scenario Analysis Showing the Relative Performance of Bonds A and B

Reinvestment Rate	Total Return for Bond A minus Total Return for Bond B (in Basis Points)							
	5.00%	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**	**11.00%**	**12.00%**
3.0%	207	136	77	28	–12	–43	–67	–85
3.5	207	136	77	28	–11	–42	–66	–84
4.0	207	136	77	28	–11	–42	–66	–84
4.5	207	136	77	29	–11	–42	–66	–83
5.0	207	137	78	29	–10	–41	–65	–83
5.5	208	137	78	29	–10	–41	–65	–82
6.0	208	137	78	30	–10	–41	–64	–82
6.5	208	137	78	30	–9	–40	–64	–81

swaps, intermarket-spread swaps, or rate-anticipation swaps. Total return analysis can be used to assess the potential return from a swap.

- *Pure yield pickup swap.* Switching from one bond to another that has a higher yield is called a *pure yield pickup swap.* The swap may be undertaken to achieve either higher current coupon income or higher yield-to-maturity or both. No expectation is made about changes in interest rates, yield spreads, or credit quality.
- *Rate-anticipation swap.* A portfolio manager who has expectations about the future direction of interest rates will use bond swaps to position the portfolio to take advantage of the anticipated interest-rate move. These are known as *rate-anticipation swaps.* If rates are expected to fall, for example, bonds with a greater price volatility will be swapped for existing bonds in the portfolio with lower price volatility (to take advantage of the larger change in price that will result if interest rates do in fact decline). The opposite will be done if rates are expected to rise.
- *Intermarket-spread swap.* These swaps are undertaken when the portfolio manager believes that the current yield spread between two bonds in the market is out of line with its historical yield spread and that the yield spread will realign by the end of the investment horizon. Yield spreads between bonds exist for the following reasons: (1) there is a difference in the credit quality of bonds (e.g., between Treasury bonds and double-A-rated public utility bonds of the same maturity), or (2) there are differences in the features of corporate bonds that make them more or less attractive to investors (for example, callable and noncallable bonds, and putable and nonputable bonds).

- *Substitution swap.* In a substitution swap, a portfolio manager swaps one bond for another bond that is thought to be identical in terms of coupon, maturity, price sensitivity to interest-rate changes, and credit quality, but that offers a higher yield. This swap depends on a capital market imperfection. Such situations sometimes exist in the bond market because of temporary market imbalances. The risk that the portfolio manager faces is that the bond purchased may not be identical to the bond for which it is exchanged. For example, if credit quality is not the same, the bond purchased may be offering a higher yield because of higher credit risk rather than because of a market imbalance.

Comparing Municipal and Corporate Bonds

The conventional methodology for comparing the relative performance of a tax-exempt municipal bond and a taxable corporate bond is to compute the *taxable equivalent yield.* The taxable equivalent yield is the yield that must be earned on a taxable bond in order to produce the same yield as a tax-exempt municipal bond. The formula is

$$\text{Taxable equivalent yield} = \frac{\text{tax-exempt yield}}{1 - \text{marginal tax rate}}$$

For example, suppose that an investor in the 35% marginal tax bracket is considering a 10-year municipal bond with a yield-to-maturity of 4.5%. The taxable equivalent yield is

$$\frac{4.5\%}{1 - 0.35} = 6.92\%$$

If the yield-to-maturity offered on a comparable-quality corporate bond with 10 years to maturity is more than 6.92%, those who use this approach would recommend that the corporate bond be purchased. If, instead, a yield-to-maturity of less than 6.92% on a comparable corporate bond is offered, the investor should invest in the municipal bond.

What's wrong with this approach? The tax-exempt yield of the municipal bond and the taxable equivalent yield suffer from the same limitations we discussed with respect to yield-to-maturity. Consider the difference in reinvestment opportunities for a corporate and a municipal bond. For the former, coupon payments will be taxed; therefore, the amount to be reinvested is not the entire coupon payment but an amount net of taxes. In contrast, because the coupon payments are free from taxes for a municipal bond, the entire coupon can be reinvested.

The total return framework can accommodate this situation by allowing us to explicitly incorporate the reinvestment opportunities. There is another advantage to the total return framework as compared with the conventional taxable equivalent yield approach. Changes in tax rates (because the investor expects either her tax rate to change or the tax structure to change) can be incorporated into the total return framework.

SUMMARY

In this chapter, the pricing of bonds and the calculation of various yield measures have been described. The price of a bond is equal to the present value of the expected cash flow. For bonds with embedded options, the cash flow is difficult to estimate. The required yield used to discount the cash flow is determined by the yield offered on comparable securities.

The two most popular yield measures cited in the bond market are the yield-to-maturity and yield-to-call. Both yield measures consider the coupon interest and any capital gain (or loss) at the maturity date or call date in the case of the yield-to-call. The coupon interest and capital gain (or loss), however, are only two of the three components of potential dollar return from owning a bond until it matures or is called. The other component is the reinvestment of coupon income, commonly referred to as the interest-on-interest component. This component can be as large as 80% of a bond's total dollar return. The yield-to-maturity assumes that the coupon payments can be reinvested at the calculated yield-to-maturity. The yield-to-call assumes that the coupon payments can be reinvested at the calculated yield-to-call.

A better measure of the potential return from holding a bond over a predetermined investment horizon is the total return measure. This measure considers all three sources of potential dollar return and can be used to analyze bond swaps.

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CHAPTER

SIX

CALCULATING INVESTMENT RETURNS

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After investment objectives have been set, strategy determined, assets allocated, and trades made, the next task is to value the portfolio and begin the process of performance measurement. Whether an investor makes his own investing decisions or delegates this duty to advisors, all parties are interested in calculating and weighing the results. The first stage in the performance measurement process is to compute a *return,* which is the income and profit earned on the capital that the investor places at risk in the investment.

Suppose that $100 is invested in a portfolio and that the portfolio subsequently increases in value such that the investor receives $130 back. What was the return on this investment? The investor gained $30. Taking this *dollar return* and dividing it by the $100 invested and multiplying the decimal result 0.3 by 100 gives us the return expressed as a percentage, that is, 30%.

A *rate of return* is the gain received from an investment over a period of time expressed as a percentage. Returns are a ratio relating how much was gained given how much was risked. We interpret a 30% return as a gain over the period equal to almost one-third of the original $100 invested.

Although it appears that no special knowledge of investments is required to calculate and interpret rates of return, several complications make the subject worthy of further investigation:

- Selection of the proper inputs to the return calculation
- Treatment of additional client contributions to and withdrawals from the investment account
- Adjusting the return to reflect the timing of these contributions and withdrawals
- Differentiating between the return produced by the manager and the return experienced by the investor
- Computing returns spanning multiple valuation periods
- Averaging periodic rates of return

These are the issues that we will address in this chapter. In this chapter we summarize what has evolved to be the investment industry standard approach to calculating portfolio rates of return. While the focus here is on fixed income portfolios, the methodology is applicable to all investments. Individual and institutional investors, investing via separate and commingled accounts, using a myriad of strategies and asset classes, use the methodology presented in this chapter to determine the returns earned by their investment portfolios. The tools covered here are relevant whether you are an individual monitoring the performance of your own personal brokerage account, a financial planner providing advice to many individuals, the manager of a mutual fund, or a plan sponsor overseeing dozens of specialist investment managers. In the illustrations that are used to explain the various concepts presented in the chapter, a spreadsheet format is used so that it is easier for the reader to replicate the calculations.

SINGLE-PERIOD RATE OF RETURN

Why do we compute rates of return to describe the performance of an investment when we could simply judge our performance by the absolute dollars earned over time? After all, there is no better gauge of investment success than money in the bank! There are several reasons that returns have emerged as the preferred statistic for summarizing investment performance.

- The rate of return concentrates a lot of information into a single statistic. Individual data points about the beginning and ending market values, income earned, cash contributions and withdrawals, and trades for all the individual security positions held by the portfolio are compressed into a single statistic.
- This single statistic, the return, is a ratio. It is faster for an investor to analyze proportions than absolute numbers. For example, if an investor is told that she earned an 8% rate of return, she can instantly begin to judge whether she is happy with this result compared with the need to pore over valuation and transaction statements first.
- Returns are comparable even if the underlying figures are not. An investor can compare returns even when the portfolios are valued using different base currencies or have different sizes. For example, if an investor puts $100 at work and gains $10, he has earned the same return as the investor who put $1 million to work and ended up with $1.1 million.
- Returns calculated for different periods are comparable; that is, an investor can compare this year's return with last year's.
- The interpretation of the rate of return is intuitive. Return is the value reconciling the beginning investment value with the ending value over the time period we are measuring. An investor can take a reported return and use it to determine the amount of money she would have at

the end of the period given the amount invested:

$$\text{MVE} = \text{MVB}\ (1 + \text{decimal return})$$

where

MVE = market value at the end of the period
MVB = market value at the start of the period.

For example, if we were to invest \$100 at a return of 40%, we would have \$140 at the end of the period: \$100 × (1 + 0.40) = \$140. Adding one to the decimal return before multiplying gives a result equal to the beginning value plus the gain/loss over the period. Multiplying the beginning value by the decimal return of 0.4 will give the gain/loss over the period (\$40).

Let's look closer at the calculation of return. In our introductory example we earned a \$30 gain on an investment of \$100. By dividing the gain by the amount invested, we derive the 30% return using

$$\text{Return, in percent} = \left(\frac{\text{gain or loss}}{\text{investment made}}\right) \times 100$$

Suppose that instead of investing and then getting our money back within a single period, we held an investment worth \$100 at the beginning of the period, and we continued to hold it at the end of the period when it was valued at \$130. Multiplying the first ratio by 100 transforms the decimal fraction into a percentage gain, 30% in our example (0.3 × 100 = 30%).

The same return can be calculated whether an investor buys and then liquidates an investment within a period or carries it over from a prior period and holds onto it. When we measure the return on an investment that we buy and hold across periods, we treat the beginning market value as if it were a new investment made during the period and the ending market value as if it were the proceeds from the sale of the investment at the end of the period.

We have used two forms of the return calculation so far. It does not matter which one we use. The two methods are equivalent.

$$\left(\frac{\text{Gain or loss}}{\text{Investment made}}\right) \times 100 = \left[\left(\frac{\text{current value}}{\text{investment made}}\right) - 1\right] \times 100$$

We can demonstrate that the two forms are the same by deriving the second form of the calculation from the first:

$$\left(\frac{\text{MVE} - \text{MVB}}{\text{MVB}}\right) \times 100 \rightarrow \left(\frac{\text{MVE}}{\text{MVB}} - \frac{\text{MVB}}{\text{MVB}}\right) \times 100 \rightarrow \left(\frac{\text{MVE}}{\text{MVB}} - 1\right) \times 100$$

Using the first form, the numerator of the rate-of-return calculation is the *unrealized gain or loss,* the difference between the starting and ending market value. If there were income earned during the period, for example, via the accrual of periodic coupon income due to the holder of a bond held by the portfolio, we also add it into the numerator, making the numerator more properly the market value plus accrued income. In either form of the calculation the denominator is the *investment made*. The number we select for the denominator represents the *money at risk* during the period. For the first measurement period, the investment made is equal to the amount originally invested in the portfolio. In subsequent periods, it is equal to the ending market value of the previous period. The calculation of a return where we invested $100 at the end of December and it rises to $110 in January and then $120 in February is provided in the following spreadsheet.

	A	B	C	D
1	**Month Ending**	**Market Value**	**Dollar Return**	**Percent Return**
2	December	100		
3	January	110	10	10.00
4	February	120	10	9.09
5				↑
6			=B4-B3	=((C4/B3)*100)

Notice that even though we earned the same $10 dollar return in January and February, the percent return is higher in January (10/100 = 10.00%) than it is in February (10/110 = 9.09%). The reason for the lower February return is that the money at risk in the portfolio for February equals not only the original investment of $100 but also the $10 gained in January. With more money put at risk, the same dollar gain results in a lower return to the investment.

By using the *market value* of the investment to calculate returns, we recognize a gain on the investment even though it is not actually *realized* by selling it at the end of the period. To calculate returns that include unrealized gains, we value the portfolio at the end of each measurement period. These dates are the periodic *valuation dates.* A return calculated between two valuation dates is called a *single-period, holding-period,* or *periodic return*. The periodicity of single-period returns is related to the frequency of portfolio valuation. For example, single-period returns can be calculated on a daily basis for mutual funds, which are valued at the close of the market each night, but may be calculated only monthly for institutional separate accounts if they are valued only monthly. Valuations are performed at least as often as participants are allowed to move money into or out of a commingled fund.

Components of Single-Period Returns

When there are no transactions into or out of an investment account and no income earned, to calculate a single-period return, we simply divide the ending market value by the beginning market value. Total portfolio market values are derived by summing up the values of the underlying investments within the portfolio. If we are calculating the return earned on our share of a commingled portfolio, such as a mutual fund, the market value equals the sum of the shares we own multiplied by the value of each share on the valuation date. Share values are calculated by dividing the sum of the individual security market values that comprise the fund by the number of shares outstanding. Portfolio holdings are determined on a trade-date basis. With *trade-date accounting,* we include securities in the portfolio valuation on the day the manager agrees to buy or sell the securities, as opposed to waiting for the day the trades are settled with the broker.

The *market value* of each security is the amount we would expect to receive if the investment were sold on the valuation date. It is calculated using observed market prices and exchange rates wherever possible. Determining market value is easy for instruments such as exchange-traded equities, but we need to estimate the current value of other investment types. For example, bonds that do not trade often are marked to market by reference to the price of similar bonds that did trade that day. Although it is possible, say, for liquidity reasons, that we could not actually realize the observed market closing price used in the valuation if we were to actually sell the investment, this method avoids introducing subjective estimates of trading impact into return calculations. Short-term instruments are valued at their amortized cost. If the portfolio holds cash, it too is included the valuation of the portfolio.

The individual security market values include a measure of income earned or *accrued income* on the investment. Accrued income is income earned but not yet received. For example, if an investor sells a bond between coupon dates, the investor sells the interest accrued from the last coupon payment date to the buyer of the bond. Because the interest sold would be part of the proceeds if the security were sold on the valuation date, we also include it in the calculation of market value. Returns that reflect both the change in market value and the income earned during the period are called *total returns*. In a similar manner, the total portfolio market value is adjusted for accrued receivables and payables to and from the portfolio. For example, the accrued management fee payable to the investment manager is subtracted from the total market value.

While it is outside the scope of this chapter to itemize the finer points of valuing every type of instrument in which the portfolio could invest, the principles of market-quote-driven, trade-date, and accrual-based valuation are used to judge the worth of each security in the portfolio, and these values are then summed to the portfolio level and result in the single-period-return calculation formula:

$$\text{Percent rate of return} = \left[\left(\frac{\text{ending market value} + \text{ending accrued income}}{\text{beginning market value} + \text{beginning accrued income}}\right) - 1\right] \times 100$$

It is also worthwhile to note what factors we do not explicitly include in the return calculation. The *cost of investments* is *not* considered in performance measurement after the first period's return calculation (except for securities that are valued at their amortized cost). For each subsequent period, the ending market value for the previous period is used as the beginning market value for the next period.

The justification for this practice is that we assume that the investment cycle begins afresh with each valuation period, and it is the current market value, not the original cost, that is invested, or put at risk again, in the next period.

The return calculation makes no reference to gains *realized* in the course of security sales during the period. In fact, the portfolio beginning and ending market values include both *unrealized* and *realized capital appreciation* generated by trading within the portfolio during the period. Consider a portfolio with this sequence of activity:

December 31: Holds 100 shares of stock A priced at $1 per share = $100 MVB.

January 31: Stock A is worth $110 for a 10% (10/100 = 10%) return in January.

February 28: Stock A is valued at $115 for a 4.55% (5/110 = 4.55%) return in February.

March 1:

- 50 shares of stock A are sold for $1.15 per share, netting $57.50.
- The realized gain on the sale is $7.50 ($57.50 – $50 = $7.50).
- 10 shares of stock B at $5.75 a share are purchased with the proceeds.

March 31:

- Stock A is valued at $50 (50 shares × $1 = $50).
- Stock B is valued at $50 (10 shares × $5 = $50).
- The total portfolio is worth $100, for a 13.04% (–15/115 = –13.04%) loss in March

The following spreadsheet shows that we do not explicitly use the realized gain of $7.50 in the return calculation for March.

	A	B	C	D	E	F
1	**Date**	**MV Stock A**	**MV Stock B**	**Total MV**	**Gain/Loss**	**% Return**
2	December 31	100.00	0.00	100.00		
3	January 31	110.00	0.00	110.00	10.00	10.00
4	February 28	115.00	0.00	115.00	5.00	4.55
5	March 1	57.50	57.50	115.00		
6	March 31	50.00	50.00	100.00	-15.00	-13.04
7						↑
8					=D6-D5	=((E6/D5)*100)

The realized gain on the sale of stock A was committed to the purchase of stock B, which was then marked to market at the end of March. We explicitly calculate the unrealized market-value change during the period (–15.00), and this market-value change implicitly includes any realized gains/losses on securities sold during the period.

It is possible that the manager might not reinvest the sale proceeds via the purchase of another security. In this case, we still do not explicitly include the realized gain in the calculation of return. Instead, we include the cash received on the sale in the total fund market value. The following spreadsheet illustrates the fact that we do not need to know about the transactions *within* the portfolio during the valuation period in order to calculate portfolio level performance.

	A	B	C	D	E	F
1	**Date**	**MV Stock A**	**Cash**	**Total MV**	**Gain/Loss**	**% Return**
2	31-Dec-2000	100.00	0.00	100.00		
3	31-Jan-2001	110.00	0.00	110.00	10.00	10.00
4	28-Feb-2001	115.00	0.00	115.00	5.00	4.55
5	01-Mar-2001	57.50	57.50	115.00		
6	31-Mar-2001	50.00	57.90	107.90	-7.10	-6.17
7						↑
8					=D6-D5	=((E6/D5)*100)

Transactions within the portfolio during the period do not affect the total fund level return calculation because they have an equal and opposite impact on performance—a purchase of one security is a sale of another (cash). This is also true of income received during the period. Income received on a security is an outflow from that security but an inflow of cash. To calculate portfolio-level performance when there are no additional contributions and withdrawals, we only need to sum up the market value of all the securities in the fund plus cash balances at the beginning and end of the holding period.

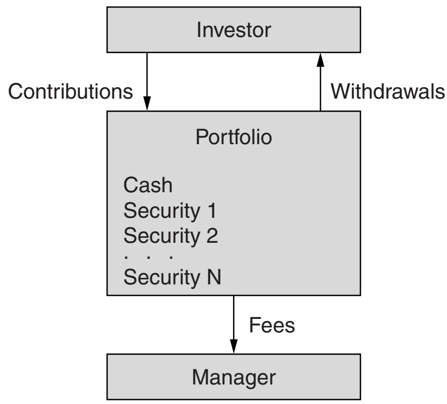
Return on Investment

So far we have looked at the calculation of a single-period return for situations where the market value of our holdings is made available for investment at the start of the next period. Individual and institutional investors also make periodic additional investments, or *contributions,* to and *withdrawals* from investment accounts. These net contributions to the fund are *not* included as a component of investment return; they represent an increase of capital at risk but not a capital gain on our investment. For this reason, when a fund receives new money, it is not possible to measure performance simply by observing the change in market value.

These asset transfers into and out of the fund are sometimes called *cash flows*. Cash flow is a generic term for different transaction types. For a defined-benefit pension plan, the cash flows include periodic corporate contributions to fund the plan and withdrawals to service retirees. For a mutual fund, cash flows include purchases or liquidations of fund shares and exchanges of shares between funds. Exhibit 6–1 shows the generic transactional relationships among the investor, the manager, and the portfolio.

EXHIBIT 6–1

Portfolio Cash Flows



The value of the cash flow is the amount of money deposited or withdrawn. A positive cash flow is a flow into the fund. A negative cash flow is a flow out of the fund. Sometimes contributions are made in securities and not cash, for example, when a portfolio is transitioned to a new investment manager. The monetary value of these "in kind" contributions is measured by the current value of the assets transferred at the time of the contribution. In these situations, it is important to use the current market value rather than the original cost. If the original cost were used, the return calculation for the first period after the contribution would credit the entire return to date as earned in the first period after the transfer.

When there are cash flows, we need to adjust the calculation of gain/loss in the numerator of the return calculation to account for the fact that the increase in market value was not entirely due to investment earnings. For example, suppose that we have a portfolio with an MVB of 100 and an MVE of 130. What is the gain if we invested an additional $10 during the period? We started off with $100 and ended up with $130. We subtract out the additional investment before calculating the gain:

$$\text{Gain/loss} = (\text{current value} - \text{original investment} - \text{net cash inflows} + \text{net cash outflows})$$

The gain in this case is $20 (130 – 100 – 10 + 0). The $20 gain/loss during the period combines two amounts: the gain on the original $100 and the gain on the additional $10 invested. If instead of a net inflow we had a net outflow because we took money out of the portfolio during the period, the second component would be the gain earned up until the money was withdrawn.

When there are cash flows, in addition to modifying the numerator, we need to modify the denominator of the return calculation to account for additional capital invested or withdrawn during the measurement period. We can modify the rate-of-return calculation to account for additional investment or withdrawals; the result is the *return-on-investment* (ROI) *formula*. ROI is the gain or loss generated by an investment expressed as a percentage of the amount invested, adjusted for contributions and withdrawals:

$$\text{ROI, in percent} = \left(\frac{(\text{MVE}+\text{NOF})-(\text{MVB}+\text{NIF})}{\text{MVB}+\text{NIF}}\right)\times 100$$

where NIF are the net inflows and NOF are the net outflows. The following spreadsheet shows the calculation of the ROI:

	A	B	C	D	E
1	MVB	In Flows	Out Flows	MVE	Return on Investment %
2	100.00	10.00	0.00	130.00	18.18
3					
4					

=(((D2+C2)-(A2+B2))/(A2+B2))*100

The first expression in the numerator (MVE + NOF) replaces the MVE used in the ROI calculation. We adjust the ending market value for any withdrawals from the portfolio. Notice that this increases the numerator and the resulting return. Withdrawals are treated as a *benefit* to performance. In the second expression, we are subtracting the amount invested in order to calculate the gain. The inflows are treated as an investment, which reduces the gain. Contributions are treated as a *cost* to performance. The total amount invested (MVB + NIF) is the ROI denominator. By adding the contributions to the MVB, we reduce the return because we are dividing gain by a larger number.

Is 18.18% a fair return to account for the case where MVB = 100, MVE = 130, and there was an NIF of 10? The answer is: it depends. Note that there is an implicit assumption that the NIF was available for investing, or at risk, for the complete period. If the additional inflow was put into the portfolio at the beginning of the period, the investor did not have use of the money for the whole period. He would expect a higher portfolio return to compensate for this as compared with his keeping the money and investing in the portfolio only at the end of the period. Thus returns should take into account the timing of the additional cash flows. If the investment were made sometime during the period, the investor did have use of the capital for some part of the period. For example, if the measurement period were a month and the $10 contribution came midway through the month, the fund had $100 of invested capital for the first half of the month and $110 for the second half. The gain of $20 was made on a smaller invested balance; therefore, the return credited to the portfolio and its manager should be *higher* than 18.18%.

While ROI adjusts for portfolio contributions and withdrawals, it does not adjust for the *timing* of these cash flows. Because of the assumption that contributions were available for the whole period, ROI will give the same return no matter when in the period the flows occur. Another drawback of the ROI as a measure of investment performance is that it does not adjust for the *length* of the holding period. The ROI calculation gives the same result whether the gain was earned over a day, a year, or 10 years. For these reasons, we need a measure of return that reflects both the timing of cash flows and the length of the period for which the assets were at risk. Both adjustments are derived from concepts related to the time value of money, which we review in the next section.

Time Value of Money

Returns can be equated to the interest rates used in the calculation of the future value of a fixed income investment. However, unlike returns, coupon interest rates are known ahead of time, so we can project the future value at the beginning of the period. The future value of an investment equals the present value plus the interest and other gains earned over the period.

$$\text{FV} = \text{PV} \times (1 + R)^N$$

where

FV = value at end of period
PV = current value of the investment
R = rate of income earned per period
N = number of valuation periods

In return calculations, it is the R that is unknown. We calculate this rate R using observations of the beginning and ending market values. To derive the equivalent of the future value, which is the MVE of an investment during a single period, we multiply the MVB by one plus the interest rate.

$$\text{Ending market value} = \text{beginning market value} \times (1 + \text{interest rate})$$

The difference between the start and end values is the income earned. *Compounding* is the reinvestment of income to earn more income in subsequent periods. In a *simple-interest* scenario, the income earned is not reinvested in order for it to compound in the following periods. For example, if an MVB = 1,000 is put to work for a period of four months at an interest rate of 5% per month, we calculate an ending value of 1,200.

$$\begin{aligned}\text{Ending market value} &= \text{beginning market value} \\ &\quad \times [1 + (\text{rate in percent}/100) \\ &\quad \times \text{no. of time periods invested}] \\ &= 1{,}000 \times [1 + (5\%/100 \times 4)] = 1{,}200\end{aligned}$$

We use the simple-interest calculation if the investor withdraws the income earned at the end of each period. In this example, the total gain over the

EXHIBIT 6–2

Compound Interest

	A	B	C	D	E	F	G	H
1	Year	MVB	Interest Rate	MVE	Principal	Interest	Interest on Interest	% of Value
2	0			100.00	100.00			
3	1	100.00	0.07	107.00	100.00	7.00	0.00	
4	2	107.00	0.07	114.49	100.00	14.00	0.49	0%
5	3	114.49	0.07	122.50	100.00	21.00	1.50	1%
6	4	122.50	0.07	131.08	100.00	28.00	3.08	2%
7	5	131.08	0.07	140.26	100.00	35.00	5.26	4%
8	6	140.26	0.07	150.07	100.00	42.00	8.07	5%
9	7	150.07	0.07	160.58	100.00	49.00	11.58	7%
10	8	160.58	0.07	171.82	100.00	56.00	15.82	9%
11	9	171.82	0.07	183.85	100.00	63.00	20.85	11%
12	10	183.85	0.07	196.72	100.00	70.00	26.72	14%
13								
14		=D11		=B12*(1+C12)		=C12*B3*A12	=D12-(E12+F12)	=G12/D12

four months is 200. Divided by the $1,000 invested gives a 20% return for the four-month period. This equals the monthly periodic dollar return multiplied by four.

If the income and gains are retained within the investment vehicle or *reinvested,* they will accumulate and increase the starting balance for each subsequent period's income calculation. For example, in Exhibit 6–2 we show that $100 invested at 7% for 10 years, assuming yearly compounding, produces an ending value of $196.72, or $\$100 \times (1 + 0.07)^{10} = \$196.72$.

Notice that our original principal of $100 invested at 7% doubled in 10 years *before* the addition of any more principal. This was possible because we reinvested all the gains, also at 7%. Unfortunately, the reinvestment assumption is not realistic for all investors. For example, any taxable investor investing outside a vehicle shielded from taxes, such as a qualified retirement account, will have to pay taxes on income earned. The taxes reduce the income available for reinvestment in the next period. Given this fact, investors can take taxes into account when comparing the performance of taxable investments.

The reinvestment assumption is important because the power of investing lies in *compound interest,* the interest on the interest earned in prior periods. When interest earnings are withdrawn after each period, the simple-interest calculation is a better measure of the situation. If income is left to earn more income, then compound interest is the better measure. Compound interest is assumed in almost all investment applications. With interest rates, we usually assume that interest is reinvested at the same interest rate for subsequent periods. The difference between working with returns instead of interest rates is that in return calculations, while we also assume that the income is reinvested, we recognize that the periodic returns fluctuate over time.

While we understand that earning a higher return over the holding period will increase the ending investment value, the frequency of compounding also has an impact on the ending value. As shown in the spreadsheet that follows, an investment that has the same return has a higher value if the income is compounded more frequently.

	A	B	C	D	E
1	**Frequency**	**MVB**	**Periods**	**Return**	**MVE**
2	Yearly	1000.00	1.00	0.07	1070.00
3	Monthly	1000.00	12.00	0.07	1072.29
4	Daily	1000.00	365.25	0.07	1072.50
5					
6			=FV(D4/C4,C4,0,B4*-1)		

Interest rates usually are quoted on a yearly, or *annual,* basis. We can adjust the future-value formula to account for more frequent compounding.

$$\text{MVE} = \text{MVB}\left(1 + \frac{r_{\text{period}} \times m}{m}\right)^{m \times \text{periods}}$$

where

r = periodic interest rate
m = times per period that interest is paid, or compounds

For example, if a \$100 investment yielded 3% for six months (i.e., MVB = 100 and MVE = 103), the value at the end of one year, assuming semiannual compounding and reinvestment of the interest, is \$106.09.

$$106.09 = 100 \times \left(1 + \frac{(0.03 \times 2)}{2}\right)^{2 \times 1(\text{year})}$$

Returns That Take Time into Account

Given the fact that money has a time value, let's return to a question that we considered earlier: What is the proper holding-period return to attribute to a fund where the MVB equals \$100, we invest an additional \$10 during the period, and the MVE = \$130?

No matter when in the period the investment was made, the dollar gain is \$20(130 – 100 – 10) for the period. The return over the period depends on the timing of the additional investment. The return could be as low as 18.18% or as high as 20%. If the \$10 was invested at the *beginning of the period,* capital employed equals the original investment of \$100 plus the additional investment of \$10.

$$\left(\frac{130-100-10}{100+10}\right)\times 100 \rightarrow \left(\frac{130-110}{110}\right)\times 100 \rightarrow \left(\frac{20}{110}\right)\times 100 = 18.18\%$$

If, instead, the additional investment was made precisely at the *end of the period,* the capital employed during the period is just \$100, so the return is 20%.

$$\left(\frac{130-100-10}{100}\right)\times 100 \rightarrow \left(\frac{130-110}{100}\right)\times 100 \rightarrow \left(\frac{20}{100}\right)\times 100 = 20.00\%$$

Given the same dollar gain, we should credit the overall investment with a higher return as the contribution is made closer to the end of the period. If the investment is made at the end of the period, the additional contribution is not included in the denominator. The same numerator divided by a smaller denominator leads to the higher return. The higher return is justified when the contribution is made at the end of the period because the capital at risk during the period was lower, yet we earned the same dollar gain.

This example shows that it is important to track the time when contributions or withdrawals are made into an investment account in order to determine returns accurately. We always adjust the numerator for the additional contributions or withdrawals during the period. We either include the full amount of the contribution in the denominator, none of it, or a partial amount, depending on the timing of the cash flow. When the denominator of a return calculation is adjusted for contributions or withdrawals, we call the denominator the a*verage capital employed* or the *average invested balance*.

PERFORMANCE OF AN INVESTMENT: MONEY-WEIGHTED RETURNS

In this section we establish the need to recognize the effects of both investor and manager decisions when calculating the return earned by the investor but to isolate the effects of investor decisions when calculating the return to be attributed to the manager. The *dollar-weighted return,* or *money-weighted return* (MWR), is the performance of the investment portfolio and incorporates the effects of both decisions.

Timing of Investor Decisions

In addition to the time value of money, the *market timing* of the investor contributions and withdrawals will affect realized returns. The capital markets provide us with positive long-term returns but volatile periodic returns. Market timing is a term that relates the time an investor makes her investment to the market cycle—that is, is the investor buying low and selling high.

For example, suppose that we are investing via a mutual fund, and during the month, the fund's net asset value per share (NAV) varies between 10.00 and 12.00, and there are no distributions.

Date	NAV per Share
5/31	10.00
6/10	12.00
6/20	10.00
6/30	11.00

The monthly return that will be published for this fund is 11/10 = 10%. The following spreadsheet shows the calculation of various holding period returns for the month.

	A	B	C	D	E
1	Period	Return From	Calculated As	% Return	
2	1	5/31 – 6/10	((12 / 10) – 1) x 100	20.00	
3	2	5/31 – 6/20	((10 / 10) –1) x 100	0.00	Published Return
4	3	5/31 – 6/30	((11 / 10) – 1) x 100	10.00	
5	4	6/10 – 6/20	((10 / 12) –1) x 100	-16.67	
6	5	6/10 – 6/30	((11 / 12) – 1) x100	-8.33	
7	6	6/20 – 6/30	((11 / 10) – 1 x 100	10.00	

The investor with perfect foresight (or good luck) invested on 5/31 and withdrew on 6/10 to earn a 20% return. The investor with poor timing, who bought at the high on 6/10 and sold at the bottom on 6/20, had a –16.67% return. This spread of 36.67% represents the return differential owing to the timing of the investor cash flows. The important point for investment performance measurement is that these cash flows were at the *discretion of the investor,* not the manager. Actions of the investment manager would have had no impact on this differential return; he would have put the money to work according to his mandate. In a time when the market moves up, down, and back up again, the returns earned by different investors can be quite different depending on the timing of their cash flows and the volatility of the returns over the period.

In the preceding example, the advertised return for the period would be the 10% return, which was measured from the start of the monthly period to the end. Even though different investors experienced different returns, the investment manager for the mutual fund had no control over these timing decisions; therefore, 10% is an accurate representation of his performance. It is the appropriate return to use when comparing the manager's performance with a peer-group average or a market index.

Timing of Investment Manager Decisions

When we calculate returns, we also can consider the timing of decisions that are the responsibility of the manager. Consider two managers starting with the same $100 portfolio at the beginning of the month. Both receive $10 client contributions. Their strategies differ only in that manager 1 attempts to time the market as shown in this example. Assume that the market moves down 10% during the month.

Manager 1 leaves the contribution in cash. The following spreadsheet shows that manager 1's return is –9.05%.

	A	B	C	D
1	**Segment**	**MVB**	**Return**	**MVE**
2	Cash	10	1.00	10.05
3	Equity	100	-10.00	90.00
4	Total	110	-9.05	100.05
5			↑	
6			=((D4/B4)-1)*100	=SUM(D2:D3)

The following spreadsheet shows that manager 2 invests the contribution in equities at the beginning of the month and receives a –10.00% return:

	A	B	C	D
1	**Segment**	**MVB**	**Return**	**MVE**
2	Cash	0.00	1.00	0.00
3	Equity	110.00	-10.00	99.00
4	Total	110.00	-10.00	99.00
5			↑	
6			=((D4/B4)-1)*100	=SUM(D2:D3)

Despite the negative returns, manager 1 earned 95 basis points (–9.05% – –10%) in *value added* over manager 2 owing to the beneficial decision to leave the contribution in the relatively higher-yielding cash segment during the month.

Segregating Investor and Manager Timing Decisions

It is often the case that the manager and the investor are two different people. The preceding sections illustrate a performance-measurement problem: Decisions made by the investor and the investment manager must be segregated in order to calculate returns properly that reflect their respective responsibilities.

The ideal statistic for measuring the return experienced by the investor would include effects of both

- The timing of investor decisions to make an investment into the portfolio
- The decisions made by the manager to allocate assets and select securities within the portfolio

The first effect is purely attributable to decisions made by the investor. The second also can be considered attributable to the investor because she made the decision to hire the manager. The actual returns experienced by the investor are affected by the combination of the two effects. The ideal statistic for measuring the return produced by the investment manager neutralizes the timing effect because he (in many situations) has no control over the timing of external cash flows. Because of this need to isolate the timing of investor decisions, we need two different measures of return.

The *money-weighted return* (MWR) is used when we need to measure the performance as experienced by the investor. MWR is a performance statistic reflecting how much money was earned during the measurement period. This amount is influenced by the timing of decisions to contribute or withdraw money from a portfolio, as well as the decisions made by the manager of the portfolio. The MWR is contrasted with the statistics used to measure manager performance, *time-weighted return* (TWR), which is discussed later. As we will see, MWRs are important even if we are interested only in evaluating manager performance because they are sometimes used in the estimation of the TWR.

MWR is the return an investor actually experiences after making an investment. It reconciles the beginning market value and additional cash flows into the portfolio to the ending market value. The timing and size of the cash flows have an impact on the ending market value, as shown in the following table.

Transaction	Before Market	Effect on Performance
Contribute	Goes up	Positive
Contribute	Goes down	Negative
Withdraw	Goes up	Negative
Withdraw	Goes down	Positive

To reflect these transactions accurately, the MWR takes into account not only the amount of the cash flows but also the timing of the cash flows. Different investors into a portfolio will invest different amounts and make their investments on different dates. Because of the differences in cash-flow timing and magnitude, it is not appropriate to compare the MWRs calculated for two different investors.

When there are no cash flows, the return is calculated as the ending market value over the beginning market value. If there were a cash flow, we need to take into account the amount and the timing of the flow. To account for the timing of the flow, we calculate a weighting adjustment, which will be used to adjust the cash flow for the portion of the period that the cash flow was invested. If we are calculating an MWR for a one-year period and there are two cash flows, the first at the end of January and the second at the end of February, the flows will be weighted by 0.92 for the January month-end flow (the flow will be available to be invested for 92% of the year) and 0.83 for the February month-end flow (the flow will be available to be invested for 83% of the year).

Internal Rate of Return

Suppose that we invest \$100 at the beginning of the year and end up with \$140 at the end of the year. We made cash flows of \$10 each at the end of January and February. What is the MWR for this situation? The MWR we are looking for will be the value that solves this equation:

$$100 \times (1 + \text{MWR}) + 10 \times (1 + \text{MWR})^{.92} + 10 \times (1 + \text{MWR})^{.83} = 140$$

The return that reconciles the beginning value and intermediate cash flows to the ending value is the *internal rate of return* (IRR). The return is the value that solves for IRR in this equation:

$$\text{MVE} = \text{MVB} \times (1+\text{IRR}) + \text{CF}_1 \times (1+\text{IRR})^1 \cdots \text{CF}_N \times (1+\text{IRR})^N$$

where CF is amount of the cash flow in or out of the portfolio, and N is percentage of the period that the CF was available for investment. The IRR is the rate implied by the observed market values and cash flows. For all but the simplest case, we cannot solve for the IRR directly. Unfortunately, we cannot use algebra to rearrange the terms of the equation to derive the solution. The IRR is calculated using a trial-and-error process where we make an initial guess and then iteratively try successive values informed by how close we were to the solution in the last try until we solve the problem. Techniques have been developed to perform the iteration efficiently and converge on a solution quickly. The following spreadsheet shows the calculation of the IRR using the Excel solver utility.

	A	B	C	D	E	F
1	**Date**	**Months Invested**	**Period Weight**	**Value**	**Future Value of Flow**	
2	December 31	12	1.00	100	117.05	=D2*((1+E8)^C2)
3	January 31	11	0.92	10	11.55	=D3*((1+E8)^C3)
4	February 28	10	0.83	10	11.40	=D4*((1+E8)^C4)
5	December 31			140	140.00	=SUM(E2:E4)
6						
7		IRR calculated using solver		Difference:	0.00	=D5-E5
8				IRR:	0.1705	
9				Percent Return:	17.05	=E8*100

Here, we set the difference between the ending market value in cell D5 equal to the sum of the future values in cell E5. We then solved for the IRR in cell E8. The IRR is 17.05% because, as demonstrated below, it is the interest rate that resolves the flows to the ending market value.

$$100 \times (1+0.1705) + 10 \times (1+0.1705)^{.92} + 10 \times (1+0.1705)^{.83} = 140$$

Notice that there is an assumption embedded in the IRR formula: The rate of return is assumed to be constant within the period. In this example, each cash flow is compounded at 17.05% for the complete portion of the year invested. We can calculate an IRR for periods that are less than a year. The period weight used for each of the cash flows is the percentage of the total period under consideration. For example, a cash flow on the tenth of a 31-day month would be weighted at (31 – 10)/31) = 0.7097 of the month. (Assuming that the contribution was made at the beginning of the day on the tenth, subtract a day if we assume that cash flows occur at the end of the day.) The results of IRR calculations done for less than a year are interpreted as an IRR over the period measured.

The following spreadsheet shows the calculation of the monthly IRR where MVB = 1,000 on December 31, MVE = 1,200 on January 31, and we had two cash flows, 400 into the portfolio on January 10 and 100 out of the portfolio on January 20.

	A	B	C	D	E	F
1	Date	Days Invested	Period Weight	Value	Future Value of Flow	
2	December 31	31	1.00	1000	919.85	=D2*((1+E8)^C2)
3	January 10	22	0.71	400	376.97	=D3*((1+E8)^C3)
4	January 20	12	0.39	-100	-96.82	=D4*((1+E8)^C4)
5	January 31			1200	1200.00	=SUM(E2:E4)
6						
7				Difference:	0.00	=D5-E5
8				IRR:	-0.0802	
9				Percent Return:	-8.02	=E8*100

When we have withdrawals from the account, we make the cash-flow adjustments used in the IRR negative. The one-month IRR for this pattern of cash flows is –8.02%.

Problems with the IRR

We classify the IRR as an MWR because it takes into account both the timing and size of cash flows into the portfolio. It is an appropriate measure of the performance of the investment as experienced by the investor. The fact that the IRR needs to be calculated via iteration used to make the IRR an expensive calculation because of the computer time used by the iteration algorithm. This is not a problem today. However, the historical problem led to the development of various creative methods to estimate the IRR cheaply. One of these methods, the *Modified Dietz method,* is still the most common method used by analysts to compute MWRs and, as we will see, estimate returns between valuation dates when we are calculating a TWR.

Modified Dietz Return

The Modified Dietz return is a simple-interest estimate of the MWR. The Modified Dietz calculation is the same as the ROI calculation, except that the cash flows added to the beginning market value are adjusted according to the time they were invested in the portfolio.

$$\text{Modified Dietz return} = \left(\frac{\text{MVE} - \text{MVB} - \text{CF}}{\text{MVB} + \{[(\text{CD} - \text{C}_i)/\text{CD}] \times \text{CF}_i\}}\right) \times 100$$

where

CF = net amount of the cash flows for the period
CD = total days in the period
C_i = the day of the cash flow
CF_i = the amount of the net cash flow on C_i.

The calculation is named for the developer, Peter Dietz, who was associated with the Frank Russell pension consulting company. The original Dietz method, not currently used, makes the assumption that cash flows occurred midway through the period.

To illustrate the calculation of a Modified Dietz return, consider the following situation:

Beginning market value + accrued income	MVB	100
Ending market value + accrued income	MVE	120
Sum (client contribution/withdrawal)	CF	10 on the twentieth of a 30-day month

To calculate the Modified Dietz return, first we calculate the adjustment factor, which is 0.33, assuming that the flow occurs at the end of the day on the twentieth (10/30 = 0.33). Then we adjust the cash flow by multiplying the amount by the adjustment factor.

$$0.33 \times \$10 = \$3.33$$

We then add the modified flow to the beginning market value in the denominator, and calculate the Modified Dietz return, 9.68%.

$$9.68\% = \left(\frac{120 - 100 - 10}{100 + 3.33} \right) \times 100$$

Both the IRR and the Modified Dietz formulas are money-weighted returns (MWRs). MWR results *are* affected by the timing and magnitude of the cash flows during the period. The return statistics that completely eliminate the impact of investor cash flows are time-weighted returns (TWRs).

PERFORMANCE OF THE INVESTMENT MANAGER: TIME-WEIGHTED RETURNS

A rate of return is the percentage change in the value of an asset over some period of time. Total returns are calculated by dividing the capital gain/loss and income earned by the value of the investment at the beginning of the period. As we saw earlier in this chapter, investors experience different returns investing in the same fund depending on the timing and magnitude of their cash flows into and out of the portfolio. Returns are used in evaluating the performance of an investment manager, but he (usually) has no control over the timing and amount of investor flows, so we need a performance measure that negates the effect of these cash flows. The desired return would judge the manager by the return on money invested over the whole period and eliminate the effect of client cash flows.

Time-Weighted Return

The *time-weighted return* (TWR) is a form of total return that measures the performance of a dollar invested in a fund over the complete measurement period. The TWR eliminates the timing effect that external portfolio cash flows have on performance, leaving only the effects of the market and manager decisions.

To calculate a TWR, we break the period of interest into subperiods, calculate the returns earned during the subperiods, and then compound these subperiod returns to derive the TWR for the whole period. The subperiod boundaries are the dates of each cash flow. Specifically, the steps to calculate a TWR are as follows.

1. Begin with the market value at the beginning of the period.
2. Move forward through time toward the end of the period.
3. Note the value of the portfolio immediately before a cash flow into or out of the portfolio.
4. Calculate a *subperiod return* for the period between the valuation dates.
5. Repeat steps 3 and 4 for each cash flow encountered.
6. When there are no more cash flows, calculate a subperiod return for the last period using the end-of-period market value.
7. Compound the subperiod returns by taking the product of (1 + the subperiod returns).

The last step is called *geometric linking,* or *chain linking*, of the returns. Chain linking has the same function as compounding in the future-value calculation. We employ chain linking instead of the future-value formula when the periodic returns change from subperiod to subperiod.

$$\text{TWR} = [(1+R_1)(1+R_2)\cdots(1+R_N)-1]100$$

where R_N is the subperiod returns.

The TWR assumes compounding and reinvestment of the gains earned in the previous subperiods. The expression (1 + the subperiod return) is called a *wealth-relative,* or *growth rate*, which represents the increase in capital over the subperiod. For example, if a portfolio is worth $100 at the beginning of the subperiod and $105 at the end of the subperiod before the next cash flow, the subperiod return is 5%, and the growth rate for the subperiod equals 1.05.

Below we illustrate the steps to calculate a TWR. We calculate the TWR for a month with one cash flow into and one cash flow out of the fund:

Date	End-of-Day Valuation	Cash Flow
5/31	1,000	
6/9	1,100	
6/10		200
6/19	1,200	
6/20		–100
6/30	1,200	

Divide the period into subperiods. The first step in the TWR calculation is to divide the period we are interested in into subperiods, where the subperiods are segregated by the cash-flow dates. The next step is to note the value of the portfolio before each cash flow. If we are working with a beginning-of-day cash-flow assumption, we use the valuation performed on the night prior to the cash flow.

Date	Beginning-of-Day Valuation	Cash Flow	End-of-Day Valuation
5/31			1,000
6/9			1,100
6/10	1,100	200	
6/19			1,200
6/20	1,200	–100	
6/30	1,200		1,200

We have two cash flows and three subperiods:

1. 5/31 to the end of day 6/9
2. 6/10 to the end of day 6/19
3. 6/20 to the end of day 6/30

Note that there are (1 + the number of cash-flow dates) subperiods.

Calculate subperiod returns. Next, we calculate a single-period return for each subperiod. The time-of-day assumption governs the treatment of the cash flows in the subperiod return formula. Here we assume that cash flows occur at the beginning of the day. With a beginning-of-day assumption, we add the cash flow to the beginning day market value to form the denominator of the return. Cash flows into the portfolio are added to the denominator, and cash flows out of the portfolio are subtracted. If there is more than one cash flow during the day, we net the flows together.

$$\text{Subperiod return (start-of-day flow assumption)} = \frac{\text{MVE}}{\text{MVB} + \text{net cash inflows}}$$

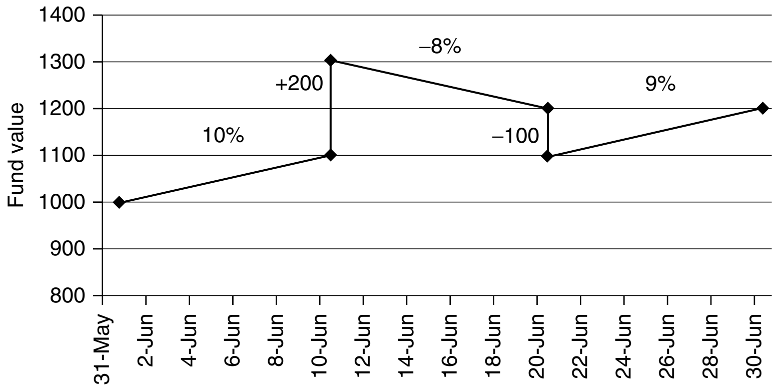
If we are calculating performance for a unitized product such as a mutual fund, the inputs to the subperiod return formula are the net asset value per share and dividend distributions. The effect of the cash-flow adjustment is to negate the effect of the contributions/withdrawals from the return calculation. The calculation of the three subperiod returns, 10.00%, –7.69%, and 9.09%, is shown in the following spreadsheet.

	A	B	C	D	E	F	G
1	Sub Period	Return From	MVB	CF	MVE	Percent Return	Growth Rate
2	1	5/31 – 6/10	1000	0	1100	10.00	1.10
3	2	6/10 – 6/20	1100	200	1200	-7.69	0.92
4	3	6/20 – 6/30	1200	-100	1200	9.09	1.09
5							
6				=((E4/(C4 + D4))-1)*100		=1+(F4/100)	

Calculate multiple-period returns. The percentage return for the month is calculated by linking the subperiod returns.

$$[(1.1000) \times (0.9231) \times (1.0909) - 1] \times 100 = 10.77\%$$

By calculating the return in this way, we have completely eliminated from the return the impact of the cash flows into and out of the portfolio. The following graph shows a way to visualize how the TWR eliminates cash-flow effects from the return calculation:



There are some exceptions to the general rule that TWR is the appropriate measure of manager performance. In some situations, the portfolio manager does have discretion over the timing of cash flows. For example, in the management of private equity funds, the general partner draws down the capital committed when she wants to invest it. However, in most performance-measurement applications, the TWR is the appropriate measure of manager performance.

Estimating the Time-Weighted Return

There is a potential hurdle to implementing this methodology. TWR requires a valuation of the portfolio before each cash flow. Unfortunately, these periodic valuations are not always available. For example, many institutional separate accounts are valued on a monthly frequency, but the client may deposit or withdraw from the account at any time during the month. While industry trends lean in the direction of daily valuations, until these are available for all investment vehicles, we need a way of estimating the true TWR when contributions and withdrawals are made in between valuation dates.

We can approximate a TWR by calculating an MWR for each subperiod between valuation dates and compounding them over longer periods using the chain-linking method employed to link subperiod returns into a TWR. This linked MWR estimate of TWR provides a reliable approximation of the TWR in situations where the cash flows are small relative to the portfolio size and there is low return volatility within the subperiod. If the cash flows are large and the market is volatile during the period, the MWR estimate of TWR will be inaccurate. Thus it is important to note that the linked MWR is an *estimate* of the TWR over the longer period. Even though the cash flows are weighted within the subperiod, the cash flows are influencing the returns. The linking process does not

EXHIBIT 6–3

Summary of the Differences between the Money- and Time-Weighted Return

	Money-Weighted Returns	Time-Weighted Returns
Measures	The average growth rate of all dollars invested over the period	The growth rate of a single dollar invested over the period
Usage in analyzing investment results	Appropriate measure of investor or fund performance	Appropriate for measuring performance of vehicle or manager Appropriate for market comparison Appropriate for comparing managers
Effect of external cash flows	Reflects both the timing and amount of dollars at work over the period	Eliminates the effect of both timing and amount of money at work
Statistic represents	The return that reconciles MVB, CF, and MVE	The return of $1 invested in the portfolio from beginning to end
Calculation drawbacks	Iteration required for IRR calculation	A valuation is required before each flow

remove the effect of the cash flows from the cumulative return calculation. A compromise solution to calculating a TWR is to perform a special valuation whenever there are large cash flows and then to link the subperiod MWR. Exhibit 6–3 summarizes the differences between the money- and time-weighted returns.

MULTIPLE-PERIOD RETURN CALCULATION

We can compute rates of return over multiple periods by compounding the single-period returns. We often are interested in an average of the periodic returns that reflects the compounding function and how average returns are restated to an annual average basis. These topics are covered in this section.

Cumulative Returns

We saw the compounding process at work when we employed subperiod returns in the chain-linking process to create a multiperiod TWR. In this same way, we can derive cumulative returns for any period of interest to the analyst, such as month-to-date, year-to-date, first quarter of the year, one-year, three-year, and since account inception. To compound the returns, we multiply (1 + decimal return) for each period.

$$\text{Cumulative return} = [(\text{growth rate}_1) \times (\text{growth rate}_2) \cdots - 1] \times 100$$

The following spreadsheet shows the calculation of a cumulative five-year return given the series of yearly returns 9%, 6%, –2%, 8%, and –4%.

	A	B	C	D	E
1			**Growth Rates**		
2	**Year**	**Return**	**Single Period**	**Compounded**	**Cumulative Return**
3	1	0.09	1.09	1.09	9.00
4	2	0.06	1.06	1.16	15.54
5	3	-0.02	0.98	1.13	13.23
6	4	0.08	1.08	1.22	22.29
7	5	-0.04	0.96	1.17	17.40
8				=PRODUCT(C3:C7)	=(D7-1)*100

By compounding the returns, we find that the cumulative 5-year return is 17.40%.

Since we often are interested in the performance of an investment over time, we can maintain *cumulative growth rates*. Cumulative growth rates are useful for quickly calculating the cumulative return over multiple periods because we do not need to reference the intermediate returns or growth rates. Cumulative growth rates are calculated by taking the previous period ending cumulative growth rate and multiplying by (1 + current period return). We can use cumulative growth rates to calculate the expected value of an investment by multiplying it by the cumulative growth factor. For example, \$100 invested into a fund with a compound five-year growth rate of 1.2568 will result in an ending value of \$125.68.

$$100 \times (1.2568) = 125.68$$

Growth rates also can be used to derive the return between any two dates.

$$\text{Return} = \left[\left(\frac{\text{ending period growth rate}}{\text{beginning period growth rate}}\right) - 1\right] \times 100$$

We calculate cumulative returns when we are interested in the performance of investments over long-term time periods. Note that cumulative returns incorporate the assumption that investment gains are reinvested into the fund and compounded over time. The appreciation at the end of each period, as measured by the return, is treated as if it is income that is reinvested into the portfolio in the next period.

Averaging Returns

Often we are interested in calculating average, or mean, investment returns. Average returns can be used to compare the performance of investment managers or funds over time. There are two methods for calculating the average of a series of returns: the arithmetic and geometric methods. As a measure of the average return, a mean return can be calculated by adding the periodic returns together and dividing by the number of returns. The *arithmetic mean return* cannot be used in all applications. For example, we may want to use an average yearly return to project the future value of an investment. One problem with using arithmetic mean returns is that they do not take into account the compounding of returns over time. For example, if we have two yearly returns

Year	Return
1	10%
2	20%

the arithmetic mean return is 15% (20 + 10/2). The compound two-year return is 32%.

$$[(1.10) \times (1.20) - 1] \times 100 = 32.00\%$$

If we take the arithmetic mean return and plug it into the compounding formula, we will get a higher result than we did using the actual periodic returns.

$$[(1.15) \times (1.15) - 1] \times 100 = 32.25\%$$

Use of the arithmetic mean return to reconcile the beginning to ending investment value overstates the ending value. The average return we use in this application should be lower than the arithmetic mean return in order to account for the compounding process.

Geometric Mean Return

When we multiply the average yearly return by the total number of years, it does not equal the compounded return because it does not take into account the income earned by reinvesting the prior-period income. In the preceding example, the 20% return in year two was earned by reinvesting the 10% year one return, but that is not accounted for in the arithmetic average. To fix this, instead of taking the arithmetic mean return, we calculate the geometric mean return. The *geometric mean return* is the *n*th root of the compound return, where *n* is the number of periods used to calculate the compound cumulative return. Finding the root is the inverse of multiplying the growth rates.

$$\text{Geometric mean return} = \left[\left(\sqrt[N]{1 + \text{cumulative return}} - 1\right)\right] \times 100$$

The following spreadsheet shows that the geometric average yearly return derived from a two-year compound return of 32% equals 14.89%.

	A	B	C	D	E
1				Growth Rates	
2	Year	Return	Single Period	Compounded	Cumulative %
3	1	0.10	1.10	1.10	
4	2	0.20	1.20	1.32	32.00
5		=PRODUCT(C3:C4)			
6				Arithmetic yearly average:	15.00
7				Geometric yearly average:	14.89
8				=((D4^(1/2))-1)*100	
9					

Plugging the geometric mean return into the compound growth formula yields the compound return for the period.

$$\text{Compound return} = \{[1 + (\text{geometric mean return}/100)]^N - 1\} \times 100$$

We can back into the 32% compound return for two months using the geometric average return of 14.89%.

$$[(1.1489 \times 1.1489) - 1] \times 100 = 32\%$$

Column C in the spreadsheet that follows shows that one advantage of using average returns is that we do not need to know the actual periodic returns in order to calculate a future value.

	A	B	C	D
1	Year	Actual Return	Geometric Average Return	
2	1	15.00	5.34	=(((1+(B6/100))^(1/3))-1)*100
3	2	7.00	5.34	=C2
4	3	-5.00	5.34	=C2
5				
6	Year 1-3 in %	16.90	16.90	=((1+C2/100)*(1+C3/100)*(1+C4/100)-1)*100
7			=((1+B2/100)*(1+B3/100)*(1+B4/100)-1)*100	
8				

Annualizing Returns

Returns typically are presented on a *yearly,* or *annual, basis*. We do this because it is easier to compare investment returns if the time periods over which each investment has been made are put on an equivalent basis. The geometric mean return when calculated for a one-year period is called an *average annual return, compound annual return,* or *annualized return.* If the multiperiod compound return that we are annualizing was calculated for a period greater than a year long, the rate is restated to an annual basis using the inverse of the compounding formula. The inverse of taking a number and raising it to a power *n* is to take the *n*th root of the number.

$$\left[\left(\sqrt[\text{no. of years}]{(1 + \text{period rate})}\right) - 1\right] \times 100$$

An investment that earned 19.1% over a three-year period can be quoted as an annual average return of 6% by finding the third root of the cumulative growth rate.

$$\left(\sqrt[3]{1.19102}-1\right)\times 100 = 6.00$$

Notice that we calculate the annualized return by first taking the root of the cumulative growth rate (1.19102) as opposed to taking the *n*th root of the cumulative return. The *n*th root of the growth rate is the geometric average growth rate. To transform the average growth rate into a geometric average return, we subtract 1 and multiply by 100. We usually need to calculate an annualized return for cumulative periods that are not exact multiples of a year. To calculate annualized returns for such odd periods, we can calculate the actual number of calendar days in the cumulative period and divide by 365.25 to calculate an annualized equivalent.

$$\text{Annualized return} = \left[\left(\sqrt[\frac{\text{number of days}}{365.25}]{\text{linked growth rates}}\right)-1\right]\times 100$$

For example, the annualized equivalent of a 14% return earned over 16 months is equal to 10.37%.

If we are working with a dollar-weighted IRR calculated over periods longer than a year, we also can calculate an annual equivalent. To do this, we adjust the weights used to reconcile the cash flows to the ending market value so that they are multiples of a year. If we are calculating an IRR over five years, where cash flows are made at the beginning of each year, we weight the beginning investment balance by five years, the first cash flow by four years, and so on.

SUMMARY

In this chapter we outlined the procedures for calculating and interpreting the meaning of investment returns. Periodic portfolio valuation and cash-flow figures are transformed into single-period returns. Time-weighted returns measure the results attributable to the investment manager. Dollar-weighted returns reflect both the performance of the manager and the timing of investor transactions.

Rates of return are a description of one facet of investment performance. Performance measurement is also concerned with measuring the risks taken to earn these returns and the attribution of returns to market activity and active management.[1] As the investment cycle turns, the return, risk, and attribution statistics we calculate in performance measurement are the inputs to the next round of asset allocation and security-selection decisions.

1. For more on these topics, see Bruce Feibel, *Investment Performance Measurement* (Hoboken, NJ: Wiley, 2003).

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CHAPTER
SEVEN

THE STRUCTURE OF INTEREST RATES

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There is no single interest rate for any economy; rather, there is an interdependent structure of interest rates. The interest rate that a borrower has to pay depends on a myriad of factors. In this chapter we describe these factors. We begin with a discussion of the *base interest rate:* the interest rate on U.S. government securities. Next, we explain the factors that affect the yield spread or risk premium for non-Treasury securities. Finally, we focus on one particular factor that affects the interest rate demanded in an economy for a particular security: maturity. The relationship between yield and maturity (or term) is called the *term structure of interest rates*, and this relationship is critical in the valuation of securities. Determinants of the *general* level of interest rates in the economy will not be discussed.

THE BASE INTEREST RATE

The securities issued by the U.S. Department of the Treasury are backed by the full faith and credit of the U.S. government. Consequently, market participants throughout the world view them as having no credit risk. Therefore, interest rates on Treasury securities are the benchmark interest rates throughout the U.S. economy. The large sizes of Treasury issues have contributed to making the Treasury market the most active and hence the most liquid market in the world.

The minimum interest rate or *base interest rate* that investors will demand for investing in a non-Treasury security is the yield offered on a comparable maturity for an on-the-run Treasury security. The base interest rate is also referred to as the *benchmark interest rate.*

RISK PREMIUM

Market participants describe interest rates on non-Treasury securities as trading at a spread to a particular on-the-run Treasury security. For example, if the yield on a 10-year non-Treasury security is 7.68% and the yield on a 10-year Treasury security is 6.68%, the spread is 100 basis points. This spread reflects the additional risks the investor faces by acquiring a security that is not issued by the U.S. government and therefore can be called a *risk premium*. Thus we can express the interest rate offered on a non-Treasury security as

Base interest rate + spread

or equivalently,

Base interest rate + risk premium

The factors that affect the spread include (1) the type of issuer, (2) the issuer's perceived creditworthiness, (3) the term or maturity of the instrument, (4) provisions that grant either the issuer or the investor the option to do something, (5) the taxability of the interest received by investors, and (6) the expected liquidity of the issue.

Types of Issuers

A key feature of a debt obligation is the nature of the issuer. In addition to the U.S. government, there are agencies of the U.S. government, municipal governments, corporations (domestic and foreign), and foreign governments that issue bonds.

The bond market is classified by the type of issuer. These are referred to as *market sectors.* The spread between the interest rate offered in two sectors of the bond market with the same maturity is referred to as an *intermarket-sector spread.*

Excluding the Treasury market sector, other market sectors have a wide range of issuers, each with different abilities to satisfy bond obligations. For example, within the corporate market sector, issuers are classified as utilities, transportations, industrials, and banks and finance companies. The spread between two issues within a market sector is called an *intramarket-sector spread*.

Perceived Creditworthiness of Issuer

Default risk or *credit risk* refers to the risk that the issuer of a bond may be unable to make timely payment of principal or interest payments. Most market participants rely primarily on commercial rating companies to assess the default risk of an issuer. We discuss these rating companies in Chapters 13 and 32. The spread between Treasury securities and non-Treasury securities that are identical in all respects except for quality is referred to as a *credit spread* or *quality spread.*

Term-to-Maturity

As we explained in Chapter 5, the price of a bond will fluctuate over its life as yields in the market change. As demonstrated in Chapter 9, the volatility of a bond's price is dependent on its maturity. With all other factors constant, the longer the maturity of a bond, the greater is the price volatility resulting from a change in market yields.

The spread between any two maturity sectors of the market is called a *yield-curve spread* or *maturity spread.* The relationship between the yields on comparable securities with different maturities, as mentioned earlier, is called the *term structure of interest rates*.

The term-to-maturity topic is very important, and we have devoted more time to this topic later in this chapter.

Inclusion of Options

It is not uncommon for a bond issue to include a provision that gives the bondholder or the issuer an option to take some action against the other party. An option that is included in a bond issue is referred to as an *embedded option.* We discussed the various types of embedded options in Chapter 1. The most common type of option in a bond issue is the call provision, which grants the issuer the right to retire the debt, fully or partially, before the scheduled maturity date. The inclusion of a call feature benefits issuers by allowing them to replace an old bond issue with a lower-interest-cost issue when interest rates in the market decline. In effect, a call provision allows the issuer to alter the maturity of a bond. The exercise of a call provision is disadvantageous to the bondholder because the bondholder must reinvest the proceeds received at a lower interest rate.

The presence of an embedded option affects both the spread of an issue relative to a Treasury security and the spread relative to otherwise comparable issues that do not have an embedded option. In general, market participants will require a larger spread to a comparable Treasury security for an issue with an embedded option that is favorable to the issuer (such as a call option) than for an issue without such an option. In contrast, market participants will require a smaller spread to a comparable Treasury security for an issue with an embedded option that is favorable to the investor (such as a put option or a conversion option). In fact, the interest rate on a bond with an option that is favorable to an investor may be less than that on a comparable Treasury security.

Taxability of Interest

Unless exempted under the federal income tax code, interest income is taxable at the federal level. In addition to federal income taxes, there may be state and local taxes on interest income.

The federal tax code specifically exempts the interest income from qualified municipal bond issues. Because of this tax exemption, the yield on municipal bonds is less than on Treasuries with the same maturity. The difference in yield between tax-exempt securities and Treasury securities is typically measured not in basis points but in percentage terms. More specifically, it is measured as the percentage of the yield on a tax-exempt security relative to a comparable Treasury security.

The yield on a taxable bond issue after federal income taxes are paid is equal to

$$\text{After-tax yield} = \text{pretax yield} \times (1 - \text{marginal tax rate})$$

For example, suppose that a taxable bond issue offers a yield of 4% and is acquired by an investor facing a marginal tax rate of 35%. The after-tax yield would be

$$\text{After-tax yield} = 0.04 \times (1 - 0.35) = 0.026 = 2.60\%$$

Alternatively, we can determine the yield that must be offered on a taxable bond issue to give the same after-tax yield as a tax-exempt issue. This yield is called the *equivalent taxable yield* and is determined as follows:

$$\text{Equivalent taxable yield} = \frac{\text{tax-exempt yield}}{(1 - \text{marginal tax rate})}$$

For example, consider an investor facing a 35% marginal tax rate who purchases a tax-exempt issue with a yield of 2.6%. The equivalent taxable yield is then

$$\text{Equivalent taxable yield} = \frac{0.026}{(1 - 0.35)} = 0.04 = 4\%$$

Notice that the lower the marginal tax rate, the lower is the equivalent taxable yield. For example, in our previous example, if the marginal tax rate is 25% rather than 35%, the equivalent taxable yield would be 3.47% rather than 4%, as shown below.

$$\text{Equivalent taxable yield} = \frac{0.026}{(1 - 0.25)} = 0.0347 = 3.47\%$$

State and local governments may tax interest income on bond issues that are exempt from federal income taxes. Some municipalities exempt interest income from all municipal issues from taxation; others do not. Some states exempt interest income from bonds issued by municipalities within the state but tax the interest income from bonds issued by municipalities outside the state. The implication is that two municipal securities of the same quality rating and the same maturity may trade at some spread because of the relative demand for bonds of municipalities in different states. For example, in a high-income-tax state such as New York, the demand for bonds of municipalities will drive down their yield relative to municipalities in a low-income-tax state such as Florida, holding all credit issues aside.

Municipalities are not permitted to tax the interest income from securities issued by the U.S. Treasury. Thus part of the spread between Treasury securities and taxable non-Treasury securities of the same maturity reflects the value of the exemption from state and local taxes.

Expected Liquidity of an Issue

Bonds trade with different degrees of liquidity. The greater the expected liquidity at which an issue will trade, the lower is the yield that investors require. As noted earlier, Treasury securities are the most liquid securities in the world. The lower yield offered on Treasury securities relative to non-Treasury securities reflects the difference in liquidity as well as perceived credit risk. Even within the Treasury market, on-the-run issues have greater liquidity than off-the-run issues.

THE TERM STRUCTURE OF INTEREST RATES

In future chapters we will see the key role that the term structure of interest rates plays in the valuation of bonds. For this reason, we devote a good deal of space to this important topic.

The Yield Curve

The graphic depiction of the relationship between the yield on bonds of the same credit quality but different maturities is known as the *yield curve.* In the past, most market participants have constructed yield curves from the observations of prices and yields in the Treasury market. Two reasons account for this tendency. First, Treasury securities are free of default risk, and differences in creditworthiness do not affect yield estimates. Second, as the most active bond market, the Treasury market offers the fewest problems of illiquidity or infrequent trading. Exhibit 7–1 shows the shape of three hypothetical Treasury yield curves that have been observed in the United States, as well as other countries. Exhibit 7–2 shows the bellwether yield curves (presented in table format) for government bond issues for four countries (United States, Germany, United Kingdom, and Japan) for four different maturities on May 7, 2004.

From a practical viewpoint, as we explained earlier in this chapter, the key function of the Treasury yield curve is to serve as a benchmark for pricing bonds and setting yields in other sectors of the debt market, such as bank loans, mortgages, corporate debt, and international bonds. However, market participants are coming to realize that the traditionally constructed Treasury yield curve is an unsatisfactory measure of the relation between required yield and maturity. The key reason is that securities with the same maturity actually may carry different yields. As we will explain, this phenomenon reflects the impact of differences in the bonds' coupon rates. Hence it is necessary to develop more accurate and

EXHIBIT 7–1

Three Hypothetical Yield Curves

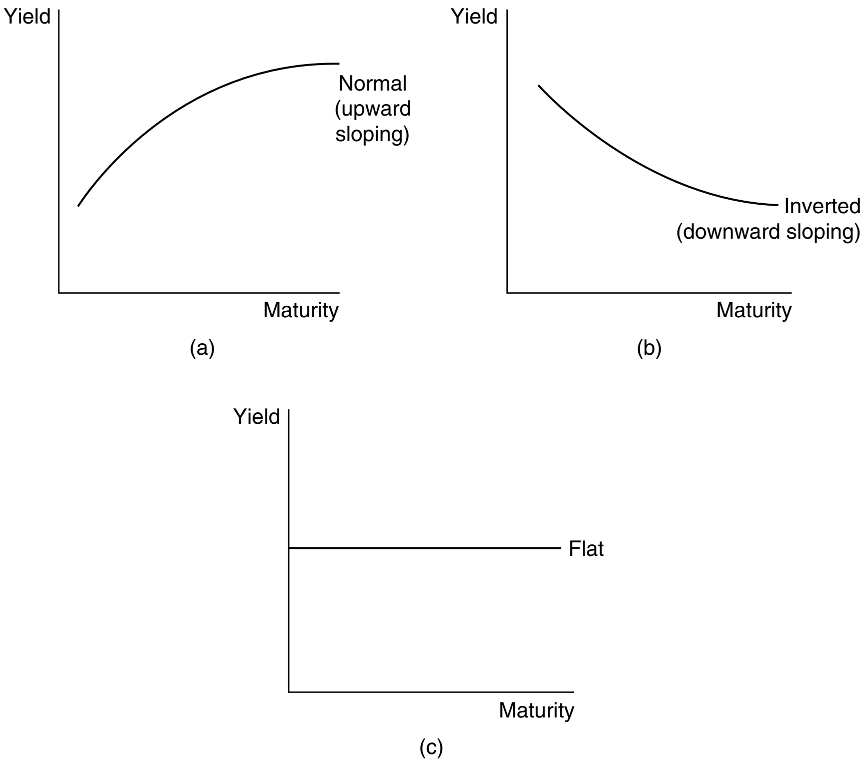

EXHIBIT 7–2

Bellwether Government Yield Curves for the United States, Germany, United Kingdom, and Japan on May 7, 2004

Maturity	United States	Germany	United Kingdom	Japan
2 years	2.60%	2.56%	4.70%	0.14%
5 years	3.43	3.55	5.02	0.61
10 years	4.77	4.29	5.11	1.47
30 years	5.46	4.99	4.93	2.06*

*Japanese 20 years used instead of 30 years.

Source: Lehman Brothers, *Relative Value Report*, May 10, 2004, p. 12.

reliable estimates of the Treasury yield curve. We will show the problems posed by traditional approaches to the Treasury yield curve, and we will explain the proper approach to building a yield curve. The approach consists of identifying yields that apply to zero-coupon bonds and, therefore, eliminates the problem of nonuniqueness in the yield-maturity relationship.

Using the Yield Curve to Price a Bond

The price of a bond is the present value of its cash flows. However, in our discussion of the pricing of a bond in Chapter 5, we assumed that one interest rate should be used to discount all the bond's cash flows. The appropriate interest rate is the yield on a Treasury security with the same maturity as the bond plus an appropriate risk premium or spread.

However, there is a problem with using the Treasury yield curve to determine the appropriate yield at which to discount the cash flow of a bond. To illustrate this problem, consider two hypothetical five-year Treasury bonds, A and B. The difference between these two Treasury bonds is the coupon rate, which is 12% for A and 3% for B. The cash flow for these two bonds per $100 of par value for the 10 six-month periods to maturity would be as follows:

Period	Cash Flow for A	Cash Flow for B
1–9	$ 6.00	$ 1.50
10	106.00	101.50

Because of the different cash flow patterns, it is not appropriate to use the same interest rate to discount all cash flows. Instead, each cash flow should be discounted at a unique interest rate that is appropriate for the time period in which the cash flow will be received. But what should be the interest rate for each period?

The correct way to think about bonds A and B is not as bonds but as packages of cash flows. More specifically, they are packages of zero-coupon instruments. Thus the interest earned is the difference between the maturity value and the price paid. For example, bond A can be viewed as 10 zero-coupon instruments: One with a maturity value of $6 maturing six months from now, a second with a maturity value of $6 maturing one year from now, a third with a maturity value of $6 maturing 1.5 years from now, and so on. The final zero-coupon instrument matures 10 six-month periods from now and has a maturity value of $106. Likewise, bond B can be viewed as 10 zero-coupon instruments: One with a maturity value of $1.50 maturing six months from now, one with a maturity value of $1.50 maturing one year from now, one with a maturity value of $1.50 maturing 1.5 years from now, and so on. The final zero-coupon instrument matures 10 six-month periods from now and has a maturity value of $101.50. Obviously, in the case of each coupon bond, the value or price of the bond is equal to the total value of its component zero-coupon instruments.

In general, any bond can be viewed as a package of zero-coupon instruments. That is, each zero-coupon instrument in the package has a maturity equal to its coupon payment date or, in the case of the principal, the maturity date. The value of the bond should equal the value of all the component zero-coupon instruments. If this does not hold, a market participant may generate riskless profits by stripping the security and creating stripped securities.

To determine the value of each zero-coupon instrument, it is necessary to know the yield on a zero-coupon Treasury with that same maturity. This yield is called the *spot rate,* and the graphic depiction of the relationship between the spot rate and its maturity is called the *spot-rate curve.* Because there are no zero-coupon Treasury debt issues with a maturity greater than one year, it is not possible to construct such a curve solely from observations of Treasury yields. Rather, it is necessary to derive this curve from theoretical considerations as applied to the yields of actual Treasury securities. Such a curve is called a *theoretical spot-rate curve.*

Constructing the Theoretical Spot-Rate Curve

The theoretical spot-rate curve is constructed from the yield curve based on the observed yields of Treasury bills and Treasury coupon securities. The process of creating a theoretical spot-rate curve in this way is called *bootstrapping.*[1] To explain this process, we use the data for the hypothetical price, annualized yield (yield-to-maturity), and maturity of the 20 Treasury securities shown in Exhibit 7–3.

Throughout the analysis and illustrations to come, it is important to remember that the basic principle of bootstrapping is that the value of a Treasury coupon security should be equal to the value of the package of zero-coupon Treasury securities that duplicates the coupon bond's cash flow.

Consider the six-month Treasury bill in Exhibit 7–3. As explained in Chapter 10, a Treasury bill is a zero-coupon instrument. Therefore, its annualized

1. In practice, the securities used to construct the theoretical spot-rate curve are the most recently auctioned Treasury securities of a given maturity. Such issues are referred to as the *on-the-run Treasury issues*. As we explain in Chapter 10, there are actual zero-coupon Treasury securities with a maturity greater than one year that are outstanding in the market. These securities are not issued by the U.S. Treasury but are created by market participants from actual coupon Treasury securities. It would seem logical that the observed yield on zero-coupon Treasury securities can be used to construct an actual spot-rate curve. However, there are problems with this approach. First, the liquidity of these securities is not as great as that of the coupon Treasury market. Second, there are maturity sectors of the zero-coupon Treasury market that attract specific investors who may be willing to trade yield in exchange for an attractive feature associated with that particular maturity sector, thereby distorting the term-structure relationship.

EXHIBIT 7–3

Maturity and Yield-to-Maturity for 20 Hypothetical Treasury Securities

Maturity	Coupon Rate	Yield-to-Maturity	Price
0.50 years	0.0000	0.0800	$ 96.15
1.00	0.0000	0.0830	92.19
1.50	0.0850	0.0890	99.45
2.00	0.0900	0.0920	99.64
2.50	0.1100	0.0940	103.49
3.00	0.0950	0.0970	99.49
3.50	0.1000	0.1000	100.00
4.00	0.1000	0.1040	98.72
4.50	0.1150	0.1060	103.16
5.00	0.0875	0.1080	92.24
5.50	0.1050	0.1090	98.38
6.00	0.1100	0.1120	99.14
6.50	0.0850	0.1140	86.94
7.00	0.0825	0.1160	84.24
7.50	0.1100	0.1180	96.09
8.00	0.0650	0.1190	72.62
8.50	0.0875	0.1200	82.97
9.00	0.1300	0.1220	104.30
9.50	0.1150	0.1240	95.06
10.00	0.1250	0.1250	100.00

yield of 8% is equal to the spot rate. Similarly, for the one-year Treasury bill, the cited yield of 8.3% is the one-year spot rate. Given these two spot rates, we can compute the spot rate for a theoretical 1.5-year zero-coupon Treasury. The price of a theoretical 1.5-year Treasury should equal the present value of three cash flows from an actual 1.5-year coupon Treasury, where the yield used for discounting is the spot rate corresponding to the cash flow. Using $100 as par, the cash flow for the 1.5-year coupon Treasury is as follows:

$$\begin{array}{lll} 0.5 \text{ years} & 0.085 \times \$100 \times 0.5 & = \$4.25 \\ 1.0 \text{ years} & 0.085 \times \$100 \times 0.5 & = \$4.25 \\ 1.5 \text{ years} & 0.085 \times \$100 \times 0.5 + 100 & = \$104.25 \end{array}$$

The present value of the cash flow is then

$$\frac{4.25}{(1+z_1)^1} + \frac{4.25}{(1+z_2)^2} + \frac{104.25}{(1+z_3)^3}$$

where

z_1 = one-half the annualized six-month theoretical spot rate
z_2 = one-half the one-year theoretical spot rate
z_3 = one-half the 1.5-year theoretical spot rate

Because the six-month spot rate and one-year spot rate are 8.0% and 8.3%, respectively, we know that

$$z_1 = 0.04 \qquad \text{and} \qquad z_2 = 0.0415.$$

We can compute the present value of the 1.5-year coupon Treasury security as

$$\frac{4.25}{(1.0400)^1} + \frac{4.25}{(1.0415)^2} + \frac{104.25}{(1+z_3)^3}$$

Because the price of the 1.5-year coupon Treasury security (from Exhibit 7–3) is \$99.45, the following relationship must hold:

$$99.45 = \frac{4.25}{(1.0400)^1} + \frac{4.25}{(1.0415)^2} + \frac{104.25}{(1+z_3)^3}$$

We can solve for the theoretical 1.5-year spot rate as follows:

$$99.45 = 4.08654 + 3.91805 + \frac{104.25}{(1+z_3)^3}$$

$$91.44541 = \frac{104.25}{(1+z_3)^3}$$

$$(1+z_3)^3 = 1.140024$$

$$z_3 = 0.04465$$

Doubling this yield, we obtain the bond-equivalent yield of 0.0893, or 8.93%, which is the theoretical 1.5-year spot rate. This rate is the rate that the market would apply to a 1.5-year zero-coupon Treasury security, if such a security existed.

Given the theoretical 1.5-year spot rate, we can obtain the theoretical two-year spot rate. The cash flow for the two-year coupon Treasury in Exhibit 7–3 is

$$\begin{aligned}
&0.5 \text{ years} \quad 0.090 \times \$100 \times 0.5 &&= \$4.50\\
&1.0 \text{ years} \quad 0.090 \times \$100 \times 0.5 &&= \$4.50\\
&1.5 \text{ years} \quad 0.090 \times \$100 \times 0.5 &&= \$4.50\\
&2.0 \text{ years} \quad 0.090 \times \$100 \times 0.5 + 100 &&= \$104.50
\end{aligned}$$

The present value of the cash flow is then

$$\frac{4.50}{(1+z_1)^1} + \frac{4.50}{(1+z_2)^2} + \frac{4.50}{(1+z_3)^3} + \frac{104.50}{(1+z_4)^4}$$

where

z_4 = one-half the two-year theoretical spot rate

Because the six-month spot rate, the one-year spot rate, and the 1.5-year spot rate are 8.0%, 8.3%, and 8.93%, respectively, then

$$z_1 = 0.04 \qquad z_2 = 0.0415 \qquad \text{and} \qquad z_3 = 0.04465$$

Therefore, the present value of the two-year coupon Treasury security is

$$\frac{4.50}{(1.0400)^1} + \frac{4.50}{(1.0415)^2} + \frac{4.50}{(1.04465)^3} + \frac{104.50}{(1+z_4)^4}$$

Because the price of the two-year coupon Treasury security is $99.64, the following relationship must hold:

$$99.64 = \frac{4.50}{(1.0400)^1} + \frac{4.50}{(1.0415)^2} + \frac{4.50}{(1.04465)^3} + \frac{104.50}{(1+z_4)^4}$$

We can solve for the theoretical two-year spot rate as follows:

$$99.64 = 4.32692 + 4.14853 + 3.94730 + \frac{104.50}{(1+z_4)^4}$$

$$87.21725 = \frac{104.50}{(1+z_4)^4}$$

$$(1+z_4)^4 = 1.198158$$

$$z_4 = 0.046235$$

Doubling this yield, we obtain the theoretical two-year spot rate bond-equivalent yield of 9.247%.

One can follow this approach sequentially to derive the theoretical 2.5-year spot rate from the calculated values of z_1, z_2, z_3, and z_4 (the six-month, one-year, 1.5-year, and two-year rates) and the price and coupon of the bond with a maturity of 2.5 years. Further, one could derive theoretical spot rates for the remaining 15 half-yearly rates. The spot rates thus obtained are shown in Exhibit 7–4. They represent the term structure of interest rates for maturities up to 10 years at the particular time to which the bond price quotations refer.

Why Treasuries Must Be Priced Based on Spot Rates

Financial theory tells us that the theoretical price of a Treasury security should be equal to the present value of the cash flows, where each cash flow is discounted at the appropriate theoretical spot rate. What we did not do, however, is demonstrate the economic force that ensures that the actual market price of a Treasury security does not depart significantly from its theoretical price.

EXHIBIT 7–4

Theoretical Spot Rates

Maturity	Yield-to-Maturity	Theoretical Spot Rate
0.50 years	0.0800	0.08000
1.00	0.0830	0.08300
1.50	0.0890	0.08930
2.00	0.0920	0.09247
2.50	0.0940	0.09468
3.00	0.0970	0.09787
3.50	0.1000	0.10129
4.00	0.1040	0.10592
4.50	0.1060	0.10850
5.00	0.1080	0.11021
5.50	0.1090	0.11175
6.00	0.1120	0.11584
6.50	0.1140	0.11744
7.00	0.1160	0.11991
7.50	0.1180	0.12405
8.00	0.1190	0.12278
8.50	0.1200	0.12546
9.00	0.1220	0.13152
9.50	0.1240	0.13377
10.00	0.1250	0.13623

To demonstrate this, we will use the 20 hypothetical Treasury securities introduced in Exhibit 7–3. The longest-maturity bond given in that exhibit is the 10-year, 12.5% coupon bond selling at par with a yield-to-maturity of 12.5%. Suppose that a government dealer buys the issue at par and strips it, expecting to sell the zero-coupon Treasury securities at the yields-to-maturity indicated in Exhibit 7–4 for the corresponding maturity.

Exhibit 7–5 shows the price that would be received for each zero-coupon Treasury security created. The price for each is the present value of the cash flow from the stripped Treasury discounted at the yield-to-maturity corresponding to the maturity of the security (from Exhibit 7–3). The total proceeds received from selling the zero-coupon Treasury securities created would be $104.1880 per $100 of par value of the original Treasury issue. This would result in an arbitrage profit of $4.1880 per $100 of the 10-year, 12.5% coupon Treasury security purchased.

To understand why the government dealer has the opportunity to realize this profit, look at the third column of Exhibit 7–5, which shows how much the

EXHIBIT 7–5

Illustration of Arbitrage Profit from Coupon Stripping

Maturity	Cash Flow	Present Value at 12.5%	Yield-to-Maturity	Present Value at Yield-to-Maturity
0.50 years	$ 6.25	$ 5.8824	0.0800	$6.0096
1.00	6.25	5.5363	0.0830	5.7618
1.50	6.25	5.2107	0.0890	5.4847
2.00	6.25	4.9042	0.0920	5.2210
2.50	6.25	4.6157	0.0940	4.9676
3.00	6.25	4.3442	0.0970	4.7040
3.50	6.25	4.0886	0.1000	4.4418
4.00	6.25	3.8481	0.1040	4.1663
4.50	6.25	3.6218	0.1060	3.9267
5.00	6.25	3.4087	0.1080	3.6938
5.50	6.25	3.2082	0.1090	3.4863
6.00	6.25	3.0195	0.1120	3.2502
6.50	6.25	2.8419	0.1140	3.0402
7.00	6.25	2.6747	0.1160	2.8384
7.50	6.25	2.5174	0.1180	2.6451
8.00	6.25	2.3693	0.1190	2.4789
8.50	6.25	2.2299	0.1200	2.3210
9.00	6.25	2.0987	0.1220	2.1528
9.50	6.25	1.9753	0.1240	1.9930
10.00	106.25	31.6046	0.1250	31.6046
Total		100.0000		$104.1880

government dealer paid for each cash flow by buying the entire package of cash flows (i.e., by buying the bond). For example, consider the $6.25 coupon payment in four years. By buying the 10-year Treasury bond priced to yield 12.5%, the dealer effectively pays a price based on 12.5% (6.25% semiannually) for that coupon payment or, equivalently, $3.8481. Under the assumptions of this illustration, however, investors were willing to accept a lower yield-to-maturity, 10.4% (5.2% semiannually), to purchase a zero-coupon Treasury security with four years to maturity. Thus investors were willing to pay $4.1663. On this one coupon payment, the government dealer realizes a profit equal to the difference between $4.1663 and $3.8481 (or $0.3182). From all the cash flows, the total profit is $4.1880. In this instance, coupon stripping shows that the sum of the parts is greater than the whole.

Suppose that instead of the observed yield-to-maturity from Exhibit 7–3, the yields investors want are the same as the theoretical spot rates shown in

Exhibit 7–4. If we use these spot rates to discount the cash flows, the total proceeds from the sale of the zero-coupon Treasury securities would be equal to \$100, making coupon stripping uneconomic.

In our illustration of coupon stripping, the price of the Treasury security is less than its theoretical price. Suppose instead that the price of the Treasury security is greater than its theoretical price. In such cases, investors can purchase a package of zero-coupon Treasury securities such that the cash flow of the package of securities replicates the cash flow of the mispriced coupon Treasury security. By doing so, the investor will realize a yield higher than the yield on the coupon Treasury security. For example, suppose that the market price of the 10-year Treasury security we used in our illustration (Exhibit 7–5) is \$106. By buying the 20 zero-coupon bonds shown in Exhibit 7–5 with a maturity value identical to the cash flow shown in the second column, the investor is effectively purchasing a 10-year Treasury coupon security at a cost of \$104.1880 instead of \$106.

The process of coupon stripping and reconstituting prevents the actual spot-rate curve observed on zero-coupon Treasuries from departing significantly from the theoretical spot-rate curve. As more stripping and reconstituting occurs, forces of demand and supply will cause rates to return to their theoretical spot-rate levels. This is what has happened in the Treasury market.

Forward Rates

Consider an investor who has a one-year investment horizon and is faced with the following two alternatives:

Alternative 1: Buy a one-year Treasury bill.

Alternative 2: Buy a six-month Treasury bill, and when it matures in six months, buy another six-month Treasury bill.

The investor will be indifferent between the two alternatives if they produce the same return over the one-year investment horizon. The investor knows the spot rate on the six-month Treasury bill and the one-year Treasury bill. However, she does not know what yield will be available on a six-month Treasury bill that will be purchased six months from now. The yield on a six-month Treasury bill six months from now is called a *forward rate.* Given the spot rates for the six-month Treasury bill and the one-year bill, we wish to determine the forward rate on a six-month Treasury bill that will make the investor indifferent between the two alternatives. That rate can be readily determined.

At this point, however, we need to digress briefly and recall several present-value and investment relationships. First, if you invested in a one-year Treasury bill, you would receive \$100 at the end of one year. The price of the one-year Treasury bill would be

$$\frac{100}{(1+z_2)^2}$$

where z_2 is one-half the bond-equivalent yield of the theoretical one-year spot rate.

Second, suppose that you purchased a six-month Treasury bill for $X. At the end of six months, the value of this investment would be

$$X(1+z_1)$$

where z_1 is one-half the bond-equivalent yield of the theoretical six-month spot rate.

Let f represent one-half the forward rate (expressed as a bond-equivalent basis) on a six-month Treasury bill available six months from now. If the investor were to renew her investment by purchasing that bill at that time, then the future dollars available at the end of one year from the $X investment would be

$$X(1+z_1)(1+f)$$

Third, it is easy to use this formula to find out how many $X the investor must invest in order to get $100 one year from now. This can be found as follows:

$$X(1+z_1)(1+f)=100$$

which gives us

$$X=\frac{100}{(1+z_1)(1+f)}$$

We are now prepared to return to the investor's choices and analyze what that situation says about forward rates. The investor will be indifferent between the two alternatives confronting her if she makes the same dollar investment and receives $100 from both alternatives at the end of one year. That is, the investor will be indifferent if

$$\frac{100}{(1+z_2)^2}=\frac{100}{(1+z_1)(1+f)}$$

Solving for f, we get

$$f=\frac{(1+z_2)^2}{(1+z_1)^1}-1$$

Doubling f gives the bond-equivalent yield for the six-month forward rate six months from now.

We can illustrate the use of this formula with the theoretical spot rates shown in Exhibit 7–4. From that exhibit, we know that

$$\text{Six-month bill spot rate} = 0.080 \quad \text{so} \quad z_1 = 0.0400$$

$$\text{One-year bill spot rate} = 0.083 \quad \text{so} \quad z_2 = 0.0415$$

Substituting into the formula, we have

$$f = \frac{(1.0415)^2}{1.0400} - 1$$
$$= 0.043$$

Therefore, the forward rate on a six-month Treasury security, quoted on a bond-equivalent basis, is 8.6% (0.043 × 2). Let's confirm our results. The price of a one-year Treasury bill with a $100 maturity value is

$$\frac{100}{(1.0415)^2} = 92.19$$

If $92.19 is invested for six months at the six-month spot rate of 8%, the amount at the end of six months would be

$$92.19(1.0400) = 95.8776$$

If $95.8776 is reinvested for another six months in a six-month Treasury offering 4.3% for six months (8.6% annually), the amount at the end of one year would be

$$95.8776(1.043) = 100$$

Both alternatives will have the same $100 payoff if the six-month Treasury bill yield six months from now is 4.3% (8.6% on a bond-equivalent basis). This means that if an investor is guaranteed a 4.3% yield (8.6% bond-equivalent basis) on a six-month Treasury bill six months from now, she will be indifferent between the two alternatives.

We used the theoretical spot rates to compute the forward rate. The resulting forward rate is also called the *implied forward rate.*

We can take this sort of analysis much further. It is not necessary to limit ourselves to implied forward rates six months from now. The yield curve can be used to calculate the implied forward rate for any time in the future for any investment horizon. For example, the following can be calculated:

- The two-year implied forward rate five years from now
- The six-year implied forward rate two years from now
- The seven-year implied forward rate three years from now

Relationship between Spot Rates and Short-Term Forward Rates

Suppose that an investor purchases a five-year zero-coupon Treasury security for $58.42 with a maturity value of $100. He could instead buy a six-month Treasury bill and reinvest the proceeds every six months for five years. The number of dollars that will be realized depends on the six-month forward rates. Suppose that the investor actually can reinvest the proceeds maturing every six months at the implied six-month forward rates. Let's see how many dollars would accumulate at the end of five years. The implied six-month forward rates were calculated for the yield curve given in Exhibit 7–4. Letting f_t denote the six-month forward rate beginning t six-month periods from now, the semiannual implied forward rates using the spot rates shown in that exhibit are as follows:

$$f_1 = 0.043000 \quad f_2 = 0.050980 \quad f_3 = 0.051005 \quad f_4 = 0.051770$$
$$f_5 = 0.056945 \quad f_6 = 0.060965 \quad f_7 = 0.069310 \quad f_8 = 0.064625$$
$$f_9 = 0.062830$$

If he invests the \$58.48 at the six-month spot rate of 4% (8% on a bond-equivalent basis) and reinvests at the forward rates shown above, the number of dollars accumulated at the end of five years would be

$$\$58.48(1.04)(1.043)(1.05098)(1.051005)(1.05177)(1.056945)$$
$$\times (1.060965)(1.069310)(1.064625)(1.06283) = \$100$$

Therefore, we see that if the implied forward rates are realized, the \$58.48 investment will produce the same number of dollars as an investment in a five-year zero-coupon Treasury security at the five-year spot rate. From this illustration, we can see that the five-year spot rate is related to the current six-month spot rate and the implied six-month forward rates.

In general, the relationship between a t-period spot rate, the current six-month spot rate, and the implied six-month forward rates is as follows:

$$z_t = [(1 + z_1)(1 + f_1)(1 + f_2)(1 + f_3)\cdots(1 + f_{t-1})]^{1/t} - 1$$

Why should an investor care about forward rates? There are actually very good reasons for doing so. Knowledge of the forward rates implied in the current long-term rate is relevant in formulating an investment policy. In addition, forward rates are key inputs into the valuation of bonds with embedded options.

For example, suppose that an investor wants to invest for one year (two six-month periods); the current six-month or short rate (z_1) is 7%, and the one-year (two-period) rate (z_2) is 6%. Using the formulas we have developed, the investor finds that by buying a two-period security, she is effectively making a forward contract to lend money six months from now at the rate of 5% for six months. If the investor believes that the second-period rate will turn out to be higher than 5%, it will be to her advantage to lend initially on a one-period contract and then at the end of the first period to reinvest interest and principal in the one-period contract available for the second period.

Determinants of the Shape of the Term Structure

If we plot the term structure—the yield-to-maturity, or the spot rate, at successive maturities against maturity—what will it look like? Exhibit 7–1 shows three shapes that have appeared with some frequency over time. Panel *a* shows an upward-sloping yield curve; that is, yield rises steadily as maturity increases. This shape is commonly referred to as a *normal* or *upward-sloping yield curve.* Panel *b* shows a *downward-sloping* or *inverted yield curve,* where yields decline as maturity increases. Finally, panel *c* shows a *flat yield curve.*

Two major theories have evolved to account for these shapes: the *expectations theory* and the *market-segmentation theory*.

There are three forms of the expectations theory: the *pure expectations theory,* the *liquidity theory*, and the *preferred-habitat theory*. All share a hypothesis about the behavior of short-term forward rates and also assume that the forward rates in current long-term bonds are closely related to the market's expectations about future short-term rates. These three theories differ, however, on whether other factors also affect forward rates and how. The pure expectations theory postulates that no systematic factors other than expected future short-term rates affect forward rates; the liquidity theory and the preferred-habitat theory assert that there are other factors. Accordingly, the last two forms of the expectations theory are sometimes referred to as *biased expectations theories*.

The Pure Expectations Theory

According to the pure expectations theory, the forward rates exclusively represent expected future rates. Thus the entire term structure at a given time reflects the market's current expectations of future short-term rates. Under this view, a rising term structure, as shown in panel *a* of Exhibit 7–1, must indicate that the market expects short-term rates to rise throughout the relevant future. Similarly, a flat term structure reflects an expectation that future short-term rates will be mostly constant, and a falling term structure must reflect an expectation that future short-term rates will decline steadily.

We can illustrate this theory by considering how an expectation of a rising short-term future rate would affect the behavior of various market participants to result in a rising yield curve. Assume an initially flat term structure, and suppose that economic news leads market participants to expect interest rates to rise.

- Market participants interested in a long-term investment would not want to buy long-term bonds because they would expect the yield structure to rise sooner or later, resulting in a price decline for the bonds and a capital loss on the long-term bonds purchased. Instead, they would want to invest in short-term debt obligations until the rise in yield had occurred, permitting them to reinvest their funds at the higher yield.
- Speculators expecting rising rates would anticipate a decline in the price of long-term bonds and therefore would want to sell any long-term bonds they own and possibly to "short sell" some they do not now own. (Should interest rates rise as expected, the price of longer-term bonds will fall. Because the speculator sold these bonds short and can then purchase them at a lower price to cover the short sale, a profit will be earned.) The proceeds received from the selling of long-term debt

issues or the shorting of longer-term bonds will be invested in short-term debt obligations.

- Borrowers wishing to acquire long-term funds would be pulled toward borrowing now, in the long end of the market, by the expectation that borrowing at a later time would be more expensive.

All these responses would tend either to lower the net demand for or to increase the supply of long-maturity bonds, and two responses would increase demand for short-term debt obligations. This would require a rise in long-term yields in relation to short-term yields; that is, these actions by investors, speculators, and borrowers would tilt the term structure upward until it is consistent with expectations of higher future interest rates. By analogous reasoning, an unexpected event leading to the expectation of lower future rates will result in a downward-sloping yield curve.

Unfortunately, the pure expectations theory suffers from one serious shortcoming. It does not account for the risks inherent in investing in bonds and like instruments. If forward rates were perfect predictors of future interest rates, then the future prices of bonds would be known with certainty. The return over any investment period would be certain and independent of the maturity of the instrument initially acquired and of the time at which the investor needed to liquidate the instrument. However, with uncertainty about future interest rates and hence about future prices of bonds, these instruments become risky investments in the sense that the return over some investment horizon is unknown.

There are two risks that cause uncertainty about the return over some investment horizon. The first is the uncertainty about the price of the bond at the end of the investment horizon. For example, an investor who plans to invest for five years might consider the following three investment alternatives: (1) invest in a 5-year bond and hold it for five years, (2) invest in a 12-year bond and sell it at the end of five years, and (3) invest in a 30-year bond and sell it at the end of five years. The return that will be realized for the second and third alternatives is not known because the price of each long-term bond at the end of five years is not known. In the case of the 12-year bond, the price will depend on the yield on 7-year debt securities five years from now, and the price of the 30-year bond will depend on the yield on 25-year bonds five years from now. Because forward rates implied in the current term structure for a future 7-year bond and a future 25-year bond are not perfect predictors of the actual future rates, there is uncertainty about the price for both bonds five years from now. Thus there is *price risk:* The risk that the price of the bond will be lower than currently expected at the end of the investment horizon. As explained in Chapter 9, an important feature of price risk is that it increases as the maturity of the bond increases.

The second risk involves the uncertainty about the rate at which the proceeds from a bond that matures during the investment horizon can be reinvested and is known as *reinvestment risk*. For example, an investor who plans to invest for five years might consider the following three alternative investments: (1) invest in a five-year bond and hold it for five years, (2) invest in a six-month instrument and, when it matures, reinvest the proceeds in six-month instruments over the entire five-year investment horizon, and (3) invest in a two-year bond and, when it matures, reinvest the proceeds in a three-year bond. The risk in the second and third alternatives is that the return over the five-year investment horizon is unknown because rates at which the proceeds can be reinvested are unknown.

Several interpretations of the pure expectations theory have been put forth by economists. These interpretations are not exact equivalents, nor are they consistent with each other, in large part because they offer different treatments of price risk and reinvestment risk.[2]

The broadest interpretation of the pure expectations theory suggests that investors expect the return for any investment horizon to be the same, regardless of the maturity strategy selected.[3] For example, consider an investor who has a five-year investment horizon. According to this theory, it makes no difference if a 5-year, 12-year, or 30-year bond is purchased and held for five years because the investor expects the return from all three bonds to be the same over five years. A major criticism of this very broad interpretation of the theory is that because of price risk associated with investing in bonds with a maturity greater than the investment horizon, the expected returns from these three very different bond investments should differ in significant ways.[4]

A second interpretation, referred to as the *local-expectations* form of the pure expectations theory, suggests that the return will be the same over a short-term investment horizon starting today. For example, if an investor has a six-month investment horizon, buying a 5-year, 10-year, or 20-year bond will produce the same six-month return. It has been demonstrated that the local expectations formulation, which is narrow in scope, is the only interpretation of the pure expectations theory that can be sustained in equilibrium.[5]

The third interpretation of the pure expectations theory suggests that the return an investor will realize by rolling over short-term bonds to some investment horizon will be the same as holding a zero-coupon bond with a maturity that is the same as that investment horizon. (A zero-coupon bond has no reinvestment risk, so future interest rates over the investment horizon do not affect the return.) This variant is called the *return-to-maturity expectations* interpretation. For example, let's once again assume that an investor has a five-year investment horizon. If he buys a five-year zero-coupon bond and holds it to maturity, his return is the difference between the maturity value and the price of the bond, all divided by the price of the bond. According to the return-to-maturity expectations, the same return will be

2. These formulations are summarized by John Cox, Jonathan Ingersoll, Jr., and Stephen Ross, "A Re-Examination of Traditional Hypotheses about the Term Structure of Interest Rates," *Journal of Finance* (September 1981), pp. 769–799.
3. F Lutz, "The Structure of Interest Rates," *Quarterly Journal of Economics* (1940–41), pp. 36–63.
4. Cox, Ingersoll, and Ross, *op. cit.*, pp. 774–775.
5. Cox, Ingersoll, and Ross, *op. cit.*, p. 788.

realized by buying a six-month instrument and rolling it over for five years. At this time, the validity of this interpretation is subject to considerable doubt.

The Liquidity Theory

We have explained that the drawback of the pure expectations theory is that it does not account for the risks associated with investing in bonds. Nonetheless, we have just shown that there is indeed risk in holding a long-term bond for one period, and that risk increases with the bond's maturity because maturity and price volatility are directly related.

Given this uncertainty, and the reasonable consideration that investors typically do not like uncertainty, some economists and financial analysts have suggested a different theory. This theory states that investors will hold longer-term maturities if they are offered a long-term rate higher than the average of expected future rates by a risk premium that is positively related to the term to maturity.[6] Put differently, the forward rates should reflect both interest-rate expectations and a liquidity premium (which is really a risk premium), and the premium should be higher for longer maturities.

According to this theory, which is called the *liquidity theory of the term structure,* the implied forward rates will not be an unbiased estimate of the market's expectations of future interest rates because they include a liquidity premium. Thus an upward-sloping yield curve may reflect expectations that future interest rates either will rise or will be flat (or even fall) but with a liquidity premium increasing fast enough with maturity so as to produce an upward-sloping yield curve.

The Preferred-Habitat Theory

Another theory, known as the *preferred-habitat theory,* also adopts the view that the term structure reflects the expectation of the future path of interest rates as well as a risk premium. However, the preferred-habitat theory rejects the assertion that the risk premium must rise uniformly with maturity.[7] Proponents of the preferred-habitat theory say that the latter conclusion could be accepted if all investors intend to liquidate their investment at the shortest possible date and all borrowers are anxious to borrow long. This assumption can be rejected because institutions have holding periods dictated by the nature of their liabilities.

The preferred-habitat theory asserts that, to the extent that the demand and supply of funds in a given maturity range do not match, some lenders and borrowers will be induced to shift to maturities showing the opposite imbalances. However, they will need to be compensated by an appropriate risk premium that reflects the extent of aversion to either price or reinvestment risk.

6. John R. Hicks, *Value and Capital*, second 2d ed. (London: Oxford University Press, 1946), pp. 141–145.

7. Franco Modigliani and Richard Sutch, "Innovations in Interest Rate Policy," *American Economic Review* (May 1966), pp. 178–197.

Thus this theory proposes that the shape of the yield curve is determined by both expectations of future interest rates and a risk premium, positive or negative, to induce market participants to shift out of their preferred habitat. Clearly, according to this theory, yield curves sloping up, down, flat, or humped are all possible.

Market-Segmentation Theory

The *market-segmentation theory* recognizes that investors have preferred habitats dictated by the nature of their liabilities. This theory also proposes that the major reason for the shape of the yield curve lies in asset/liability management constraints (either regulatory or self-imposed) and creditors (borrowers) restricting their lending (financing) to specific maturity sectors.[8] However, the market-segmentation theory differs from the preferred-habitat theory in that it assumes that neither investors nor borrowers are willing to shift from one maturity sector to another to take advantage of opportunities arising from differences between expectations and forward rates. Thus, for the segmentation theory, the shape of the yield curve is determined by supply of and demand for securities within each maturity sector.

SUMMARY

In all economies, there is not just one interest rate but a structure of interest rates. The difference between the yields on any two bonds is called the yield spread. The base interest rate is the yield on a Treasury security. The yield spread between a non-Treasury security and a comparable on-the-run Treasury security is called a risk premium. The factors that affect the spread include (1) the type of issuer (e.g., agency, corporate, municipality), (2) the issuer's perceived creditworthiness as measured by the rating system of commercial rating companies, (3) the term or maturity of the instrument, (4) the embedded options in a bond issue (e.g., call, put, or conversion provisions), (5) the taxability of interest income at the federal and municipal levels, and (6) the expected liquidity of the issue.

The relationship between yield and maturity is referred to as the term structure of interest rates. The graphic depiction of the relationship between the yield on bonds of the same credit quality but different maturities is known as the yield curve. Because the yield on Treasury securities is the base rate from which a nongovernment bond's yield often is benchmarked, the most commonly constructed yield curve is the Treasury yield curve.

There is a problem with using the Treasury yield curve to determine the one yield at which to discount all the cash payments of any bond. Each cash flow should be discounted at a unique interest rate that is applicable to the time period in which the cash flow is to be received. Because any bond can be viewed as a

8. This theory was suggested in J. M. Culbertson, "The Term Structure of Interest Rates," *Quarterly Journal of Economics* (November 1957), pp. 489–504.

package of zero-coupon instruments, its value should equal the value of all the component zero-coupon instruments. The rate on a zero-coupon bond is called the spot rate. The theoretical spot-rate curve for Treasury securities can be estimated from the Treasury yield curve using a method known as bootstrapping.

Under certain assumptions, the market's expectation of future interest rates can be extrapolated from the theoretical Treasury spot-rate curve. The resulting forward rate is called the implied forward rate.

Several theories have been proposed about the determinants of the term structure: the pure expectations theory, the biased expectations theories (the liquidity theory and the preferred-habitat theory), and the market-segmentation theory. All the expectation theories hypothesize that the one-period forward rates represent the market's expectations of future actual rates. The pure expectations theory asserts that these rates constitute the only factor. The biased expectations theories assert that there are other factors that determine the term structure.

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CHAPTER
EIGHT

OVERVIEW OF FORWARD RATE ANALYSIS

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Over the years, advances have been made in both the theoretical and the empirical analysis of the term structure of interest rates. However, such analysis is often very quantitative, and it rarely emphasizes practical investment applications. In this chapter we briefly describe the computation of par, spot, and forward rates, present a framework for interpreting the forward rates by identifying their main determinants, and develop practical tools for using the information in forward rates in active bond portfolio management.

The three main influences on the Treasury yield curve shape are (1) the market's expectations of future rate changes, (2) bond risk premiums (expected return differentials across bonds of different maturities), and (3) convexity bias. Conceptually, it is easy to divide the yield curve (or the term structure of forward rates) into these three components. It is much harder to interpret real-world yield-curve shapes, but the potential benefits are substantial. For example, investors often wonder whether the curve steepness reflects the market's expectations of rising rates or a positive risk premium. The answer to this question determines whether a duration extension increases expected returns. It also shows whether we can view forward rates as the market's expectations of future spot rates. In addition, in this chapter we will explain how the market's curve reshaping and volatility expectations influence the shape of today's yield curve. These expectations determine the cost of enhancing portfolio convexity via a duration-neutral yield curve trade.[1]

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1. Details on each of the three influences on the yield curve can be found at Antti Ilmanen, "Market's Rate Expectations and Forward Rates," *Journal of Fixed Income* (September 1996), pp. 8–22; Antti Ilmanen, "Does Duration Extension Enhance Long-Term Expected Returns?" *Journal of Fixed Income* (September 1996), pp. 23–36; and Antti Ilmanen, "Convexity Bias in the Yield Curve," Chapter 3 in Narasimgan Jegadeesh and Bruce Tuckman (eds.), *Advanced Fixed-Income Valuation Tools* (New York: Wiley, 2000).

Forward rate analysis also can be valuable in direct applications. Forward rates may be used as break-even rates to which subjective rate forecasts are compared or as relative-value tools to identify attractive yield curve sectors.[2]

COMPUTATION OF PAR, SPOT, AND FORWARD RATES

At the outset, it is useful to review the concepts yield-to-maturity, par yield, spot rate, and forward rate to ensure that we are using our terms consistently. Appendix 8A is a reference that describes the notation and definitions of the main concepts used in this chapter. Our analysis focuses on government bonds that have known cash flows (no default risk, no embedded options). *Yield-to-maturity* is the single discount rate that equates the present value of a bond's cash flows to its market price. *A yield curve* is a graph of bond yields against their maturities. (Alternatively, bond yields may be plotted against their durations, as we do in many of the exhibits presented in this chapter.) The best-known yield curves are the on-the-run Treasury curve and the interest-rate-swap curve. On-the-run bonds are the most recently issued government bonds at each maturity sector. Since these bonds are always issued with price near par (100), the on-the-run curve often resembles the *par yield curve,* which is a curve constructed for theoretical bonds whose prices equal par. The swap curve based on receive-fixed, pay-floating contracts is by construction a par curve.

While the yield-to-maturity is a convenient summary measure of a bond's expected return—and therefore a popular tool in relative-value analysis—the use of a single rate to discount multiple cash flows can be problematic unless the yield curve is flat. First, all cash flows of a given bond are discounted at the same rate, even if the yield-curve slope suggests that different discount rates are appropriate for different cash-flow dates. Second, the assumed reinvestment rate of a cash flow paid on a given date can vary across bonds because it depends on the yield of the bond to which the cash flow is attached. In this chapter we will show how to analyze the yield curve using simpler building blocks—single cash flows and one-period discount rates—than the yield-to-maturity, an *average* discount rate of multiple cash flows with various maturities.

A coupon bond can be viewed as a bundle of zero-coupon bonds (zeros). It can be unbundled to a set of zeros that can be valued separately. Then these can be bundled back together into a more complex bond whose price should equal the sum of the component prices.[3] The *spot rate* is the discount rate of a single future cash flow such as a zero. Equation (8.1) shows the simple relation between an

2. For a discussion of how to analyze many aspects of yield-curve trades, such as barbell-bullet trades, and a presentation of empirical evidence about their historical behavior, see Antti Ilmanen and Ray Iwanowski, "Dynamics of the Shape of the Yield Curve," *Journal of Fixed Income* (September 1997), pp. 47–60; and Chapter 40 in this Handbook.

3. Arbitrage activities ensure that a bond's present value is very similar when its cash flows are discounted using the marketwide spot rates as when its cash flows are discounted using the

n-year zero's price P_n and the annualized n-year spot rate s_n.

$$P_n = \frac{100}{(1+S_n)^n} \tag{8.1}$$

A single cash flow is easy to analyze, but its discount rate can be unbundled even further to one-period rates. A multiyear spot rate can be decomposed into a product of *one-year forward rates,* the simplest building blocks in a term structure of interest rates. A given term structure of spot rates implies a specific term structure of forward rates. For example, if the m-year and n-year spot rates are known, the annualized forward rate between maturities m and n, that is, $f_{m,n}$, is easily computed from Eq. (8.2).

$$(1+f_{m,n})^{n-m} = \frac{(1+s_n)^n}{(1+s_m)^m} \tag{8.2}$$

The forward rate is the interest rate for a loan between any two dates in the future, contracted today. Any forward rate can be "locked in" today by buying one unit of the n-year zero at price $P_n = 100/(1 + s_n)^n$ and by shortselling P_n/P_m units of the m-year zero at price $P_m = 100/(1 + s_m)^m$. (Such a weighting requires no net investment today because both the cash inflow and cash outflow amount to P_n.) The one-year forward rate ($f_{n-1,n}$ such as $f_{1,2}, f_{2,3}, f_{3,4}, \ldots$) represents a special case of Eq. (8.3) where $m = n - 1$. The spot rate represents another special case where $m = 0$; thus $s_n = f_{0,n}$.

To summarize, a par rate is used to discount a set of cash flows (those of a par bond) to today, a spot rate is used to discount a single future cash flow to today, and a forward rate is used to discount a single future cash flow to another (nearer) future date. The par yield curve, the spot-rate curve, and the forward-rate curve contain the same information about today's term structure of interest rates.[4] If one set of rates is known, it is easy to compute the other sets.[5] Exhibit 8–1 shows a hypothetical example of the three curves. In Appendix 8B, we show how the spot and forward rates were computed based on the par yields.

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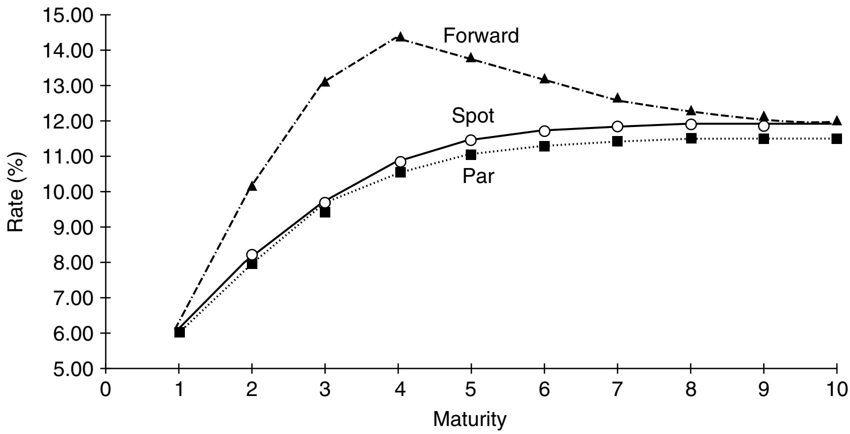
bond's own yield-to-maturity. However, some deviations are possible because of transaction costs and other market imperfections. In other words, the term structure of spot rates gives a consistent set of discount rates for all government bonds, but all bonds' market prices are not exactly consistent with these discount rates. Individual bonds may be rich or cheap relative to the curve because of bond-specific-liquidity, coupon, tax, or supply effects.

4. These curves can be computed directly by interpolating between on-the-run bond yields (approximate par curve) or between zero yields (spot curve). Because these assets have special liquidity characteristics, these curves may not be representative of the broad Treasury market. Therefore, the par, spot, or forward rate curve is typically estimated using a broad universe of coupon Treasury bond prices. There are many different curve-fitting techniques, but a common goal is to fit the prices well with a reasonably shaped curve. This chapter does not focus on yield-curve estimation but on the interpretation and practical uses of the curve once it has been estimated.

5. Further, one can use today's spot rates and Eq. (8.2) to back out implied spot curves for any future date and implied future paths for the spot rate of any maturity. It is important to distinguish

EXHIBIT 8–1

Par, Spot, and One-Year Forward Rate Curves



In this example, the par and spot curves are monotonically upward-sloping, whereas the forward rate curve[6] is first upward-sloping and then inverts (because of the flattening of the spot curve). The spot curve lies above the par curve, and the forward rate curve lies above the spot curve. This is always the case if the spot curve is upward-sloping. If it is inverted, the ordering is reversed: The par curve is highest, and the forward curve lowest. Thus loose characterizations of one curve (e.g., steeply upward-sloping, flat, inverted, humped) generally are applicable to the other curves. However, the three curves are identical only if they are horizontal. The forward rate curve magnifies any variation in the slope of the spot curve. One-year forward rates measure the *marginal* reward for lengthening the maturity of the investment by one year, whereas the spot rates measure an investment's *average* reward from today to maturity n. Therefore, spot rates are (geometric) averages of one or more forward rates. Similarly, par rates are averages of one or more spot rates; thus par curves have the flattest shape of the three curves. In Appendix 8C, we discuss further the relation between spot and forward rate curves.

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the implied spot curve one year forward ($f_{1,2}, f_{1,3}, f_{1,4}, \ldots$), a special case of Eq. (8.2) where $m = 1$, from the one-year forward rate curve ($f_{1,2}, f_{2,3}, f_{3,4}, \ldots$). Today's spot curve can be subtracted from the former curve to derive the yield changes implied by the forwards. (This terminology is somewhat misleading because these "implied" forward curves/paths do not reflect only the market's expectations of future rates.)

6. Note that all one-year forward rates actually have a one-year maturity even though in the x axis of Exhibit 8–1 each forward rate's maturity refers to the final maturity. For example, the one-year forward rate between $n - 1$ and n ($f_{n-1,n}$) matures n years from today.

It is useful to view forward rates as *break-even rates*. The implied spot rates one year forward ($f_{1,2}$, $f_{1,3}$, $f_{1,4}$, . . .) are, by construction, equal to such future spot rates that would make all government bonds earn the same return over the next year as the (riskless) one-year zero. For example, the holding-period return of today's two-year zero (whose rate today is s_2) will depend on its selling rate (as a one-year zero) in one year's time. The implied one-year spot rate one year forward ($f_{1,2}$) is computed as the selling rate that would make the two-year zero's return [the left-hand side of Eq. (8.3)] equal to the one-year spot rate [the right-hand side of Eq. (8.3)]. Formally, Eq. (8.3) is derived from Eq. (8.2) by setting $m = 1$ and $n = 2$ and rearranging.

$$\frac{(1+s_2)^2}{1+f_{1,2}} = 1+s_1 \tag{8.3}$$

Consider an example using numbers from Exhibit 8B–1 in Appendix 8B, where the one-year spot rate (s_1) equals 6% and the two-year spot rate (s_2) equals 8.08%. Plugging these spot rates into Eq. (8.3), we find that the implied one-year spot rate one year forward ($f_{1,2}$) equals 10.20%. If this implied forward rate is exactly realized one year hence, today's two-year zero will be worth 100/1.1020 = 90.74 next year. Today, this zero is worth $100/1.0808^2$ = 85.61; thus its return over the next year would be 90.74/85.61 – 1 = 6%, exactly the same as today's one-year spot rate. Thus 10.20% is the break-even level of the future one-year spot rate. In other words, the one-year rate has to increase by more than 420 basis points (10.20% – 6.00%) before the two-year zero underperforms the one-year zero over the next year. If the one-year rate increases, but by less than 420 basis points, the capital loss of the two-year zero will not fully offset its initial yield advantage over the one-year zero.

More generally, if the yield changes implied by the forward rates are realized subsequently, all government bonds, regardless of maturity, earn the same holding-period return. In addition, all self-financed positions of government bonds (such as long a barbell versus short a bullet) earn zero return; that is, they break even. However, if the yield curve remains unchanged over a year, each n-year zero earns the corresponding one-year forward rate $f_{n-1,n}$. This can be seen from Eq. (8.2) when $m = n - 1$; $1 + f_{n-1,n}$ equals $(1 + s_n)^n/(1 + s_{n-1})^{n-1}$, which is the holding-period return from buying an n-year zero at rate s_n and selling it one year later at rate s_{n-1}. Thus the one-year forward rate equals a zero's horizon return for an unchanged yield curve. See Appendix 8C for details.

MAIN INFLUENCES ON THE YIELD-CURVE SHAPE

In this section we describe some economic forces that influence the term structure of forward rates or, more generally, the yield-curve shape. The three main influences are the market's rate expectations, the bond risk premiums (expected return differentials across bonds), and the so-called convexity bias. In fact, these three components fully determine the yield curve; it can be shown that the difference between each one-year forward rate and the one-year spot rate is approximately equal to the sum of an expected spot-rate change, a bond risk premium, and the convexity bias.[7] We first discuss separately how each component alone influences the curve shape and then analyze their combined impact.

Expectations

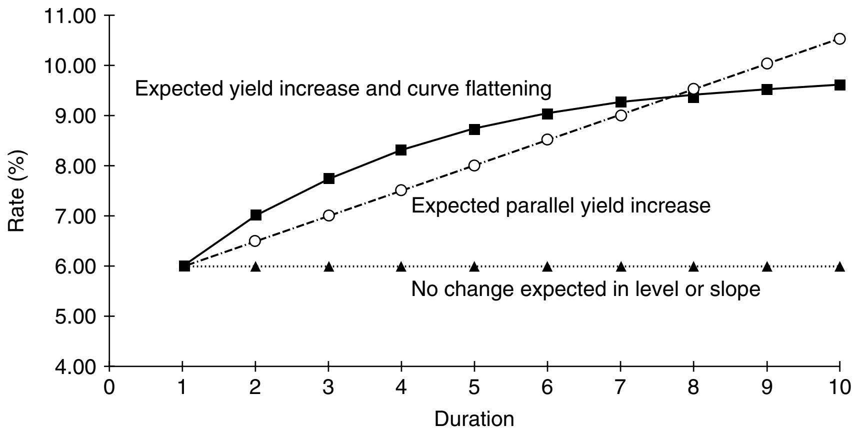
It is clear that the market's expectations of future rate changes are one important determinant of the yield-curve shape. For example, a steeply upward-sloping curve may indicate market expectations of near-term Fed tightening or of rising inflation. However, it may be too restrictive to assume that the yield differences across bonds with different maturities *only* reflect the market's rate expectations. The well-known pure expectations hypothesis has such an extreme implication. The *pure expectations hypothesis* asserts that all government bonds have the same near-term expected return (as the nominally riskless short-term bond) because the return-seeking activity of risk-neutral traders removes all expected return differentials across bonds. Near-term expected returns are equalized if all bonds that have higher yields than the short-term rate are expected to suffer capital losses that offset their yield advantage. When the market expects an increase in bond yields, the current term structure becomes upward-sloping so that any long-term bond's yield advantage and expected capital loss (owing to the expected yield increase) exactly offset each other. Stated differently, if investors expect that their long-term bond investments will lose value owing to an increase in interest rates, they will require a higher initial yield as a compensation for duration extension. Conversely, expectations of yield declines and capital gains will lower current long-term bond yields below the short-term rate, making the term structure inverted.

The same logic—that positive (negative) initial yield spreads offset expected capital losses (gains) to equate near-term expected returns—also holds for combinations of bonds, including duration-neutral yield-curve positions. One example is a trade that benefits from the flattening of the yield curve between two- and ten-year maturities: selling a unit of the two-year bond, buying a duration-weighted amount (market value) of the ten-year bond, and putting the remaining proceeds from the sale to "cash" (very short-term bonds). Given the typical concave yield-curve shape, such a curve-flattening position earns a negative carry.[8] The trade will be profitable only if the curve flattens enough to offset the impact of the negative carry. Implied forward

7. The proof is provided in the appendix to Chapter 40.
8. A concave shape means that the (upward-sloping) yield curve is steeper in the front end than in the long end. The yield loss of moving from the two-year bond to cash is greater than the yield gain of moving from the two-year bond to the ten-year bond. Thus the yield earned from the combination of cash and tens is lower than the forgone yield from twos.

EXHIBIT 8–2

Yield Curves Given the Market's Various Rate Expectations



rates indicate how much flattening (narrowing of the two- to ten-year spread) is needed for the trade to break even.

In the same way as the market's expectations regarding the future level of rates influence the *steepness* of today's yield curve, the market's expectations regarding the future steepness of the yield curve influence the *curvature* of today's yield curve. If the market expects more curve flattening, the negative carry of the flattening trades needs to be larger (to offset the expected capital gains), which makes today's yield curve more concave (curved). Exhibit 8–2 illustrates these points. This figure plots coupon bonds' yields against their durations or, equivalently, zeros' yields against their maturities, given various rate expectations. Ignoring the bond risk premium and convexity bias, if the market expects no change in the level or slope of the curve, today's yield curve will be horizontal. If the market expects a parallel rise in rates over the next year (but no reshaping), today's yield curve will be linearly increasing (as a function of duration). If the market expects rising rates *and* a flattening curve, today's yield curve will be increasing and concave (as a function of duration).[9]

Bond Risk Premium

A key assumption in the pure expectations hypothesis is that all government bonds, regardless of maturity, have the same expected return. In contrast, many theories and empirical evidence suggest that expected returns vary across bonds. We define the *bond risk premium* as a longer-term bond's expected one-period

9. For a detailed treatment of these issues, see Ilmanen, "Market's Rate Expectations and Forward Rates," *op. cit.*

return in excess of the one-period bond's riskless return. A positive bond risk premium would tend to make the yield curve slope upward. Various theories disagree about the sign (+/−), the determinants, and the constancy (over time) of the bond risk premium. The classic liquidity premium hypothesis argues that most investors dislike short-term fluctuations in asset prices; these investors will hold long-term bonds only if they offer a positive risk premium as a compensation for their greater return volatility. Also, some modern asset-pricing theories suggest that the bond risk premium should increase with a bond's duration, its return volatility, or its covariance with market wealth. In contrast, the preferred-habitat hypothesis argues that the risk premium may decrease with duration; long-duration liability holders may perceive the long-term bond as the riskless asset and require higher expected returns for holding short-term assets. While academic analysis focuses on risk-related premiums, market practitioners often emphasize other factors that cause expected return differentials across the yield curve. These include liquidity differences between market sectors, institutional restrictions, and supply and demand effects. We use the term *bond risk premium* broadly to encompass all expected return differentials across bonds, including those caused by factors unrelated to risk.

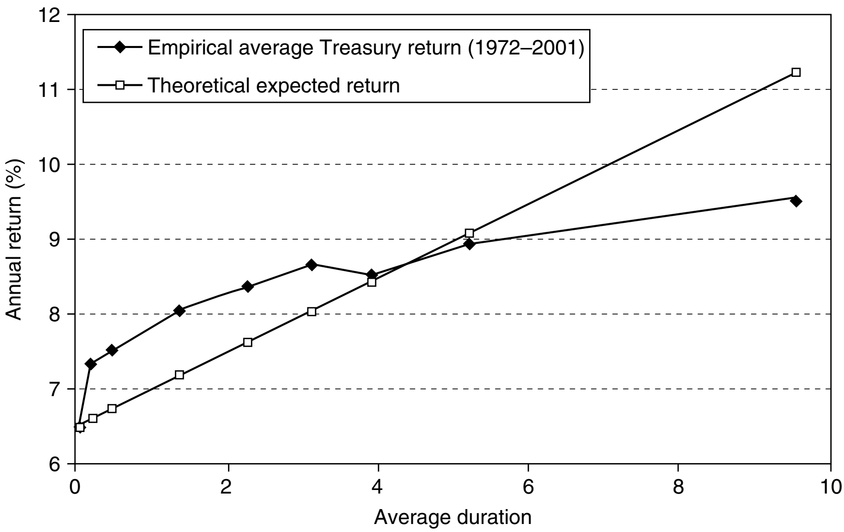
Historical data on U.S. Treasury bonds provide evidence about the empirical behavior of the bond risk premium. For example, the fact that the Treasury yield curve has been upward-sloping more than 90% of the time in recent decades may reflect the impact of positive bond risk premiums. Historical average returns provide more direct evidence about expected returns across maturities than do historical yields. Even though weekly and monthly fluctuations in bond returns are mostly unexpected, the impact of unexpected yield rises and declines should wash out over a long sample period. Therefore, the *historical average returns* of various maturity sectors over a relatively trendless sample period should reflect the *long-run expected returns*.

Exhibit 8–3 shows the empirical average return curve as a function of average duration and contrasts it with a popular theoretical expected return curve, one that increases linearly with duration. The theoretical bond risk premiums are measured in the exhibit by the difference between the annualized expected returns at various duration points and the annualized return of the riskless one-month bill (the leftmost point on the curve). Similarly, the empirical bond risk premiums are measured by the historical average bond returns (at various durations) in excess of the one-month bill.[10] Historical experience suggests that the bond risk premiums are not linear in duration but that they increase steeply with

10. The empirical bond risk premiums are computed based on monthly returns of various maturity-subsector portfolios of Treasury bills or bonds between 1972 and 2001. This period does not have an obvious bearish or bullish bias because long-term yields were at roughly similar level in the end of 2001, as they were in the beginning of 1972. Exhibit 8–3 plots arithmetic average annual returns on average durations. The geometric average returns would be a bit lower, and the curve would be much flatter after two years.

EXHIBIT 8–3

Theoretical and Empirical Bond Risk Premiums



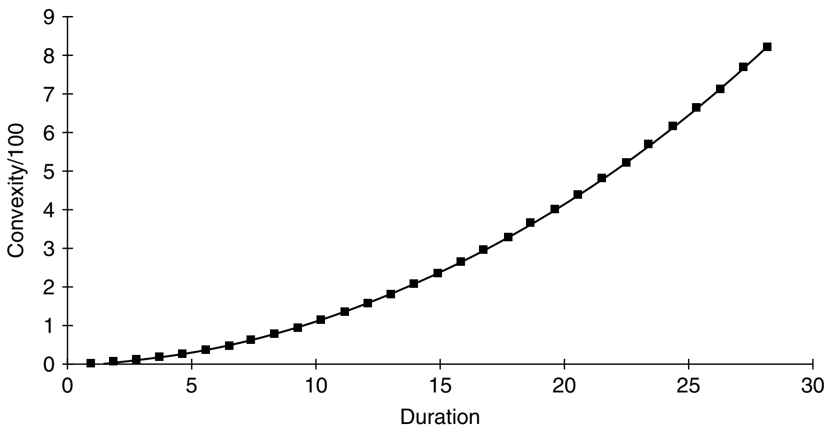
duration in the front end of the curve and much more slowly after two years. The concave shape may reflect the demand for long-term bonds from pension funds and other long-duration liability holders.

Exhibit 8–3 may give us the best empirical estimates of the long-run average bond risk premiums at various durations. However, empirical studies also suggest that the bond risk premiums are not constant but vary over time. That is, it is possible to identify in advance periods when the near-term bond risk premiums are abnormally high or low. These premiums tend to be high after poor economic conditions when the yield curve is steep, amid high inflation expectations and related inflation uncertainty. These premiums tend to be lower and even turn negative when Treasury prices benefit from safe-haven premiums (amid equity market weakness and negative stock-bond correlation, as in 1998 and 2002) or from scarcity premiums (amid fiscal surpluses and expectations of dwindling government bond markets, as in 2000).[11]

11. Long-run average return differentials across bonds with different maturities are discussed in Ilmanen, "Does Duration Extension Enhance Long-Term Expected Returns?" *op. cit*. Near-term expected return differentials across bonds and the time variation in the bond risk premiums are discussed in Antti Ilmanen, "Forecasting U.S. Bond Returns," *Journal of Fixed Income* (June 1997), pp. 22–37. A more recent study, Antti Ilmanen, "Stock-Bond Correlations," *Journal of Fixed Income* (September 2003), pp. 55–66, focuses on stock-bond correlation as a determinant of bond risk premium but also discusses other determinants.

EXHIBIT 8–4 (a)

Illustration of Convexity Bias

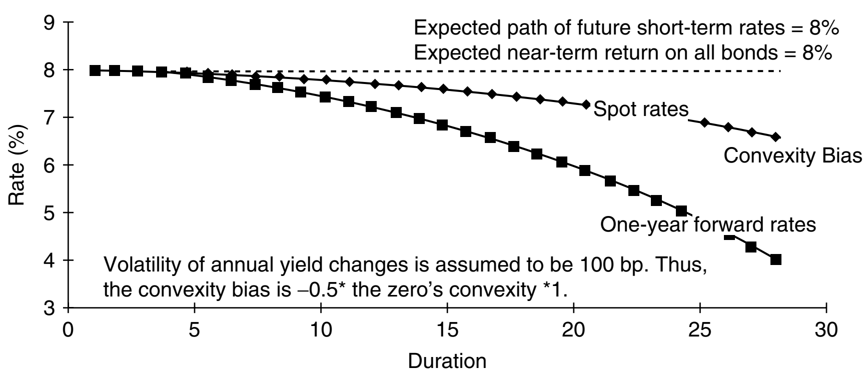


Convexity Bias

The third influence on the yield curve—convexity bias—is probably the least well known. Different bonds have different convexity characteristics, and the convexity differences across maturities can give rise to (offsetting) yield differences. In particular, long-term bonds exhibit very high convexity (see panel *a* of Exhibit 8–4), which tends to depress their yields. *Convexity bias* refers to the impact these convexity differences have on the yield-curve shape.

EXHIBIT 8–4 (b)

Pure Impact of Convexity on the Yield-Curve Shape



Convexity is closely related to the nonlinearity in the bond price-yield relationship. All noncallable bonds exhibit positive convexity; their prices rise more for a given yield decline than they fall for a similar yield increase. All else being equal, positive convexity is a desirable characteristic because it increases bond return (relative to return in the absence of convexity) whether yields go up or down—as long as they move somewhere. Because positive convexity can only improve a bond's performance (for a given yield), more convex bonds tend to have lower yields than less convex bonds with the same duration.[12] In other words, investors tend to demand less yield if they have the prospect of improving their returns as a result of convexity. Investors are primarily interested in expected returns, and these high-convexity bonds can offer a given expected return at a lower yield level.

Panel *b* of Exhibit 8–4 illustrates the pure impact of convexity on the curve shape by plotting the spot-rate curve and the curve of one-year forward rates when all bonds have the same expected return (8%) and the short-term rates are expected to remain at the current level. With no bond risk premiums and no expected rate changes, one might expect these curves to be horizontal at 8%. Instead, they slope down at an increasing pace because lower yields are needed to offset the convexity advantage of longer-duration bonds and thereby to equate the near-term expected returns across bonds.[13] Short-term bonds have little convexity, so there is little convexity bias at the front end of the yield curve, but convexity can have a dramatic impact on the curve shape at very long durations. Convexity bias can be one of the main reasons for the typical concave yield-curve shape (i.e., for the tendency of the curve to flatten or invert at long durations).

The value of convexity increases with the magnitude of yield changes. Therefore, increasing volatility should make the overall yield-curve shape more

12. The degree of convexity varies across bonds, mainly depending on their option characteristics and durations. Embedded short options decrease convexity. For bonds without embedded options, convexity increases roughly as a square of duration (see Exhibit 8–4). There also are convexity differences between bonds that have the same duration. A barbell position (with very dispersed cash flows) exhibits more convexity than a duration-matched bullet bond. The reason is that a yield rise reduces the relative weight of the barbell's longer cash flows (because the present values decline more than those of the shorter cash flows) and thereby shortens the barbell's duration. The inverse relation between duration and yield level increases a barbell's convexity, limiting its losses when yields rise and enhancing its gains when yields decline. Of all bonds with the same duration, a zero has the smallest convexity because its cash flows are not dispersed, so its Macaulay duration does not vary with the yield level.

13. Convexity bias is closely related to the distinction between different versions of the pure expectations hypothesis. Earlier we referred to *the* pure expectations hypothesis. In fact, there are alternative versions of this hypothesis that are not exactly consistent with each other. The local-expectations hypothesis (LEH) assumes that "all bonds earn the same expected return over the next period" whereas the unbiased-expectations hypothesis (UEH) assumes that "forward rates equal expected spot rates." In panel *b* of Exhibit 8–4, the LEH is assumed to hold; thus UEH is not exactly true. The expected future short rates are flat at 8% even though the curve of one-year forward rates is inverted. In yield terms, the difference between the LEH and the UEH is the convexity bias.

concave (curved) and widen the spreads between more and less convex bonds (duration-matched coupon bonds versus zeros and barbells versus bullets).[14]

Putting the Pieces Together

Of course, all three forces influence bond yields simultaneously, making the task of interpreting the overall yield-curve shape quite difficult. A steeply upward-sloping curve can reflect either the market's expectations of rising rates or a high required risk premium. A strongly humped curve (i.e., high curvature) can reflect the market's expectations of either curve flattening or high volatility (which makes convexity more valuable) or even the concave shape of the risk premium curve.

In theory, the yield curve can be neatly decomposed into expectations, risk premiums, and convexity bias. In reality, exact decomposition is not possible because the three components vary over time and are not observable directly but need to be estimated.[15] Even though an exact decomposition is not possible, the analysis in this chapter should give investors a framework for interpreting various yield-curve shapes. Furthermore, our survey of earlier literature and our new empirical work evaluate which theories and market myths are correct (consistent with data) and which are false. The main conclusions are as follows:

- We often hear that "forward rates show the market's expectations of future rates." However, this statement is true only if no bond risk premiums exist and the convexity bias is very small.[16] If the goal is to infer expected short-term rates one or two years ahead, the convexity bias is so small that it can be ignored. In contrast, our empirical analysis shows that the bond risk premiums are important at short maturities. Therefore, if the forward rates are used to infer the market's near-term rate expectations, some measures of bond risk premiums should be subtracted from

14. For detailed discussion of this topic, see Ilmanen, "Convexity Bias in the Yield Curve," *op. cit.*

15. We show in other studies how interest-rate expectations can be measured using survey data, how bond risk premiums can be estimated using historical return data, and how the convexity bias can be inferred using option prices; see Ilmanen, "Market's Rate Expectations and Forward Rates," *op. cit.*; Ilmanen, "Does Duration Extension Enhance Long-Term Expected Returns?" *op. cit.*; and Ilmanen, "Convexity Bias in the Yield Curve," *op. cit.* Alternatively, all three components could be estimated from the yield curve if one is willing to impose the structure of some term-structure model.

16. A related assertion claims that if near-term expected returns were not equal across bonds, it would imply the existence of *riskless arbitrage opportunities*. This assertion is erroneous. It is true that if forward contracts were traded assets, arbitrage forces would require their pricing to be consistent with zero prices according to Eq. (8.2). However, the arbitrage argument says nothing about the economic determinants of the zero prices themselves, such as rate expectations or risk premia. The experience of 1994 and 1999 shows that buying long-term bonds is not riskless even if they have higher expected returns than short-term bonds.

the forwards, or the estimate of the market's rate expectations will be strongly upward-biased.

- The traditional term-structure theories make the assumption of a zero risk premium (pure expectations hypothesis) or of a nonzero but *constant* risk premium (liquidity premium hypothesis, preferred-habitat hypothesis), which is inconsistent with historical data. According to the pure expectations hypothesis, an upward-sloping curve should predict increases in long-term rates so that a capital loss offsets the long-term bonds' yield advantage. However, empirical evidence shows that, on average, small declines in long-term rates, which *augment* the long-term bonds' yield advantage, follow upward-sloping curves. The steeper the yield curve, the higher is the expected bond risk premium. This finding clearly violates the pure expectations hypothesis and supports hypotheses about time-varying risk premiums.
- Modern term-structure models make less restrictive assumptions than the traditional theories just mentioned. Yet many popular one-factor models assume that bonds with the same duration earn the same expected return. Such an assumption implies that duration-neutral positions with more or less convexity earn the same expected return (because any convexity advantage is *exactly* offset by a yield disadvantage). However, if the market values very highly the insurance characteristics of positively convex positions, more convex positions may earn lower expected returns. Our analysis of the empirical performance of duration-neutral barbell-bullet trades will show that, in the long run, barbells tend to marginally underperform bullets.

USING FORWARD RATE ANALYSIS IN YIELD-CURVE TRADES

Recall that if the local expectations hypothesis holds, all bonds and bond positions have the same near-term expected return. In particular, an upward-sloping yield curve reflects expectations of rising rates and capital losses, and convexity is priced so that a yield disadvantage exactly offsets the convexity advantage. In such a world, yields do not reflect value, no trades have favorable odds, and active management can add value only if an investor has truly superior forecasting ability. Fortunately, the real world is not quite like this textbook case because expected returns do vary across bonds (see Exhibit 8–3). The main reason is probably that most investors exhibit risk aversion and preferences for other asset characteristics; moreover, investor behavior may not always be fully rational. Therefore, yields reflect value, and certain relative value trades have favorable odds.

The preceding section provided a framework for thinking about the term-structure shapes. In this section we describe practical applications, that is, different ways to use forward rates in yield-curve trades. The first approach requires strong subjective rate views and faith in one's forecasting ability.

Forwards as Break-Even Rates for Active Yield-Curve Views

The forward rates show a path of break-even future rates and spreads. This path provides a clear yardstick for an active portfolio manager's subjective yield-curve scenarios and yield-path forecasts. It incorporates directly the impact of carry on the profitability of the trade. For example, a manager should take a bearish portfolio position only if she expects rates to rise by more than what the forwards imply. However, if she expects rates to rise, but by less than what the forwards imply (i.e., by less than what is needed to offset the positive carry), she should take a bullish portfolio position. If the manager's forecast is correct, the position will be profitable. In contrast, managers who take bearish portfolio positions whenever they expect bond yields to rise—ignoring the forwards—may find that their positions lose money, because of the negative carry, even though their rate forecasts are correct.

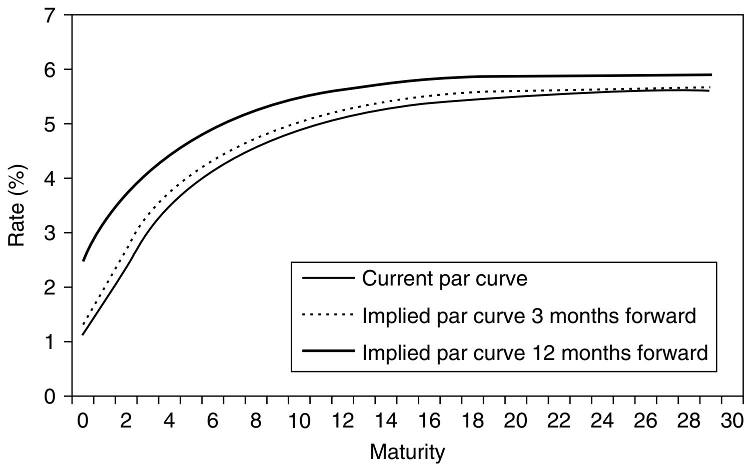
One positive aspect about the role of forward rates as break-even rates is that they do not depend on assumptions regarding expectations, risk premiums, or convexity bias. The rules are simple. If forward rates are realized, all positions earn the same return. If yields rise by more than the forwards imply, bearish positions are profitable, and bullish positions lose money. If yields rise by less than the forwards imply, the opposite is true. Similar statements hold for any yield spreads and related positions, such as curve-flattening positions.

Exhibit 8–5 shows the dollar-swap (par) yield curve and the implied-swap curves three months forward and 12 months forward as of April 2004. If we believe that forward rates only reflect the market's rate expectations, a comparison of these curves tells us that the market expects rates to rise and the curve to flatten over the next year. Alternatively, the implied yield rise may reflect a bond risk premium, and the implied curve flattening may reflect the value of convexity. Either way, the forward yield curves reflect the break-even levels between profits and losses.

The information in the forward rate structure can be expressed in several ways. Exhibit 8–5 is useful for an investor who wants to contrast his subjective view of the future yield curve with an objective break-even curve at some future horizon. Another graph may be more useful for an investor who wants to see the break-even future path of any given-maturity yield (instead of the whole curve) and contrast it with his own forecast, which may be based on a macroeconomic forecast or on the subjective view about the speed of Fed tightening. As an example, Exhibit 8–6 shows such a break-even path of future three-month rates in April 2004. Note that the first point in each implied forward par curve in Exhibit 8–5 is the implied forward three-month rate at a given future date. Therefore, the forward

EXHIBIT 8–5

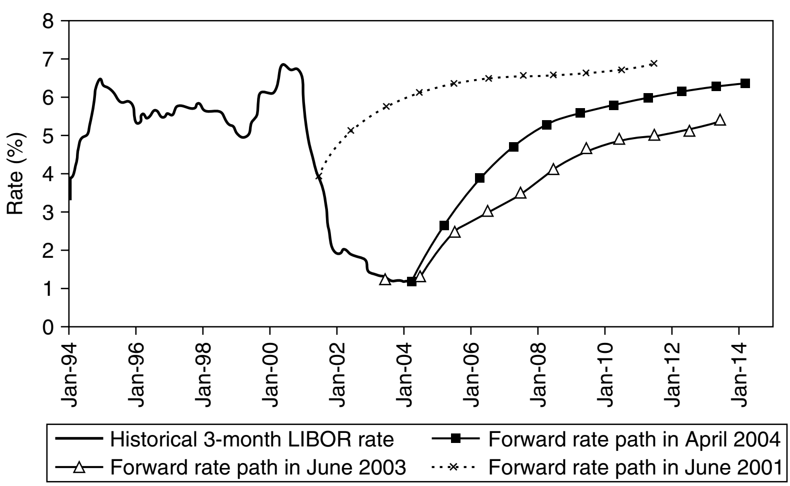
Current and Forward Par Yield Curves Based on the Dollar-Swap Curve in April 2004



path in Exhibit 8–6 can be constructed by tracing through the three-month points in the three curves of Exhibit 8–5 and through similar curves at other horizons. Because Exhibit 8–6 depicts a rate path over time, the horizontal axis is calendar years and not maturity.

EXHIBIT 8–6

Historical Three-Month Rates and Implied Forward Rate Path Based on the Dollar Swap Curve in April 2004, June 2003, and June 2001



To add perspective, the graph also contains the historical path of the three-month rate over the past decade and the break-even path of the future three-month rates in June 2003 when monetary policy expectations were much more bullish and in June 2001 when market's policy tightening expectations proved immature.

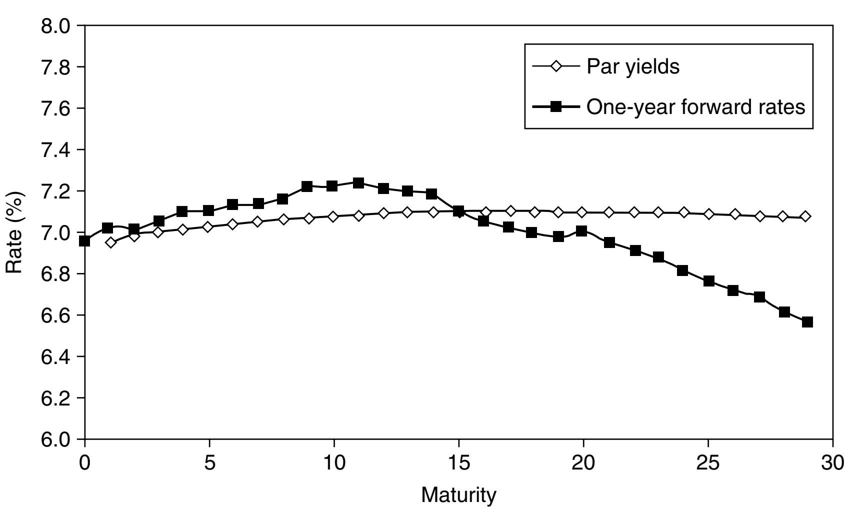
Forwards as Indicators of Cheap Maturity Sectors

The other ways to use forwards require less subjective judgment than the first one. As a simple example, the forward rate curve can be used to identify cheap maturity sectors visually. Abnormally high forward rates are more visible than high spot or par rates because the latter are averages of forward rates.

Exhibit 8–7 shows one real-world example from year 2000 when the par yield curve was extremely flat (although forwards may be equally useful when the par curve is not flat). Even though the par yield curve was almost horizontal (all par yields were within 15 basis points), the range of one-year forward rates was almost 100 basis points because the forward rate curve magnifies the cheapness/richness of different maturity sectors. High forward rates identify the 9- to 12-year sector as cheap. Forward rates are very low at the long maturities, but this characteristic probably reflects the convexity bias. Recall that forward rates are downward-biased

EXHIBIT 8–7

Par Yields and One-Year Forward Rates Based on the Dollar-Swap Curve in August 2000



estimates of expected returns because they ignore the convexity advantage, which is especially large at long maturities.

Once an investor has identified a sector with abnormally high forward rates (e.g., between 9 and 12 years), she can exploit the cheapness of this sector by buying a bond that matures at the end of the period (12 years) and by selling a bond that matures at the beginning of the period (9 years). If equal market values of these bonds are bought and sold, or received and paid fixed in swaps, the position captures the cheap forward rate (in this case the 3-year rate 9 years forward). In par-curve terms, the position is exposed to a general increase in rates and a steepening yield curve. More elaborate trades can be constructed (e.g., by selling both the 9- and 15-year bonds against the 12-year bonds with appropriate weights) to retain level and slope neutrality. To the extent that bumps and kinks in the forward curve reflect temporary local cheapness, the trade will earn capital gains when the forward curve becomes flatter and the cheap sector richens (in addition to the higher yield and rolldown the position earns).

Forwards as Relative-Value Tools for Yield-Curve Trades

Thus far in this chapter forwards are used quite loosely to identify cheap maturity sectors. A more formal way to use forwards is to construct quantitative cheapness indicators for duration-neutral flattening trades, such as barbell-bullet trades. We first introduce some concepts with an example of a market-directional trade.

When the yield curve is upward-sloping, long-term bonds' yield advantage over the riskless short-term bond provides a cushion against rising yields. In a sense, duration extensions are "cheap" when the yield curve is very steep and the cushion (positive carry) is large. These trades only lose money if capital losses caused by rising rates offset the initial yield advantage. Moreover, the longer-term bonds' rolling yield advantage[17] over the short-term bond is even larger than their yield advantage. The one-year forward rate ($f_{n-1,n}$) is, by construction, equal to the n-year zero's rolling yield (see Appendix 8C). Thus it is a direct measure of the n-year zero's rolling yield advantage. [Another forward-related measure, the change in the ($n-1$)-year spot rate implied by the forwards ($f_{1,n} - s_{n-1}$) tells how much the yield curve has to shift to offset this advantage and to equate the holding-period returns of the n-year zero and the one-year zero.]

17. As bonds age, they roll down the upward-sloping yield curve and earn some rolldown return (capital gain owing to this yield change) if the yield curve remains unchanged. A bond's rolling yield, or horizon return, includes both the yield and the rolldown return given a scenario of no change in the yield curve.

Because one-period forward rates measure zeros' near-term expected returns, they can be viewed as indicators of cheap maturity sectors. The use of such cheapness indicators does not require any subjective interest-rate view. Instead, it requires a belief, motivated by history, that an unchanged yield curve is a good base-case scenario.[18] If this is true, long-term bonds have higher (lower) near-term expected returns than short-term bonds when the forward rate curve is upward-sloping (downward-sloping). In the long run, a strategy that adjusts the portfolio duration dynamically based on the curve shape should earn higher average return than constant-duration strategies.[19]

Similar analysis holds for curve-flattening trades. Recall that when the yield curve is concave as a function of duration, any duration-neutral flattening trade earns a negative carry. Higher concavity (curvature) in the yield curve indicates less attractive terms for a flattening trade (larger negative carry) and more "implied flattening" by the forwards (that is needed to offset the negative carry). Therefore, the amount of spread change implied by the forwards is a useful cheapness indicator for yield-curve trades at different parts of the curve. If the implied change is wide historically, the trade is expensive, and vice versa.

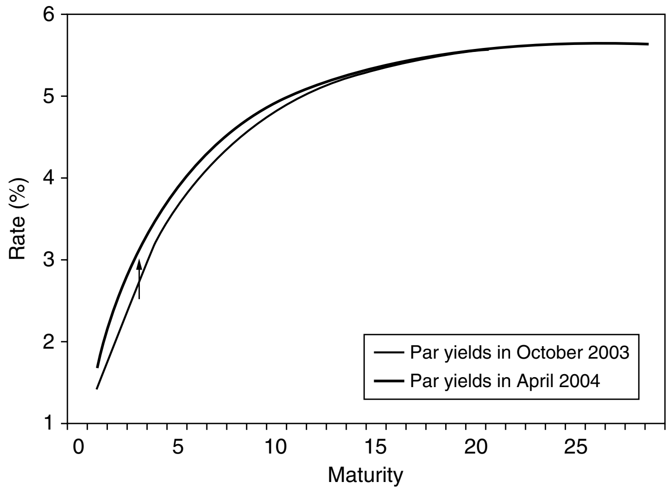
Exhibit 8–8 shows a recent example of negative carry making curve-flattening positions expensive to hold. In October 2003, high yield-curve curvature indicated strong flattening expectations—forwards implied a 50 basis point decline in the 2- to 30-year spread over the coming six months—or high expected volatility (high value of convexity). The barbell (of the 30-year bond and six-month bill) over the duration-matched two-year bullet would become profitable only if the curve flattened even more than the forwards implied or if a sudden increase in volatility occurred. Purely on yield grounds, the two-year bullet (a steepening position) appeared cheap to the barbell. With the benefit of hindsight, we know that the carry/cheapness indicator gave a correct signal in this case. Exhibit 8–8 plots the dollar-swap curves in October 2003 and in April 2004; it is perhaps surprising that a steepening position outperformed amid curve flattening. Even though the yield curve did flatten (the 2- to 30-year spread actually narrowed by 38 basis points by April 2004), the realized

18. The one-period forward rate can proxy for the near-term expected return—albeit with a downward bias because it ignores the value of convexity—*if* the current yield curve is not expected to change. Empirical studies show that the assumption of an unchanged curve is more realistic than the assumption that forward rates reflect expected future yields. Historically, current spot rates predict future spot rates better than current forward rates do because the yield changes implied by the forwards have not been realized, on average.

19. The historical performance of dynamic strategies that exploit the predictability of long-term bonds' near-term returns is evaluated in Antti Ilmanen, "Forecasting U.S. Bond Returns," *Journal of Fixed Income* (June 1997), pp. 22–37. The dynamic strategies have consistently outperformed static strategies that do not actively adjust the portfolio duration.

EXHIBIT 8–8

Dollar-Swap Curves in October 2003 and in April 2004



flattening did not match the forward-implied flattening. A steepener's (bullet's) initial carry and rolldown advantage did more than offset the capital losses owing to subsequent curve flattening.[20]

APPENDIX 8A

Notation and Definitions

P	market price of a bond
P_n	market price of an n-year zero
C	coupon rate (in percent; other rates are expressed as a decimal)
y	annualized yield-to-maturity (YTM) of a bond
n	time-to-maturity of a bond (in years)

20. We show how to use forward rate analysis to evaluate opportunities like this in Ilmanen, "Market's Rate Expectations and Forward Rates," *op. cit.*; and Ilmanen and Iwanowski, "Dynamics of the Shape of the Yield Curve," *op. cit.*

s_n	annualized n-year spot rate; the discount rate of an n-year zero
s_{n-1}	annualized (n – 1)-year spot rate next period; superscript * denotes next period's (year's) value
Δs_{n-1}	realized change in the (n – 1)-year spot rate between today and next period ($= s^*_{n-1} - s_{n-1}$)
$f_{m,n}$	annualized forward rate between maturities m and n
$f_{n-1,n}$	one-year forward rate between maturities (n – 1) and n; also, the n-year zero's rolling yield
$f_{1,n}$	annualized forward rate between maturities 1 and n; also called the implied (n – 1)-year spot rate one year forward
Δf_{n-1}	implied change in the (n – 1)-year spot rate between today and next period ($= f_{1,n} - s_{n-1}$); also called the break-even yield change (over the next period) implied by the forwards
Δfz_n	implied change in the yield of an n-year zero, a specific bond, over the next period ($= f_{1,n} - s_n$)
FSP	forward-spot premium ($FSP_n = f_{n-1,n} - s_1$)
h_n	realized holding-period return of an n-year zero [over one period (year)]

Rolling yield	a bond's horizon return given a scenario of unchanged yield curve; sum of yield and rolldown return
Bond risk premium (BRP)	expected return of a long-term bond over the next period (year) in excess of the riskless one-period bond; for the n-year zero, $BRP_n = E(h_n - s_1)$
Realized BRP	realized one-year holding-period return of a long-term bond in excess of the one-year bond; also called excess bond return; realized $BRP_n = h_n - s_1$
Persistence factor (PF)	slope coefficient in a regression of the annual realized BRP_n on FSP_n
Term spread	yield difference between a long-term bond and a short-term bond; for the n-year zero, $= s_n - s_1$
Real yield	difference between a long-term bond yield and a proxy for expected inflation; our proxy is the recently published year-on-year consumer price inflation rate
Inverse wealth	ratio of exponentially weighted past wealth to the current wealth; we proxy wealth W by the stock market level; $= (W_{t-1} + 0.9^*W_{t-2} + 0.9^{2*}W_{t-3} + \cdots)^*0.1/W_t$
Duration (Dur)	measure of a bond price's interest rate sensitivity; Dur = $-(dP/dy)^*(1/P)$
Convexity (Cx)	measure of the nonlinearity in a bond's P/y relation; Cx = $(d^2P/dy^2)^*(1/P)$
Convexity bias (CB)	impact of convexity on the forward rate curve; $CB_n = -0.5^*Cx_n{}^*(\text{volatility of } \Delta s_n)^2$

APPENDIX 8B

Calculating Spot and Forward Rates When Par Rates Are Known

A simple example illustrates how spot rates and forward rates are computed on a coupon date when the par curve is known (and coupon payments and compounding frequency are annual). The basis of the procedure is the fact that a bond's price will be the same, the sum of the present values of its cash flows, whether it is priced via yield-to-maturity—Eq. (8B.1)—or via the spot-rate curve—Eq. (8B.2).

$$P = \frac{C}{1+y} + \frac{C}{(1+y)^2} + \cdots + \frac{C+100}{(1+y)^n} \tag{8B.1}$$

$$P = \frac{C}{1+s_1} + \frac{C}{(1+s_2)^2} + \cdots + \frac{C+100}{(1+s_n)^n} \tag{8B.2}$$

where P is the bond price, C is the coupon rate (in percent), y is the annual yield-to-maturity (expressed as a decimal), s is the annual spot rate (expressed as a decimal), and n is the time-to-maturity (in years). We show only the computation for the first two years, which have par rates of 6% and 8%. For the first year, par, spot, and forward rates are equal (6%). Longer spot rates are solved recursively using known values of the par bond's price and cash flows and the previously solved spot rates. Every par bond's price is 100 (par) by construction, so its yield (the par rate) equals its coupon rate. Because the two-year par bond's market price (100) and cash flows (8 and 108) are known, as is the one-year spot rate (6%), it is easy to solve for the two-year spot rate as the only unknown in the following equation:

$$100 = \frac{C}{1+s_1} + \frac{C+100}{(1+s_2)^2} = \frac{8}{1.06} + \frac{108}{(1+s_2)^2} \tag{8B.3}$$

A little manipulation shows that the solution for s_2 is 8.08%. Equation (8B.3) also can be used to compute par rates when only spot rates are known. If the spot rates are known, the coupon rate C—which equals the par rate—is the only unknown in Eq. (8B.3).

The forward rate between one and two years is computed using Eq. (8B.3) and the known one-year and two-year spot rates.

$$(1+f_{1,2}) = \frac{(1+s_2)^2}{1+s_1} = \frac{(1.0808)^2}{1.06} = 1.1020 \tag{8B.4}$$

EXHIBIT 8B–1

Par, Spot, and One-Year Forward Rate Curves

Maturity	Par Rate	Spot Rate	Forward Rate
1	6.00	6.00	6.00
2	8.00	8.08	10.20
3	9.50	9.72	13.07
4	10.50	10.86	14.36
5	11.00	11.44	13.77
6	11.25	11.71	13.10
7	11.38	11.83	12.55
8	11.44	11.88	12.20
9	11.48	11.89	11.97
10	11.50	11.89	11.93

The solution for $f_{1,2}$ is 10.20%. The other spot rates and one-year forward rates ($f_{2,3}$, $f_{3,4}$, etc.) in Exhibit 8B–1 are computed in the same way. These numbers are shown graphically in Exhibit 8–1.

APPENDIX 8C

Relations between Spot Rates, Forward Rates, Rolling Yields, and Bond Returns

Investors often want to make quick "back of the envelope" calculations with spot rates, forward rates, and bond returns. In this appendix we discuss some simple relations between these variables, beginning with a useful approximate relation between spot rates and one-year forward rates.[21] Equation (8.2) showed exactly how the forward rate between years *m* and *n* is related to *m*- and *n*-year spot rates. Equation (8C.1) shows the same relation in an approximate but simpler form; this equation ignores nonlinear effects such as the convexity bias. The relation is exact

21. These relations are discussed in more detail in the appendix to Ilmanen, "Market's Rate Expectations and Forward Rates," *op. cit.*

if spot rates and forward rates are continuously compounded.

$$f_{m,n} \approx \frac{ns_n - ms_m}{n-m} \tag{8C.1}$$

For one-year forward rates ($m = n - 1$), Eq. (8C.1) can be simplified to

$$f_{n-1,n} \approx s_n + (n-1)(s_n - s_{n-1}) \tag{8C.2}$$

Equation (8C.2) shows that the forward rate is equal to an n-year zero's one-year horizon return given an unchanged yield curve scenario: a sum of the initial yield and the rolldown return [the zero's duration at horizon (n – 1) multiplied by the amount the zero rolls down the yield curve as it ages]. This horizon return is often called the *rolling yield.* Thus the one-year forward rates proxy for near-term expected returns at different parts of the yield curve if the yield curve is expected to remain unchanged. We can gain intuition about the equality of the one-year forward rate and the rolling yield by examining the n-year zero's realized holding-period return h_n over the next year, in Eq. (8C.3). The zero earns its initial yield s_n plus a capital gain/loss that is approximated by the product of the zero's year-end duration and its realized yield change.

$$h_n \approx s_n + (n-1) \times (s_n - s^*_{n-1}) \tag{8C.3}$$

where s^*_{n-1} is the (n – 1)-year spot rate next year. If the yield curve follows a random walk, the best forecast for s^*_{n-1} is (today's) s_{n-1}. Therefore, the n-year zero's expected holding period return is exactly the one-year forward rate in Eq. (8C.2). The key question is whether it is more reasonable to assume that the current spot rates are the optimal forecasts of future spot rates than to assume that forwards are the optimal forecasts. Empirical evidence suggests that the "random walk" forecast of an unchanged yield curve is more accurate than the forecast implied by the forwards.

Equation (8C.2) shows that the (one-year) forward rate curve lies above the spot curve as long as the latter is upward-sloping (and the rolldown return is positive). Conversely, if the spot curve is inverted, the rolldown return is negative, and the forward rate curve lies below the spot curve. If the spot curve is first rising and then declining, the forward rate curve crosses it from above at its peak. Finally, the forward rate curve can become downward-sloping even when the spot curve is upward-sloping if the spot curve's slope is first steep and then flattens (reducing the rolldown return). The following calculations illustrate this point and show that the approximation is good—within a few basis points from the correct values (10.20 – 13.07 – 14.36 – 13.77) in Exhibit 8B–1.

$$f_{1,2} \approx 8.08 + 1 * (8.08 - 6.00) = 8.08 + 2.08 = 10.16;$$

$$f_{2,3} \approx 9.72 + 2 * (9.72 - 8.08) = 9.72 + 3.28 = 13.00;$$

$$f_{3,4} \approx 10.86 + 3 * (10.86 - 9.72) = 10.86 + 3.42 = 14.28; \text{ and}$$

$$f_{4,5} \approx 11.44 + 4 * (11.44 - 10.86) = 11.44 + 2.32 = 13.76.$$

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CHAPTER

NINE

MEASURING INTEREST-RATE RISK

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The value of a bond changes in the opposite direction of the change in interest rates. A long bond position's value will decline if interest rates rise, resulting in a loss. For a short bond position, a loss will be realized if interest rates fall. However, an investor wants to know more than simply when a position will realize a loss. To control interest-rate risk, an investor must be able to quantify what will result.

The key to measuring interest-rate risk is the accuracy of the estimate of the value of the position after an adverse rate change. A valuation model is used to determine the value of a position after an adverse rate move. Consequently, if a reliable valuation model is not used, there is no way to properly measure interest-rate risk exposure.

There are two approaches to measuring interest-rate risk—*the full-valuation approach* and the *duration/convexity approach.* We begin with a discussion of the full-valuation approach. The balance of the chapter is devoted to the duration/convexity approach. As a background to the duration/convexity approach, we discuss

Parts of this chapter are adapted from several chapters in Frank J. Fabozzi, *Duration, Convexity, and Other Bond Risk Measures* (New Hope, PA: Frank J. Fabozzi Associates, 1999) and from Gerald W. Buetow and Robert R. Johnson, "A Primer on Effective Duration and Convexity," in Frank J. Fabozzi (ed.), *Professional Perspectives on Fixed Income Portfolio Management,* Vol. 1 (New Hope, PA: Frank J. Fabozzi Associates, 2000).

the price volatility characteristics of option-free bonds and bonds with embedded options. We then look at how duration can be used to estimate interest-rate risk and distinguish between various duration measures (effective, modified, and Macaulay). Next, we show how a measure referred to as "convexity" can be used to improve the duration estimate of the price volatility of a bond to rate changes. In the next to the last section we show the relationship between duration and another measure of price volatility used by investors, the price value of a basis point (or dollar value of an 01). In the last section we discuss the importance of incorporating yield volatility in estimates of exposure to interest-rate risk.

THE FULL-VALUATION APPROACH

The most obvious way to measure the interest-rate risk exposure of a bond position or a portfolio is to revalue it when interest rates change. The analysis is performed for a given scenario with respect to interest-rate changes. For example, an investor may want to measure the interest-rate exposure to a 50 basis point, 100 basis point, and 200 basis point instantaneous change in interest rates. This approach requires the revaluation of a bond or bond portfolio for a given interest-rate change scenario and is called the *full-valuation approach.* It is sometimes referred to as "scenario analysis" because it involves assessing the exposure to interest-rate change scenarios.

To illustrate this approach, suppose that an investor has a $10 million par value position in a 9% coupon 20-year bond. The bond is option-free. The current price is 134.6722 for a yield (i.e., yield to maturity) of 6%. The market value of the position is $13,467,220 (134.6722% × $10 million). Since the investor owns the bond, she is concerned with a rise in yield, since this will decrease the market value of the position. To assess the exposure to a rise in market yields, the investor decides to look at how the value of the bond will change if yields change instantaneously for the following three scenarios: (1) 50 basis point increase, (2) 100 basis point increase, and (3) 200 basis point increase. This means that the investor wants to assess what will happen to the bond position if the yield on the bond increases from 6% to (1) 6.5%, (2) 7%, and (3) 8%. Because this is an option-free bond, valuation is straightforward. We will assume that one yield is used to discount each of the cash flows. That is, we will assume a flat yield curve. The price of this bond per $100 par value and the market value of the $10 million par position is shown in Exhibit 9–1. Also shown is the change in the market value and the percentage change.

In the case of a portfolio, each bond is valued for a given scenario, and then the total value of the portfolio is computed for the scenario. For example, suppose that a manager has a portfolio with the following two option-free bonds: (1) 6% coupon 5-year bond and (2) 9% coupon 20-year bond. For the shorter-term bond, $5 million of par value is owned, and the price is 104.3760 for a yield of 5%. For the longer-term bond, $10 million of par value is owned, and the price is

EXHIBIT 9–1

Illustration of Full-Valuation Approach to Assess the Interest-Rate Risk of a Bond Position for Three Scenarios

Current bond position: 9% coupon 20-year bond (option-free)
Price: 134.6722
Yield to maturity: 6%
Par value owned: \$10 million
Market value of position: \$13,467,220.00

Scenario	Yield Change (bp)	New Yield	New Price	New Market Value (\$)	Percentage Change in Market Value (%)
1	50	6.5%	127.7606	12,776,060	–5.13%
2	100	7.0%	121.3551	12,135,510	–9.89%
3	200	8.0%	109.8964	10,989,640	–18.40%

134.6722 for a yield of 6%. Suppose that the manager wants to assess the interest-rate risk of this portfolio for a 50, 100, and 200 basis point increase in interest rates assuming that both the 5-year yield and the 20-year yield change by the same number of basis points. Exhibit 9–2 shows the exposure. Panel *a* of the exhibit shows the market value of the 5-year bond for the three scenarios. Panel *b* does the same for the 20-year bond. Panel *c* shows the total market value of the portfolio and the percentage change in the market value for the three scenarios.

In Exhibit 9–2, it is assumed that both the 5-year and the 20-year yields changed by the same number of basis points. The full-valuation approach also can handle scenarios where the yield curve does not change in a parallel fashion. Exhibit 9–3 illustrates this for our portfolio that includes the 5-year and the 20-year bonds. The scenario analyzed is a yield-curve shift scenario combined with scenarios for shifts in the level of yields. In the illustration in Exhibit 9–3, the following yield changes for the 5-year and 20-year yields are assumed:

Scenario	Change in 5-Year Rate (bp)	Change in 20-Year Rate (bp)
1	50	10
2	100	50
3	200	100

The last panel in Exhibit 9–3 shows how the market value of the portfolio changes for each scenario.

The full-valuation approach seems straightforward. If one has a good valuation model, assessing how the value of a portfolio or individual bond will change

EXHIBIT 9–2

Illustration of Full-Valuation Approach to Assess the Interest-Rate Risk of a Bond Portfolio for Three Scenarios Assuming a Parallel Shift in the Yield Curve

Two-bond portfolio (both bonds are option-free bonds)

Panel a

Bond 1:	6% coupon 5-year bond	Par value:	$5,000,000
Initial price:	104.3760	Market value:	$5,218,800
Yield:	5%		

Scenario	Yield Change (bp)	New Yield	New Price	New Market Value ($)
1	50	5.5%	102.1600	5,108,000
2	100	6.0%	100.0000	5,000,000
3	200	7.0%	95.8417	4,792,085

Panel b

Bond 2:	9% coupon 20-year bond	Par value:	$10,000,000
Initial price:	134.6722	Market value:	$13,467,220
Yield:	6%		

Scenario	Yield Change (bp)	New Yield	New Price	New Market Value ($)
1	50	6.5%	127.7602	12,776,020
2	100	7.0%	121.3551	12,135,510
3	200	8.0%	109.8964	10,989,640

Panel c

Portfolio Market value: $18,686,020.00

		Market Value of			
Scenario	**Yield Change (bp)**	**Bond 1 ($)**	**Bond 2 ($)**	**Portfolio ($)**	**Percentage Change in Market Value (%)**
1	50	5,108,000	12,776,020	17,884,020	–4.29%
2	100	5,000,000	12,135,510	17,135,510	–8.30%
3	200	4,792,085	10,989,640	15,781,725	–15.54%

for different scenarios for parallel and nonparallel yield-curve shifts measures the interest-rate risk of a portfolio.

A common question that often arises when using the full-valuation approach is what scenarios should be evaluated to assess interest-rate risk exposure. For some regulated entities, there are specified scenarios established by regulators.

EXHIBIT 9–3

Illustration of Full-Valuation Approach to Assess the Interest-Rate Risk of a Bond Portfolio for Three Scenarios Assuming a Nonparallel Shift in the Yield Curve

Two-bond portfolio (both bonds are option-free bonds)

Panel a

Bond 1:	6% coupon 5-year bond	Par value:	$5,000,000
Initial price:	104,3760	Market value:	$5,218,800
Yield:	5%		

Scenario	Yield Change (bp)	New Yield	New Price	New Market Value ($)
1	50	5.5%	102.1600	5,108,000
2	100	6.0%	100.0000	5,000,000
3	200	7.0%	95,8417	4,792,085

Panel b

Bond 2:		Par value:	$10,000,000
Initial price:	134.6722	Market value:	$13,467,220

Scenario	Yield Change (bp)	New Yield	New Price	New Market Value ($)
1	10	6.1%	133.2472	13,324,720
2	50	6.5%	127.7605	12,776,050
3	100	7.0%	121.3551	12,135,510

Panel c

Portfolio market value: $18,686,020.00

	Market Value of			
Scenario	**Bond 1 ($)**	**Bond 2 ($)**	**Portfolio ($)**	**Percentage Change in Market Value (%)**
1	5,108,000	13,324,720	18,432,720	–1.36%
2	5,000,000	12,776,050	17,776,050	–4.87%
3	4,792,085	12,135,510	16,927,595	–9.41%

For example, it is common for regulators of depository institutions to require entities to determine the impact on the value of their bond portfolio for a 100, 200, and 300 basis point instantaneous change in interest rates (up and down). (Regulators tend to refer to this as "simulating" interest-rate scenarios rather than scenario analysis.) Risk managers and highly leveraged investors such as hedge funds tend to look at extreme scenarios to assess exposure to interest-rate changes. This practice is called *stress testing.*

Of course, in assessing how changes in the yield curve can affect the exposure of a portfolio, there are an infinite number of scenarios that can be evaluated. The state-of-the-art technology involves using a complex statistical procedure to determine a likely set of yield-curve shift scenarios from historical data.

We can use the full-valuation approach to assess the exposure of a bond or portfolio to interest-rate change to evaluate any scenario, assuming—and this must be repeated continuously—*that the investor has a good valuation model to estimate what the price of the bonds will be in each interest-rate scenario.* While the full-valuation approach is the recommended approach for assessing the position of a single bond or a portfolio of a few bonds, for a portfolio with a large number of bonds and with even a minority of those bonds being complex (i.e., having embedded options), the full-valuation process is time-consuming. Investors want one measure they can use to get an idea of how a portfolio or even a single bond will change if rates change in a parallel fashion rather than having to revalue a portfolio to obtain that answer. Such a measure is duration. We will discuss this measure as well as a supplementary measure (convexity). To build a foundation to understand the limitations of these measures, we describe next the basic price volatility characteristics of bonds. The fact that there are limitations of using one or two measures to describe the interest-rate exposure of a position or portfolio should not be surprising. What is important to understand is that these measures provide a starting point for assessing interest-rate risk.

PRICE VOLATILITY CHARACTERISTICS OF BONDS

The characteristics of a bond that affect its price volatility are (1) maturity, (2) coupon rate, and (3) presence of embedded options. We also will see how the level of yields affects price volatility.

Price Volatility Characteristics of Option-Free Bonds

We begin by focusing on option-free bonds (i.e., bonds that do not have embedded options). A fundamental characteristic of an option-free bond is that the price of the bond changes in the opposite direction from a change in the bond's required yield. Exhibit 9–4 illustrates this property for four hypothetical bonds assuming a par value of $100.

When the price/yield relationship for any option-free bond is graphed, it exhibits the shape shown in Exhibit 9–5. Notice that as the required yield increases, the price of an option-free bond declines. However, this relationship is not linear (i.e., not a straight-line relationship). The shape of the price/yield relationship

EXHIBIT 9–4

Price/Yield Relationship for Four Hypothetical Option-Free Bonds

	Price ($)			
Yield (%)	**6%/5 Year**	**6%/20 Year**	**9%/5 Year**	**9%/20 Year**
4.00	108.9826	127.3555	122.4565	168.3887
5.00	104.3760	112.5514	117.5041	150.2056
5.50	102.1600	106.0195	115.1201	142.1367
5.90	100.4276	101.1651	113.2556	136.1193
5.99	100.0427	100.1157	112.8412	134.8159
6.00	100.0000	100.0000	112.7953	134.6722
6.01	99.9574	99.8845	112.7494	134.5287
6.10	99.5746	98.8535	112.3373	133.2472
6.50	97.8944	94.4479	110.5280	127.7605
7.00	95.8417	89.3225	108.3166	121.3551
8.00	91.8891	80.2072	104.0554	109.8964

for any option-free bond is called *convex*. This price/yield relationship is for an instantaneous change in the required yield.

The price sensitivity of a bond to changes in the required yield can be measured in terms of the dollar price change or the percentage price change. Exhibit 9–6 uses the four hypothetical bonds in Exhibit 9–4 to show the percentage change in each bond's price for various changes in yield, assuming that the initial yield for all

EXHIBIT 9–5

Price/Yield Relationship for a Hypothetical Option-Free Bond

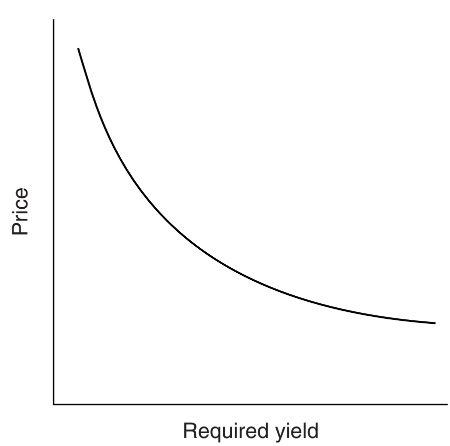


EXHIBIT 9–6

Instantaneous Percentage Price Change for Four Hypothetical Bonds (Initial yield for all four bonds is 6%)

	Percentage Price Change			
New Yield	**6%/5 Year**	**6%/20 Year**	**9%/5 Year**	**9%/20 Year**
4.00	8.98	27.36	8.57	25.04
5.00	4.38	12.55	4.17	11.53
5.50	2.16	6.02	2.06	5.54
5.90	0.43	1.17	0.41	1.07
5.99	0.04	0.12	0.04	0.11
6.01	–0.04	–0.12	–0.04	–0.11
6.10	–0.43	–1.15	–0.41	–1.06
6.50	–2.11	–5.55	–2.01	–5.13
7.00	–4.16	–10.68	–3.97	–9.89
8.00	–8.11	–19.79	–7.75	–18.40

four bonds is 6%. An examination of Exhibit 9–6 reveals the following properties concerning the price volatility of an option-free bond:

Property 1: Although the price moves in the opposite direction from the change in required yield, the percentage price change is not the same for all bonds.

Property 2: For small changes in the required yield, the percentage price change for a given bond is roughly the same, whether the required yield increases or decreases.

Property 3: For large changes in required yield, the percentage price change is not the same for an increase in required yield as it is for a decrease in required yield.

Property 4: For a given large change in basis points in the required yield, the percentage price increase is greater than the percentage price decrease.

While the properties are expressed in terms of percentage price change, they also hold for dollar price changes.

The implication of Property 4 is that if an investor is long a bond, the price appreciation that will be realized if the required yield decreases is greater than the capital loss that will be realized if the required yield increases by the same number of basis points. For an investor who is short a bond, the reverse is true: The potential capital loss is greater than the potential capital gain if the yield changes by a given number of basis points.

Bond Features That Affect Interest-Rate Risk

The degree of sensitivity of a bond's price to changes in market interest rates (i.e., a bond's interest-rate risk) depends on various features of the issue, such as maturity, coupon rate, and embedded options.

The Impact of Maturity

All other factors constant, *the longer the bond's maturity, the greater is the bond's price sensitivity to changes in interest rates.* For example, for a 6% 20-year bond selling to yield 6%, a rise in the yield required by investors to 6.5% will cause the bond's price to decline from 100 to 94.4479, a 5.55% price decline. For a 6% 5-year bond selling to yield 6%, the price is 100. A rise in the yield required by investors from 6% to 6.5% would decrease the price to 97.8944. The decline in the bond's price is only 2.11%.

The Impact of Coupon Rate

A property of a bond is that all other factors constant, *the lower the coupon rate, the greater is the bond's price sensitivity to changes in interest rates.* For example, consider a 9% 20-year bond selling to yield 6%. The price of this bond would be 134.6722. If the yield required by investors increases by 50 basis points to 6.5%, the price of this bond would fall by 5.13% to 127.7605. This decline is less than the 5.55% decline for the 6% 20-year bond selling to yield 6%.

An implication is that zero-coupon bonds have greater price sensitivity to interest-rate changes than same-maturity bonds bearing a coupon rate and trading at the same yield.

The Impact of Embedded Options

In Chapter 1 we discussed the various embedded options that may be included in a bond issue. The value of a bond with embedded options will change depending on how the value of the embedded options changes when interest rates change. For example, as interest rates decline, the price of a callable bond may not increase as much as an otherwise option-free bond (i.e., a bond with no embedded options).

To understand why, we decompose the price of a callable bond into two parts, as shown below:

$$\text{Price of callable bond} \\ = \text{price of option-free bond} - \text{price of embedded call option}$$

The reason for subtracting the price of the embedded call option from the price of the option-free bond is that the call option is a benefit to the issuer and a disadvantage to the bondholder. This reduces the price of a callable bond relative to an option-free bond.

Now, when interest rates decline, the price of an option-free bond increases. However, the price of the embedded call option increases when interest rates decline because the call option becomes more valuable to the issuer. Thus, when interest rates decline, both components increase, *but* the change in the price of the callable bond depends on the relative price change of the two components. Typically, a decline in interest rates will result in an increase in the price of the callable bond but not by as much as the price change of an otherwise comparable option-free bond.

Similarly, when interest rates rise, the price of a callable bond will not fall by as much as an otherwise option-free bond. The reason is that the price of the embedded call option declines. When interest rates rise, the price of the option-free bond declines but is partially offset by the decrease in the price of the embedded call option.

Price Volatility Characteristics of Bonds with Embedded Options

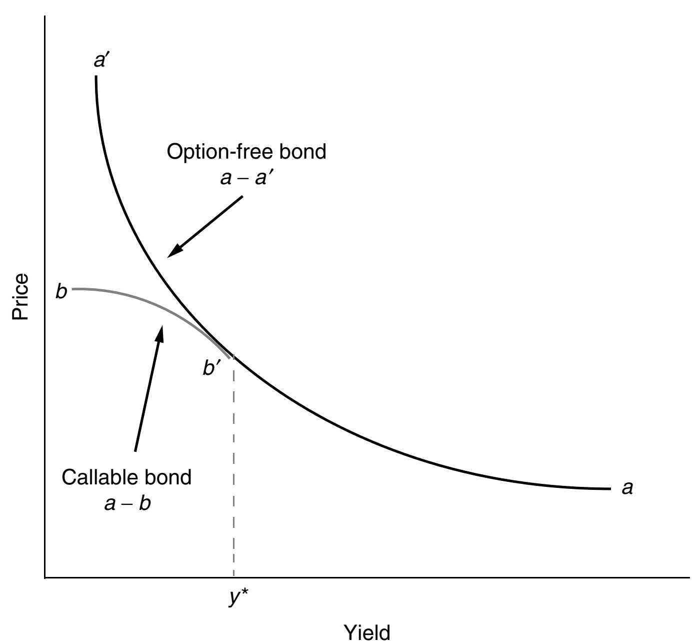
In this section we examine the price/yield relationship for bonds with both types of options (calls and puts) and implications for price volatility.

Bonds with Call and Prepay Options

In the discussion below we will refer to a bond that may be called or is prepayable as a callable bond. Exhibit 9–7 shows the price/yield relationship for an option-free bond and a callable bond. The convex curve given by *a–a′* is the price/yield

EXHIBIT 9–7

Price/Yield Relationship for a Callable Bond and an Option-Free Bond



relationship for an option-free bond. The unusually shaped curve denoted by *a–b* in the exhibit is the price/yield relationship for the callable bond.

The reason for the price/yield relationship for a callable bond is as follows. When the prevailing market yield for comparable bonds is higher than the coupon rate on the callable bond, it is unlikely that the issuer will call the issue. For example, if the coupon rate on a bond is 7% and the prevailing market yield on comparable bonds is 12%, it is highly unlikely that the issuer will call a 7% coupon bond so that it can issue a 12% coupon bond. Since the bond is unlikely to be called, the callable bond will have a similar price/yield relationship as an otherwise comparable option-free bond. Consequently, the callable bond is going to be valued as if it is an option-free bond. However, since there is still some value to the call option, the bond won't trade exactly like an option-free bond.

As yields in the market decline, the concern is that the issuer will call the bond. The issuer won't necessarily exercise the call option as soon as the market yield drops below the coupon rate. Yet the value of the embedded call option increases as yields approach the coupon rate from higher yield levels. For example, if the coupon rate on a bond is 7% and the market yield declines to 7.5%, the issuer most likely will not call the issue. However, market yields are at a level at which the investor is concerned that the issue eventually may be called if market yields decline further. Cast in terms of the value of the embedded call option, that option becomes more valuable to the issuer, and therefore, it reduces the price relative to an otherwise comparable option-free bond.[1] In Exhibit 9–7, the value of the embedded call option at a given yield can be measured by the difference between the price of an option-free bond (the price shown on the curve *a–a′*) and the price on the curve *a–b*. Notice that at low yield levels (below y^* on the horizontal axis), the value of the embedded call option is high.

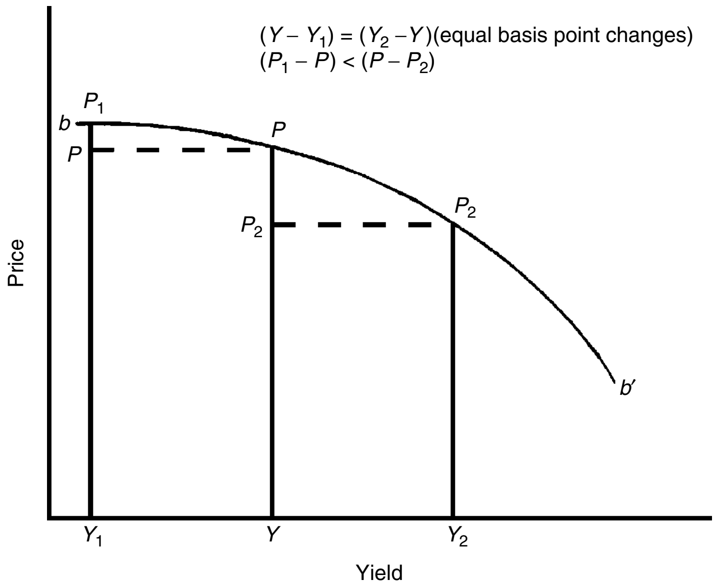
Let's look at the difference in the price volatility properties relative to an option-free bond given the price/yield relationship for a callable bond shown in Exhibit 9–7. Exhibit 9–8 blows up the portion of the price/yield relationship for the callable bond where the two curves in Exhibit 9–7 depart (segment *b–b′* in Exhibit 9–7). We know from our discussion of the price/yield relationship that for a large change in yield of a given number of basis points, the price of an option-free bond increases by more than it decreases (Property 4 above). Is that what happens for a callable bond in the region of the price/yield relationship shown in Exhibit 9–8? No, it is not. In fact, as can be seen in the exhibit, the opposite is true! That is, for a given large change in yield, the price appreciation is less than the price decline.

The price volatility characteristic of a callable bond is important to understand. The characteristic of a callable bond that its price appreciation is less than

1. For readers who are already familiar with option theory, this characteristic can be restated as follows: When the coupon rate for the issue is below the market yield, the embedded call option is said to be "out-of-the-money." When the coupon rate for the issue is above the market yield, the embedded call option is said to be "in-the-money."

EXHIBIT 9–8

Negative Convexity Region of the Price/Yield Relationship for a Callable Bond



its price decline when rates change by a large number of basis points is called *negative convexity.*[2] But notice from Exhibit 9–7 that callable bonds do not exhibit this characteristic at every yield level. When yields are high (relative to the issue's coupon rate), the bond exhibits the same price/yield relationship as an option-free bond and therefore at high yield levels also has the characteristic that the gain is greater than the loss. Because market participants have referred to the shape of the price/yield relationship shown in Exhibit 9–8 as negative convexity, market participants call the relationship for an option-free bond *positive convexity.* Consequently, a callable bond exhibits negative convexity at low yield levels and positive convexity at high yield levels.

As can be seen from the exhibits, when a bond exhibits negative convexity, as rates decline, the bond compresses in price. That is, at a certain yield level there is very little price appreciation when rates decline. When a bond enters this region, the bond is said to exhibit "price compression."

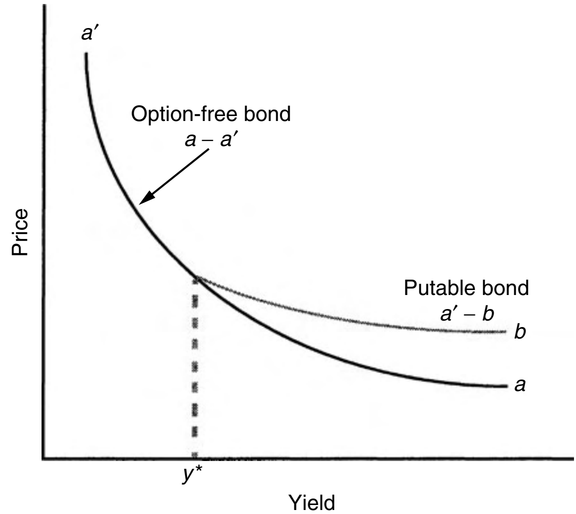
Bonds with Embedded Put Options

Putable bonds may be redeemed by the bondholder on the dates and at the put price specified in the indenture. Typically, the put price is par value. The advantage

2. Mathematicians refer to this shape as being "concave."

EXHIBIT 9–9

Price/Yield Relationship for a Putable Bond and an Option-Free Bond



to the investor is that if yields rise such that the bond's value falls below the put price, the investor will exercise the put option. If the put price is par value, this means that if market yields rise above the coupon rate, the bond's value will fall below par, and the investor will then exercise the put option.

The value of a putable bond is equal to the value of an option-free bond plus the value of the put option. Thus the difference between the value of a putable bond and the value of an otherwise comparable option-free bond is the value of the embedded put option. This can be seen in Exhibit 9–9 which shows the price/yield relationship for a putable bond (the curve *a*′–*b*) and an option-free bond (the curve *a*′–*a*′).

At low yield levels (low relative to the issue's coupon rate), the price of the putable bond is basically the same as the price of the option-free bond because the value of the put option is small. As rates rise, the price of the putable bond declines, but the price decline is less than that for an option-free bond. The divergence in the price of the putable bond and an otherwise comparable option-free bond at a given yield level is the value of the put option. When yields rise to a level where the bond's price would fall below the put price, the price at these levels is the put price.

Interest-Rate Risk for Floating-Rate Securities

The change in the price of a fixed-rate coupon bond when market interest rates change is due to the fact that the bond's coupon rate differs from the prevailing market interest rate. For a floating-rate security, the coupon rate is reset periodically based on the prevailing value for the reference rate plus the quoted margin. The quoted margin is set for the life of the security. The price of a floating-rate security will fluctuate depending on three factors.

First, the longer the time to the next coupon reset date, the greater is the potential price fluctuation.[3] For example, consider a floating-rate security whose coupon resets every six months and the coupon formula is the six-month Treasury rate plus 20 basis points. Suppose that on the coupon reset date the six-month Treasury rate is 5.8%. If on the day after the coupon is reset the six-month Treasury rate rises to 6.1%, this means that this security is offering a six-month coupon rate that is less than the prevailing six-month rate for the remaining six months. The price of the security must decline to reflect this. Suppose instead that the coupon resets every month at the one-month Treasury rate and that this rate rises immediately after the coupon rate is reset. In this case, while the investor would be realizing a submarket one-month coupon rate, it is for only a month. The price decline will be less than for the security that resets every six months.

The second reason why a floating-rate security's price will fluctuate is that the required margin that investors demand in the market changes. For example, consider once again the security whose coupon formula is the six-month Treasury rate plus 20 basis points. If market conditions change such that investors want a margin of 30 basis points rather than 20 basis points, this security would be offering a coupon rate that is 10 basis points below the market rate. As a result, the security's price will decline.

Finally, a floating-rate security typically will have a cap. Once the coupon rate as specified by the coupon formula rises above the cap rate, the coupon will be set at the cap rate, and the security then will offer a below-market coupon rate, and its price will decline. In fact, once the cap is reached, the security's price will react much the same way to changes in market interest rates as that of a fixed-rate coupon security. This risk for a floating-rate security is called *cap risk.*

The Impact of the Yield Level

Because of credit risk, different bonds trade at different yields, even if they have the same coupon rate, maturity, and embedded options. How, then, holding other factors constant, does the level of interest rates affect a bond's price sensitivity to changes in interest rates? As it turns out, the higher the level of interest rates that a bond trades, the lower is the price sensitivity.

To see this, we can compare a 6% 20-year bond initially selling at a yield of 6% and a 6% 20-year bond initially selling at a yield of 10%. The former is

3. The coupon rate is set at the beginning of the period but is not paid until the end of the period.

initially at a price of 100, and the latter, 65.68. Now, if the yield on both bonds increases by 100 basis points, the first bond trades down by 10.68 points (10.68%) to a price of 89.32. After the assumed increase in yield, the second bond will trade at a price of 59.88, for a price decline of only 5.80 points (or 8.83%). Thus we see that the bond that trades at a lower yield is more volatile in both percentage price change and absolute price change as long as the other bond characteristics are the same. An implication is that for a given change in interest rates, price sensitivity is lower when the level of interest rates in the market is high, and price sensitivity is higher when the level of interest rates is low.

DURATION

With this background about the price volatility characteristics of a bond, we can now turn to an alternate approach to full valuation: the duration/convexity approach. *Duration is a measure of the approximate sensitivity of a bond's value to rate changes.* More specifically, *it is the approximate percentage change in value for a 100 basis point change in rates.* We'll see in this section that duration is the first approximation of the percentage price change. To improve the estimate provided by duration a measure called *convexity* can be used. Hence, using duration combined with convexity to estimate the percentage price change of a bond to changes in interest rates is called the *duration/convexity approach.*

Calculating Duration

The duration of a bond is estimated as follows:

$$\frac{\text{Price if yields decline} - \text{price if yields rise}}{2(\text{initial price})(\text{change in yield in decimal})}$$

If we let

$$\begin{aligned} \Delta y &= \text{change in yield in decimal} \\ V_0 &= \text{initial price} \\ V_- &= \text{price if yields decline by } \Delta y \\ V_+ &= \text{price if yields increase by } \Delta y \end{aligned}$$

then duration can be expressed as

$$\text{Duration} = \frac{V_- - V_+}{2(V_0)(\Delta y)} \qquad (9\text{–}1)$$

For example, consider a 9% coupon 20-year option-free bond selling at 134.6722 to yield 6% (see Exhibit 9–4). Let's change (i.e., shock) the yield down and up by 20 basis points and determine what the new prices will be for the numerator. If the yield is decreased by 20 basis points from 6.0% to 5.8%, the price would increase to 137.5888. If the yield increases by 20 basis points, the price would decrease to 131.8439. Thus

$$\Delta y = 0.002$$
$$V_0 = 134.6722$$
$$V_- = 137.5888$$
$$V_+ = 131.8439$$

Then

$$\text{Duration} = \frac{137.5888 - 131.8439}{2 \times (134.6722) \times (0.002)} = 10.66$$

Duration is interpreted as the approximate percentage change in price for a 100 basis point change in rates. Consequently, a duration of 10.66 means that the approximate change in price for this bond is 10.66% for a 100 basis point change in rates.

A common question asked about this interpretation of duration is the consistency between the yield change that is used to compute duration using Eq. (9–1) and the interpretation of duration. For example, recall that in computing the duration of the 9% coupon 20-year bond, we used a 20 basis point yield change to obtain the two prices to use in the numerator of Eq. (9–1). Yet we interpret the duration computed as the approximate percentage price change for a 100 basis point change in yield. The reason is that regardless of the yield change used to estimate duration in Eq. (9–1), the interpretation is the same. If we used a 25 basis point change in yield to compute the prices used in the numerator of Eq. (9–1), the resulting duration is interpreted as the approximate percentage price change for a 100 basis point change in yield. Later we will use different changes in yield to illustrate the sensitivity of the computed duration.

Approximating the Percentage Price Change Using Duration

The following formula is used to approximate the percentage price change for a given change in yield and a given duration:

$$\text{Approximate percentage price change} = -\text{duration} \times \Delta y \times 100 \qquad (9\text{–}2)$$

The reason for the negative sign on the right-hand side of Eq. (9–2) is due to the inverse relationship between price change and yield change.

For example, consider the 9% 20-year bond trading at 134.6722 whose duration we just showed is 10.66. The approximate percentage price change for a

10 basis point increase in yield (i.e., $\Delta y = +0.001$) is

$$\text{Approximate percentage price change} = -10.66 \times (+0.001) \times 100 = -1.066\%$$

How good is this approximation? The actual percentage price change is –1.06% (as shown in Exhibit 9–6 when yield increases to 6.10%). Duration, in this case, did an excellent job in estimating the percentage price change. We would come to the same conclusion if we used duration to estimate the percentage price change if the yield declined by 10 basis points (i.e., $\Delta y = -0.001$). In this case, the approximate percentage price change would be +1.066% (i.e., the direction of the estimated price change is the reverse but the magnitude of the change is the same). Exhibit 9–6 shows that the actual percentage price change is +1.07%.

In terms of estimating the new price, let's see how duration performed. The initial price is 134.6722. For a 10 basis point increase in yield, duration estimates that the price will decline by 1.066%. Thus the price will decline to 133.2366 (found by multiplying 134.6722 by 1 minus 0.1066). The actual price from Exhibit 9–4 if the yield increases by 10 basis points is 133.2472. Thus the price estimated using duration is close to the actual price. For a 10 basis point decrease in yield, the actual price from Exhibit 9–4 is 136.1193, and the estimated price using duration is 136.1078 (a price increase of 1.066%). Consequently, the new price estimated by duration is close to the actual price for a 10 basis point change in yield.

Let's look at how well duration does in estimating the percentage price change if the yield increases by 200 basis points instead of 10 basis points. In this case, Δy is equal to +0.02. Substituting into Eq. (9–2) we have

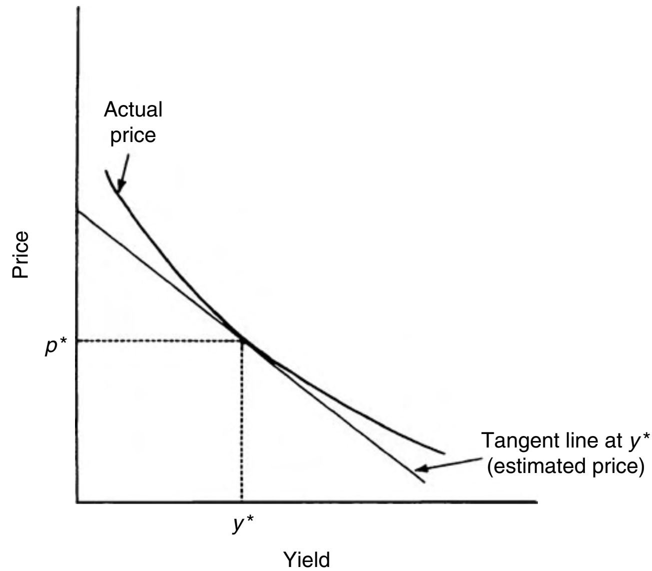
$$\text{Approximate percentage price change} = -10.66 \times (+0.02) \times 100 = -21.32\%$$

How good is this estimate? From Exhibit 9–6 we see that the actual percentage price change when the yield increases by 200 basis points to 8% is –18.40%. Thus the estimate is not as accurate as when we used duration to approximate the percentage price change for a change in yield of only 10 basis points. If we use duration to approximate the percentage price change when the yield decreases by 200 basis points, the approximate percentage price change in this scenario is +21.32%. The actual percentage price change as shown in Exhibit 9–6 is +25.04%.

Again, let's look at the use of duration in terms of estimating the new price. Since the initial price is 134.6722 and a 200 basis point increase in yield will decrease the price by 21.32%, the estimated new price using duration is 105.9601 (found by multiplying 134.6722 by 1 minus 0.2132). From Exhibit 9–4 the actual price if the yield is 8% is 109.8964. Consequently, the estimate is not as accurate as the estimate for a 10 basis point change in yield. The estimated new price using duration for a 200 basis point decrease in yield is 163.3843 compared with the actual price (from Exhibit 9–4) of 168.3887. Once again, the estimation of the price using duration is not as accurate as for a 10 basis point change. *Notice that whether the yield is increased or decreased by 200 basis points, duration underestimates what the new price will be.* We will see why shortly.

EXHIBIT 9–10

Price/Yield Relationship for an Option-Free Bond with a Tangent Line



Let's summarize what we found in our application of duration to approximate the percentage price change:

Yield Change (bp)	Initial Price	*New Price* Based on Duration	*New Price* Actual	*Percent Price Change* Based on Duration	*Percent Price Change* Actual	Comment
+10	134.6722	133.2366	133.2472	–1.066	–1.06	Estimated price close to new price
–10	134.6722	136.1078	136.1193	+1.066	+1.07	Estimated price close to new price
+200	134.6722	105.9601	109.8964	–21.320	–18.40	Underestimates new price
–200	134.6722	163.3843	168.3887	+21.320	+25.40	Underestimates new price

Look again at Eq. (9–2). Notice that whether the change in yield is an increase or a decrease, the approximate percentage price change will be the same except that the sign is reversed. This violates Properties 3 and 4 with respect to the price volatility of option-free bonds when yields change. Recall that Property 3 states that the percentage price change will not be the same for a large increase and decrease in yield by the same number of basis points. This is one reason why we see that the estimate is inaccurate for a 200 basis point yield change. Why did the duration estimate of the price change do a good job for a small change in yield of 10 basis points? Recall from Property 2 that the percentage price change will be approximately the same whether there is an increase or decrease in yield by a small number of basis points. We also can explain these results in terms of the graph of the price/yield relationship. We will do this next.

Graphic Depiction of Using Duration to Estimate Price Changes

The shape of the price/yield relationship for an option-free bond is convex. Exhibit 9–10 shows this relationship. In the exhibit, a tangent line is drawn to the price/yield relationship at yield y^*. [For those unfamiliar with the concept of a tangent line, it is a straight line that just touches a curve at one point within a relevant (local) range.] In Exhibit 9–10, the tangent line touches the curve at the point where the yield is equal to y^* and the price is equal to p^*. The tangent line can be used to estimate the new price if the yield changes. If we draw a vertical line from any yield (on the horizontal axis), as in Exhibit 9–10, the distance between the horizontal axis and the tangent line represents the price approximated by using duration starting with the initial yield y^*.

Now how is the tangent line, used to approximate what the new price will be if yields change, related to duration? Duration tells us the approximate percentage price change. Given the initial price and the approximate percentage price change provided by duration [i.e., as given by Eq. (9–2)], the approximate new price can be estimated. Mathematically, it can be demonstrated that the estimated price that is provided by duration is on the tangent line.

This helps us to understand why duration did an effective job of estimating the percentage price change or, equivalently, the new price when the yield changes by a small number of basis points. Look at Exhibit 9–11. Notice that for a small change in yield, the tangent line does not depart much from the price/yield relationship. Hence, when the yield changes up or down by 10 basis points, the tangent line does a good job of estimating the new price, as we found in our earlier numerical illustration.

Exhibit 9–11 also shows what happens to the estimate using the tangent line when the yield changes by a large number of basis points. Notice that the error in the estimate gets larger the further one moves from the initial yield. The estimate is less accurate the more convex the bond. This is illustrated in Exhibit 9–12.

Also note that regardless of the magnitude of the yield change, the tangent line always underestimates what the new price will be for an option-free bond because the tangent line is below the price/yield relationship. This explains why we found in our illustration that when using duration we underestimated what the actual price will be.

Rate Shocks and Duration Estimate

In calculating duration using Eq. (9–1), it is necessary to shock interest rates (yields) up and down by the same number of basis points to obtain the values for V_- and V_+.

EXHIBIT 9–11

Estimating the New Price Using a Tangent Line

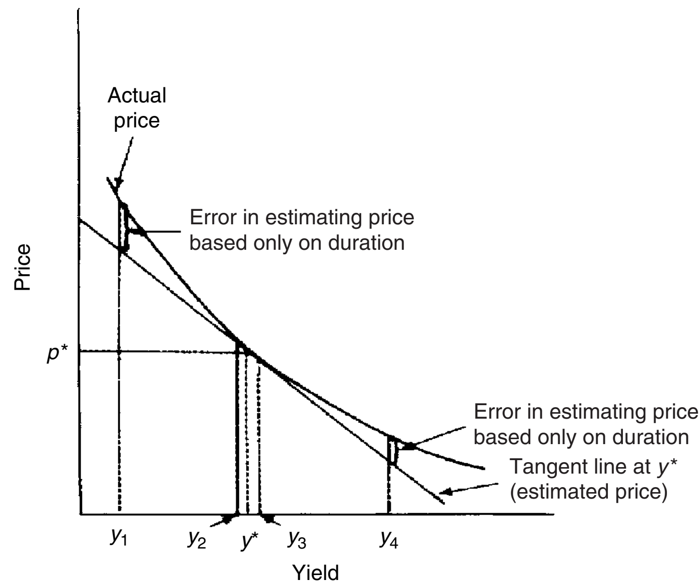


EXHIBIT 9–12

Estimating the New Price for a Large Yield Change for Bonds with Different Convexities

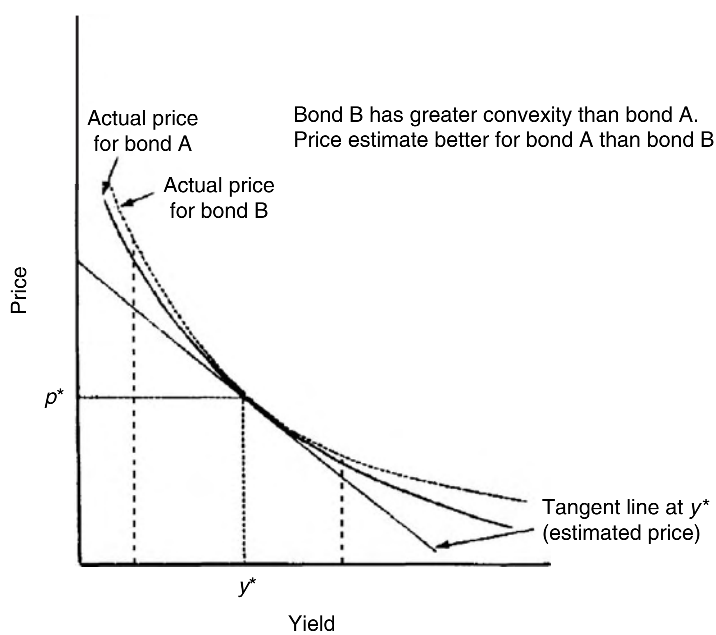


EXHIBIT 9–13

Duration Estimates for Different Rate Shocks

Bond	1 bp	10 bps	20 bps	50 bps	100 bps	150 bps	200 bps
6% 5-year	4.27	4.27	4.27	4.27	4.27	4.27	4.27
6% 20-year	11.56	11.56	11.56	11.57	11.61	11.69	11.79
9% 5-year	4.07	4.07	4.07	4.07	4.07	4.08	4.08
9% 20-year	10.66	10.66	10.66	10.67	10.71	10.77	10.86

Initial yield: 6%

In our illustration, 20 basis points was arbitrarily selected. But how large should the shock be? That is, how many basis points should be used to shock the rate?

In Exhibit 9–13, the duration estimate for our four hypothetical bonds using Eq. (9–1) for rate shocks of 1 basis point to 200 basis points is reported. The duration estimates for the two 5-year bonds are not affected by the size of the shock. The two 5-year bonds are less convex than the two 20-year bonds. But even for the two 20-year bonds, for the size of the shocks reported in Exhibit 9–13, the duration estimates are not materially affected by the greater convexity.

Thus it would seem that the size of the shock is unimportant. However, the results reported in Exhibit 9–13 are for option-free bonds. When we deal with more complicated securities, small rate shocks that do not reflect the types of rate changes that may occur in the market do not permit the determination of how prices can change because expected cash flows may change when dealing with bonds with embedded options. In comparison, if large rate shocks are used, we encounter the asymmetry caused by convexity. Moreover, large rate shocks may cause dramatic changes in the expected cash flows for bonds with embedded options that may be far different from how the expected cash flows will change for smaller rate shocks.

There is another potential problem with using small rate shocks for complicated securities. The prices that are inserted into the duration formula as given by Eq. (9–1) are derived from a valuation model. In Chapters 37 and 38 we will discuss various valuation models and their underlying assumptions. The duration measure depends crucially on a valuation model. If the rate shock is small and the valuation model used to obtain the prices for Eq. (9–1) is poor, dividing poor price estimates by a small shock in rates in the denominator will have a significant effect on the duration estimate.

What is done in practice by dealers and vendors of analytical systems? Each system developer uses rate shocks he or she believes to be realistic based on historical rate changes.

MODIFIED DURATION VERSUS EFFECTIVE DURATION

One form of duration that is cited by practitioners is *modified duration.* Modified duration is the approximate percentage change in a bond's price for a 100 basis point change in yield *assuming that the bond's expected cash flows do not change* *when the yield changes.* What this means is that in calculating the values of V_- and V_+ in Eq. (9–1), the same cash flows used to calculate V_0 are used. Therefore, the change in the bond's price when the yield is changed is due solely to discounting cash flows at the new yield level.

The assumption that the cash flows will not change when the yield is changed makes sense for option-free bonds such as noncallable Treasury securities. This is so because the payments made by the U.S. Department of the Treasury to holders of its obligations do not change when interest rates change. However, the same cannot be said for bonds with embedded options (i.e., callable and putable bonds and mortgage-backed securities). For these securities, a change in yield may alter the expected cash flows significantly.

Earlier we showed the price/yield relationship for callable and prepayable bonds. Failure to recognize how changes in yield can alter the expected cash flows will produce two values used in the numerator of Eq. (9–1) that are not good estimates of how the price actually will change. The duration is then not a good number to use to estimate how the price will change.

In later chapters where valuation models for bonds with embedded options will be discussed, it will be explained how these models take into account how changes in yield will affect the expected cash flows. Thus, when V_- and V_+ are the values produced from these valuation models, the resulting duration takes into account both the discounting at different interest rates and how the expected cash flows may change. When duration is calculated in this manner, it is called *effective duration* or *option-adjusted duration.* Exhibit 9–14 summarizes the distinction between modified duration and effective duration.

The difference between modified duration and effective duration for bonds with embedded options can be quite dramatic. For example, a callable bond could have a modified duration of 5 but an effective duration of only 3. For certain collateralized mortgage obligations, the modified duration could be 7 and the effective duration 20! Thus, using modified duration as a measure of the price sensitivity of a security with embedded options to changes in yield would be misleading. The more appropriate measure for any bond with an embedded option is effective duration.

EXHIBIT 9–14

Modified Duration versus Effective Duration

Duration

Interpretation: Generic description of the sensitivity of a bond's price (as a percentage of initial price) to a change in yield

Modified duration	*Effective duration*
Duration measure in which it is assumed that yield changes do not change the expected cash flows	Duration measure in which recognition is given to the fact that yield changes may change the expected cash flows

Macaulay Duration and Modified Duration

It is worth comparing the relationship between modified duration and Macaulay duration. Modified duration also can be written as[4]:

$$\frac{1}{(1+\text{yield}/k)}\left(\frac{1\times \text{PVCF}_1 + 2\times \text{PVCF}_2 + \cdots + n\times \text{PVCF}_n}{k\times \text{price}}\right) \tag{9–3}$$

where

k = number of periods, or payments, per year (e.g., $k = 2$ for semiannual-pay bonds and $k = 12$ for monthly-pay bonds)
n = number of periods until maturity (i.e., number of years to maturity times k)
yield = yield to maturity of the bond
PVCF_t = present value of the cash flow in period t discounted at the yield to maturity

The expression in the parentheses on the right of the modified duration formula given by Eq. (9–3) is a measure formulated in 1938 by Frederick Macaulay.[5] This measure is popularly called the *Macaulay duration.* Thus modified duration is commonly expressed as

$$\text{Modified duration} = \frac{\text{Macaulay duration}}{(1+\text{yield}/k)}$$

The general formulation for duration as given by Eq. (9–1) provides a shortcut procedure for determining a bond's modified duration. Because it is easier to calculate the modified duration using the shortcut procedure, most vendors of analytical software will use Eq. (9–1) rather than Eq. (9–3) to reduce computation time.

However, it must be understood clearly that modified duration is a flawed measure of a bond's price sensitivity to interest-rate changes for a bond with an embedded option, and therefore, so is Macaulay duration. The use of the formula for duration given by Eq. (9–3) *misleads* the user because it masks the fact that changes in the expected cash flows must be recognized for bonds with embedded options. Although Eq. (9–3) will give the same estimate of percent price change for an option-free bond as Eq. (9–1), Eq. (9–1) is still better because it acknowledges that cash flows and thus value can change owing to yield changes.

4. More specifically, this is the formula for the modified duration of a bond on a coupon anniversary date.
5. Frederick Macaulay, *Some Theoretical Problems Suggested by the Movement of Interest Rates, Bond Yields, and Stock Prices in the U.S. Since 1856* (New York: National Bureau of Economics Research, 1938).

Interpretations of Duration

At the outset of this section we defined duration as the approximate percentage change in price for a 100 basis point change in rates. If you understand this definition, you need never use the equation for the approximate percentage price change given by Eq. (9–2), and you can easily calculate the change in a bond's value.

For example, suppose that we want to know the approximate percentage change in price for a 50 basis point change in yield for our hypothetical 9% coupon 20-year bond selling for 134.6722. Since the duration is 10.66, a 100 basis point change in yield would change the price by about 10.66%. For a 50 basis point change in yield, the price will change by approximately 5.33% (= 10.66%/2). Thus, if the yield changes by 50 basis points, the price will change by 5.33% from 134.6722 to 127.4942.

Now let's look at some other definitions or interpretations of duration that have been used.

Duration Is the "First Derivative"

Sometimes a market participant will refer to duration as the "first derivative of the price/yield function" or simply the "first derivative." *Derivative* here has nothing to do with "derivative instruments" (i.e., futures, swaps, options, etc.). A derivative as used in this context is obtained by differentiating a mathematical function. There are first derivatives, second derivatives, and so on. When market participants say that duration is the first derivative, here is what they mean. If it were possible to write a mathematical equation for a bond in closed form, the first derivative would be the result of differentiating that equation the first time. While it is a correct interpretation of duration, it is an interpretation that in no way helps us understand what the interest-rate risk is of a bond. That is, it is an operationally meaningless interpretation.

Why is it an operationally meaningless interpretation? Go back to the $10 million bond position with a duration of 6. Suppose that a client is concerned with the exposure of the bond to changes in interest rates. Now, tell that client the duration is 6 and that it is the first derivative of the price function for that bond. What have you told the client? Not much. In contrast, tell that client that the duration is 6 and that duration is the approximate price sensitivity of a bond to a 100 basis point change in rates, and you've told the client a great deal with respect to the bond's interest-rate risk.

Duration Is Some Measure of Time

When the concept of duration was introduced by Macaulay in 1938, he used it as a gauge of the time that the bond was outstanding. More specifically, Macaulay defined *duration* as the weighted average of the time to each coupon and principal payment of a bond. Subsequently, *duration* has too often been thought of in temporal terms, that is, years. This is most unfortunate for two reasons.

First, in terms of dimensions, there is nothing wrong with expressing duration in terms of years because that is the proper dimension of this value. But the proper interpretation is that duration is the price volatility of a zero-coupon bond with that number of years to maturity. Thus, when a manager says that a bond has a duration of four years, it is not useful to think of this measure in terms of time, but rather that the bond has the price sensitivity to rate changes of a four-year zero-coupon bond.

Second, thinking of duration in terms of years makes it difficult for managers and their clients to understand the duration of some complex securities. Here are a few examples. For a mortgage-backed security that is an interest-only security, the duration is negative. What does a negative number of, say,–4 mean? In terms of our interpretation as a percentage price change, it means that when rates change by 100 basis points, the price of the bond changes by about 4%, but the change is in the same direction as the change in rates.

As a second example, consider the duration of an option that expires in one year. Suppose that it is reported that its duration is 60. What does that mean? To someone who interprets duration in terms of time, does that mean 60 years, 60 days, or 60 seconds? It doesn't mean any of these. It simply means that the option tends to have the price sensitivity to rate changes of a 60-year zero-coupon bond.

Forget First Derivatives and Temporal Definitions

The bottom line is that one should not care if it is technically correct to think of duration in terms of years (volatility of a zero-coupon bond) or in terms of first derivatives. There are even some who interpret duration in terms of the "half life" of a security. Subject to the limitations that we will describe later, duration is used as a measure of the sensitivity of a security's price to changes in yield. We will fine-tune this definition as we move along.

Users of this interest-rate risk measure are interested in what it tells them about the price sensitivity of a bond (or a portfolio) to changes in rates. Duration provides the investor with a feel for the dollar price exposure or the percentage price exposure to potential rate changes.

Spread Duration

For non-Treasury securities, the yield is equal to the Treasury yield plus a spread to the Treasury yield curve. Non-Treasury securities are called *spread products.* The risk that the price of a bond changes due to changes in spreads is called *spread risk.* A measure of how a spread product's price changes if the spread sought by the market changes is called *spread duration.* Spread duration indicates the approximate percentage change in price for a 100 basis point change in the spread, holding the Treasury yield constant. For example, suppose that the spread duration of a corporate bond is 1. This means that for a 100 basis point change in the spread, the value of the corporate bond will change by approximately 1%.

Portfolio Duration

A portfolio's duration can be obtained by calculating the weighted average of the duration of the bonds in the portfolio. The weight is the proportion of the portfolio that a security comprises. Mathematically, a portfolio's duration can be calculated as follows:

$$w_1 D_1 + w_2 D_2 + w_3 D_3 + \cdots + w_K D_K$$

where

w_i = market value of bond i/market value of the portfolio
D_i = duration of bond i
K = number of bonds in the portfolio

To illustrate this calculation, consider the following three-bond portfolio in which all three bonds are option free:

Bond	Price ($)	Yield (%)	Par Amount Owned	Market Value	Duration
10% 5-year	100.0000	10	$4 million	$4,000,000	3.861
8% 15-year	84.6275	10	5 million	4,231,375	8.047
14% 30-year	137.8590	10	1 million	1,378,586	9.168

In this illustration it is assumed that the next coupon payment for each bond is exactly six months from now (i.e., there is no accrued interest). The market value for the portfolio is $9,609,961. Since each bond is option free, the modified duration can be used. The market price per $100 par value of each bond, its yield, and its duration are given below:

In this illustration, K is equal to 3 and:

$$w_1 = \$4{,}000{,}000/\$9{,}609{,}961 = 0.416 \quad D_1 = 3.861$$
$$w_2 = \$4{,}231{,}375/\$9{,}609{,}961 = 0.440 \quad D_2 = 8.047$$
$$w_3 = \$1{,}378{,}586/\$9{,}609{,}961 = 0.144 \quad D_3 = 9.168$$

The portfolio's duration is:

$$0.416\,(3.861) + 0.440\,(8.047) + 0.144\,(9.168) = 6.47$$

A portfolio duration of 6.47 means that for a 100 basis point change in the yield of all three bonds, the market value of the portfolio will change by approximately 6.47%. But keep in mind that the yield on all three bonds must change by 100 basis points for the duration measure to be useful. This is a *critical assumption,* and its importance cannot be overemphasized.[6]

An alternative procedure for calculating the duration of a portfolio is to calculate the dollar price change for a given number of basis points for each security

6. This is equivalent to saying that the correlation between the yield change for every maturity is equal to 1.

in the portfolio and then add up all the price changes. Dividing the total of the price changes by the initial market value of the portfolio produces a percentage price change that can be adjusted to obtain the portfolio's duration.

For example, consider the three-bond portfolio shown above. Suppose that we calculate the dollar price change for each bond in the portfolio based on its respective duration for a 50 basis point change in yield. We would then have

Bond	Market Value	Duration	Change in Value for 50 bp Yield Change
10% 5-year	$4,000,000	3.861	$77,220
8% 15-year	4,231,375	8.047	170,249
14% 30-year	1,378,586	9.168	63,194
		Total	$310,663

Thus a 50 basis point change in all rates changes the market value of the three-bond portfolio by $310,663. Since the market value of the portfolio is $9,609,961, a 50 basis point change produced a change in value of 3.23% ($310,663 divided by $9,609,961). Since duration is the approximate percentage change for a 100 basis point change in rates, this means that the portfolio duration is 6.46 (found by doubling 3.23). This is the same value for the portfolio's duration as found earlier.

The spread duration for a portfolio or a bond index is computed as a market-weighted average of the spread duration for each sector.

Contribution to Portfolio Duration

Some portfolio managers look at exposure of a portfolio or a benchmark index to an issue or to a sector simply in terms of the market value percentage of that issue or sector in the portfolio. A better measure of exposure to an individual issue or sector is its *contribution to portfolio duration* or *contribution to benchmark index duration*. This is found by multiplying the percentage of the market value of the portfolio represented by the individual issue or sector by the duration of the individual issue or sector. That is,

$$\text{Contribution to portfolio duration} = \text{weight of issue or sector in portfolio} \times \text{duration of issue or sector}$$

$$\text{Contribution to benchmark index duration} = \text{weight of issue or sector in benchmark index} \times \text{duration of issue or sector}$$

A portfolio manager who wants to determine the contribution of a sector to portfolio duration relative to the contribution of the same sector in a broad-based market index can compute the difference between the two contributions. The difference in the percentage distribution by sector is not as meaningful as is the difference in the contribution to duration.

CONVEXITY

The duration measure indicates that regardless of whether interest rates increase or decrease, the approximate percentage price change is the same. However, as we noted earlier, this is not consistent with Property 3 of a bond's price volatility. Specifically, while for small changes in yield the percentage price change will be the same for an increase or decrease in yield, for large changes in yield this is not true. This suggests that duration is only a good approximation of the percentage price change for small changes in yield.

We demonstrated this property earlier using a 9% 20-year bond selling to yield 6% with a duration of 10.66. For a 10 basis point change in yield, the estimate was accurate for both an increase or a decrease in yield. However, for a 200 basis point change in yield, the approximate percentage price change was off considerably.

The reason for this result is that duration is in fact a first (linear) approximation for a small change in yield.[7] The approximation can be improved by using a second approximation. This approximation is referred to as "convexity." *The use of this term in the industry is unfortunate because the term convexity is also used to describe the shape or curvature of the price/yield relationship.* The *convexity measure* of a security can be used to approximate the change in price that is not explained by duration.

Convexity Measure

The convexity measure of a bond is approximated using the following formula:

$$\text{Convexity measure} = \frac{V_+ + V_- - 2V_0}{2V_0(\Delta y)^2} \qquad (9\text{–}4)$$

where the notation is the same as used earlier for duration as given by Eq. (9–1).

For our hypothetical 9% 20-year bond selling to yield 6%, we know that for a 20 basis point change in yield ($\Delta y = 0.002$),

$$V_0 = 134.6722, \quad V_- = 137.5888, \quad \text{and} \quad V_+ = 131.8439$$

Substituting these values into the convexity measure given by Eq. (9–4) gives

$$\text{Convexity measure} = \frac{131.8439 + 137.5888 - 2(134.6722)}{2(134.6722)(0.002)^2} = 81.96$$

7. The reason it is a linear approximation can be seen in Exhibit 9–11, where the tangent line is used to estimate the new price. That is, a straight line is being used to approximate a nonlinear (i.e., convex) relationship.

We'll see how to use this convexity measure shortly. Before doing so, there are three points that should be noted. First, there is no simple interpretation of the convexity measure. Second, in contrast to duration, it is more common for market participants to refer to the value computed in Eq. (9–4) as the "convexity of a bond" rather than the "convexity measure of a bond." Finally, the convexity measure reported by dealers and vendors will differ for an option-free bond. The reason is that the value obtained from Eq. (9–4) is often scaled for the reason explained after we demonstrate how to use the convexity measure.

Convexity Adjustment to Percentage Price Change

Given the convexity measure, the approximate percentage price change adjustment due to the bond's convexity (i.e., the percentage price change not explained by duration) is

$$\text{Convexity adjustment} = \text{convexity measure} \times (\Delta y)^2 \times 100$$

For example, for the 9% coupon bond maturing in 20 years, the convexity adjustment to the percentage price change based on duration if the yield increases from 6% to 8% is

$$81.96 \times (0.02)^2 \times 100 = 3.28\%$$

If the yield decreases from 6% to 4%, the convexity adjustment to the approximate percentage price change based on duration also would be 3.28%.

The approximate percentage price change based on duration and the convexity adjustment is found by adding the two estimates. Thus, for example, if yields change from 6% to 8%, the estimated percentage price change would be

$$\begin{aligned} \text{Estimated change using duration} &= -21.32\% \\ \text{Convexity adjustment} &= \underline{+3.28\%} \\ \text{Total estimated percentage price change} &= -18.04\% \end{aligned}$$

The actual percentage price change is –18.40%.

For a decrease of 200 basis points, from 6% to 4%, the approximate percentage price change would be as follows:

$$\begin{aligned} \text{Estimated change using duration} &= +21.32\% \\ \text{Convexity adjustment} &= \underline{+3.28\%} \\ \text{Total estimated percentage price change} &= +24.60\% \end{aligned}$$

The actual percentage price change is +25.04%. Thus duration combined with the convexity adjustment does a better job of estimating the sensitivity of a bond's price change to large changes in yield.

Notice that when the convexity measure is positive, we have the situation described earlier that the gain is greater than the loss for a given large change in rates. That is, the bond exhibits positive convexity. We can see this in the preceding example. However, if the convexity measure is negative, we have the situation where the loss will be greater than the gain. For example, suppose that a callable bond has an effective duration of 4 and a convexity measure of −30. This means that the approximate percentage price change for a 200 basis point change is 8%. The convexity adjustment for a 200 basis point change in rates is then

$$-30 \times (0.02)^2 \times 100 = -1.2$$

The convexity adjustment is −1.2%, and therefore, the bond exhibits the negative convexity property illustrated in Exhibit 9–7. The approximate percentage price change after adjusting for convexity is

$$\begin{aligned} \text{Estimated change using duration} &= -8.0\% \\ \text{Convexity adjustment} &= \underline{-1.2\%} \\ \text{Total estimated percentage price change} &= -9.2\% \end{aligned}$$

For a decrease of 200 basis points, the approximate percentage price change would be as follows:

$$\begin{aligned} \text{Estimated change using duration} &= +8.0\% \\ \text{Convexity adjustment} &= \underline{-1.2\%} \\ \text{Total estimated percentage price change} &= 6.8\% \end{aligned}$$

Notice that the loss is greater than the gain—a property called *negative convexity* that we discussed earlier and illustrated in Exhibit 9–7.

Scaling the Convexity Measure

The convexity measure as given by Eq. (9–4) means nothing in isolation. It is the substitution of the computed convexity measure into Eq. (9–5) that provides the estimated adjustment for convexity. Therefore, it is possible to scale the convexity measure in any way and obtain the same convexity adjustment.

For example, in some books the convexity measure is defined as follows:

$$\text{Convexity measure} = \frac{V_+ + V_- - 2V_0}{V_0(\Delta y)^2} \tag{9–6}$$

Equation (9–6) differs from Eq. (9–4) because it does not include 2 in the denominator. Thus the convexity measure computed using Eq. (9–6) will be double the convexity measure using Eq. (9–4). Thus, for our earlier illustration, since the convexity measure using Eq. (9–4) is 81.96, the convexity measure using Eq. (9–6) would be 163.92.

Which is correct, 81.96 or 163.92? The answer is both. The reason is that the corresponding equation for computing the convexity adjustment would not be given by Eq. (9–5) if the convexity measure is obtained from Eq. (9–6). Instead, the corresponding convexity adjustment formula would be

$$\text{Convexity adjustment} = (\text{convexity measure}/2) \times (\Delta y)^2 \times 100 \qquad (9\text{–}7)$$

Equation (9–7) differs from Eq. (9–5) in that the convexity measure is divided by 2. Thus the convexity adjustment will be the same whether one uses Eq. (9–4) to get the convexity measure and Eq. (9–5) to get the convexity adjustment or one uses Eq. (9–6) to compute the convexity measure and Eq. (9–7) to determine the convexity adjustment.

Some dealers and vendors scale the convexity measure in a different way. One also can compute the convexity measure as follows:

$$\text{Convexity measure} = \frac{V_+ + V_- - 2V_0}{2V_0(\Delta y)^2(100)} \qquad (9\text{–}8)$$

Equation (9–8) differs from Eq. (9–4) by the inclusion of 100 in the denominator. In our illustration, the convexity measure would be 0.8196 rather than 81.96 using Eq. (9–4). The convexity adjustment formula corresponding to the convexity measure given by Eq. (9–8) is then

$$\text{Convexity adjustment} = \text{convexity measure} \times (\Delta y)^2 \times 10{,}000 \qquad (9\text{–}9)$$

Similarly, one can express the convexity measure as shown in Eq. (9–10):

$$\text{Convexity measure} = \frac{V_+ + V_- - 2V_0}{V_0(\Delta y)^2(100)} \qquad (9\text{–}10)$$

For the bond we have been using in our illustrations, the convexity measure is 1.6392. The corresponding convexity adjustment is

$$\text{Convexity adjustment} = (\text{convexity measure}/2) \times (\Delta y)^2 \times 10{,}000 \qquad (9\text{–}11)$$

Consequently, the convexity measures (or just simply "convexity" as it is referred to by some market participants) that could be reported for this option-free bond are 81.96, 163.92, 0.8196, and 1.6392. All these values are correct, but they mean nothing in isolation. To use them to obtain the convexity adjustment to the price change estimated by duration requires knowing how they are computed so that the correct convexity adjustment formula is used. *It is the convexity adjustment that is important—not the convexity measure in isolation.*

It is also important to understand this when comparing the convexity measures reported by dealers and vendors. For example, if one dealer shows a portfolio manager bond A with a duration of 4 and a convexity measure of 50, and a second dealer shows the manager bond B with a duration of 4 and a convexity measure of 80, which bond has the greater percentage price change response to changes in interest rates? Since the duration of the two bonds is identical, the bond with the larger convexity measure will change more when rates decline. However, not knowing how the two dealers computed the convexity measure means that the manager does not know which bond will have the greater convexity adjustment. If the first dealer used Eq. (9–4) and the second dealer used Eq. (9–6), then the convexity measures must be adjusted in terms of either equation. For example, using Eq. (9–4), the convexity measure of 80 computed using Eq. (9–6) is equal to a convexity measure of 40 based on Eq. (9–4).

Modified Convexity and Effective Convexity

The prices used in Eq. (9–4) to calculate convexity can be obtained by assuming that when the yield changes the expected cash flows either do not change or they do change. In the former case, the resulting convexity is called *modified convexity.* (Actually, in the industry, convexity is not qualified by the adjective *modified.*) In contrast, *effective convexity* assumes that the cash flows do change when yields change. This is the same distinction made for duration.

As with duration, there is little difference between modified convexity and effective convexity for option-free bonds. However, for bonds with embedded options, there can be quite a difference between the calculated modified convexity and the effective convexity measures. In fact, for all option-free bonds, either convexity measure will have a positive value. For bonds with embedded options, the calculated effective convexity can be negative when the calculated modified convexity measure is positive.

Illustrations of Effective Duration and Convexity

As noted earlier, modified duration and effective duration are two ways to measure the price sensitivity of a fixed income security. Modified duration ignores any effect on cash flows that might take place as a result of changes in interest rates. Effective duration does not ignore the potential for such changes in cash flows. For example, bonds with embedded options will have very different cash-flow properties as interest rates (or yields) change. Modified duration ignores these effects completely. In order to apply effective duration, an available interest-rate model and corresponding valuation model are needed. The example in this section shows how to compute the effective duration of securities with cash flows that are dependent on interest rates.

There is no difference between modified and effective duration for option-free or straight bonds. In fact, it can be shown that they are mathematically identical when the change in rates (or yields) becomes very small. As shown in the example, even for bonds with embedded options, the differences between the two measures are minimal over certain ranges of yields. For example, when the embedded option is far out-of-the-money, the cash flows of the bond are not affected by small changes in yields, resulting in almost no difference in cash flows between the two measures.

Convexity (sometimes referred to as "standard convexity") suffers the same limitations as modified duration and therefore is not generally useful for securities with embedded options. However, similar to the duration measures, in ranges of rates (or yields) where the cash flows are not materially affected by small changes in yields, the two convexity measures are almost identical.

The following example illustrates how to calculate and interpret effective duration and effective convexity for option-free bonds and bonds with embedded options.

Suppose that we need to measure the interest-rate sensitivity of the following three securities:

1. A five-year 6.70% coupon option-free semiannual coupon bond with a current price of 102.75% of par
2. A five-year 6.25% coupon bond, callable at par in years 2 through 5 on the semiannual coupon dates, with a current price of 99.80% of par
3. A five-year 5.75% coupon bond, putable at par in years 2 through 5 on the semiannual coupon dates, with a current price of 100.11% of par

The cash flows of these securities are very different as interest rates change. Consequently, the sensitivities to changes in interest rates are also very different.

Using an interest-rate model that is based on the existing term structure,[8] the term structure of interest rates is shifted up and down by 10 basis points (bps), and the resulting price changes are recorded. Using the notation for duration and convexity earlier in this chapter, V_- corresponds to the price after a downward shift in interest rates, V_+ corresponds to the price after an upward shift in interest rates, V_0 is the current price, and Δy is the assumed shift in the term structure.[9] Exhibit 9–15 shows these prices for each bond using Eq. (9–1) for duration and Eq. (9–6) for the convexity measure.

It is very important to realize the importance of the valuation model in this exercise. The model must account for the change in cash flows of the securities as interest rates change. The callable and putable bonds have very different cash-flow characteristics that depend on the level of interest rates. The valuation model used must account for this property. (Note that when calculating the measures, users are cautioned not to round values. Since the denominators of both the duration and convexity terms are very small, any rounding will have a significant impact on results.)

8. The Black-Derman-Toy no arbitrage binomial model was used to perform this analysis. See Fischer Black, Emanuel Derman, and William Toy, "A One-Factor Model of Interest Rates and Its Application to Treasury Bond Options," *Financial Analysts Journal* (January–February 1990), pp. 24–32.
9. Note that shifting the term structure in a parallel manner will result in a change in yields equal to the shift for option-free bonds.

EXHIBIT 9–15

Original Prices and Resulting Prices from a Downward and Upward 10 Basis Point Interest-Rate Shift and the Corresponding Effective Duration and Effective Convexity for Three Bonds Based on the Black-Derman-Toy Model

Price Changes Following 10-bp Shift

Variable	Original Price, V_0	Upward Shift of 10 bp, V_+	Downward Shift of 10 bp, V_-
Option-free bond price	102.7509029	102.3191235	103.1848805
Callable bond price	99.80297176	99.49321718	100.1085624
Putable bond price	100.1089131	99.84237604	100.3819059

Effective Duration and Effective Convexity Measures Calculated from Using the Price Changes Resulting from the 10-bp Shifts in the Term Structure

	Effective Duration	Effective Convexity
Option-free bond	4.21	21.39
Callable bond	3.08	–41.72
Putable bond	2.70	64.49

Option-Free Bond

The effective duration for the straight bond is found by recording the price changes from shifting the term structure up (V_+) and down (V_-) by 10 bps and then substituting these values into Eq. (9–1). The prices are shown in Exhibit 9–15. Consequently, the computation is

$$\text{Effective duration} = \frac{103.1848805 - 102.3191235}{2(102.7509029)(0.001)} = 4.21$$

Similarly, the calculation for effective convexity is found by substituting the corresponding prices into Eq. (9–6):

$$\text{Effective convexity} = \frac{103.1848805 + 102.3191235 - 2(102.7509029)}{102.7509029(0.001)^2}$$
$$= 21.39$$

For the option-free bond, the modified duration is 4.21 and the convexity is 21.40. These are very close to the effective measures shown in Exhibit 9–15. This demonstrates that, for option-free bonds, the two measures are almost the same for small changes in yields.

Exhibit 9–16 shows the effects of the term structure shifts on the effective duration and effective convexity of the option-free bond. The effective duration increases as yields decrease because as yields decrease the slope of the price/yield

EXHIBIT 9–16

Effective Duration and Effective Convexity for Various Shifts in the Term Structure for Three Bonds

Term Structure Shift (bps)	Option-free Bond		Callable Bond		Putable Bond	
	Effective Duration	Effective Convexity	Effective Duration	Effective Convexity	Effective Duration	Effective Convexity
–500	4.40	23.00	1.91	4.67	4.46	23.46
–250	4.30	22.19	1.88	4.55	4.37	22.68
0	4.21	21.39	3.08	–41.72	2.70	64.49
250	4.12	20.62	4.15	20.85	1.87	7.07
500	4.03	19.87	4.07	20.10	1.81	4.23
1000	3.85	18.42	3.89	18.66	1.77	4.03

relationship for option-free bonds becomes steeper and effective duration (and modified duration) is directly proportional to the slope of this relationship. For example, the effective duration at very low yields (–500-bp shift) is 4.40 and decreases to 3.85 at very high rates (+1,000 bps). Exhibit 9–17 illustrates this phenomenon; as yields increase, notice how the slope of the price/yield relationship decreases (becomes more horizontal or flatter).

As the term structure shifts up (i.e., as rates rise), the yield to maturity on an option-free bond increases by approximately the same amount. As the yield increases, the bond's convexity decreases. Exhibit 9–17 illustrates this property. As yields increase, the curvature (or the rate of change of the slope) decreases. The results in Exhibit 9–16 for the option-free bond also bear this out. The effective convexity values become smaller as yields increase. For example, the effective convexity at very low yields (–500-bp shift) is 23.00 and decreases to 18.43 at very high rates (+1,000-bp shift).

These are both well-documented properties of option-free bonds. The modified duration and convexity numbers for the option-free bond are almost identical to the effective measures for the option-free bond shown in Exhibit 9–16.

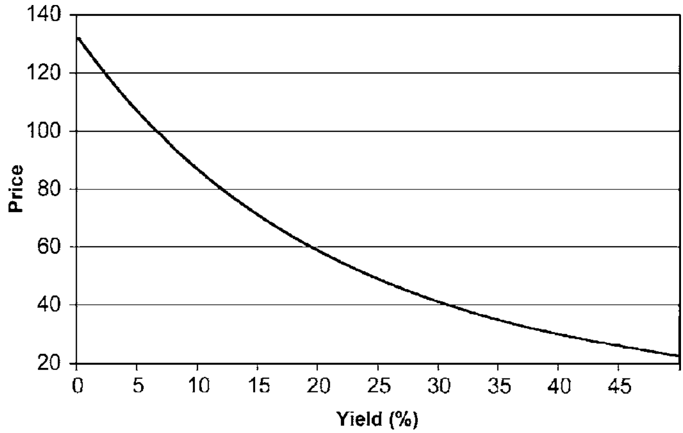
Callable Bond

The effective duration for the callable bond is found by recording the price changes from shifting the term structure up (V_+) and down (V_-) by 10 bps and then substituting these values into Eq. (9–1). The prices are shown in Exhibit 9–15. Note that these prices take into account the changing cash flows resulting from the embedded call option. Consequently, the computation is

$$\text{Effective duration} = \frac{100.1085624 - 99.4932178}{2(99.800297)(0.001)} = 3.08$$

EXHIBIT 9–17

Price/Yield Relationship of the Option-Free Bond



Similarly, the calculation for effective convexity is found by substituting the corresponding prices into Eq. (9–6):

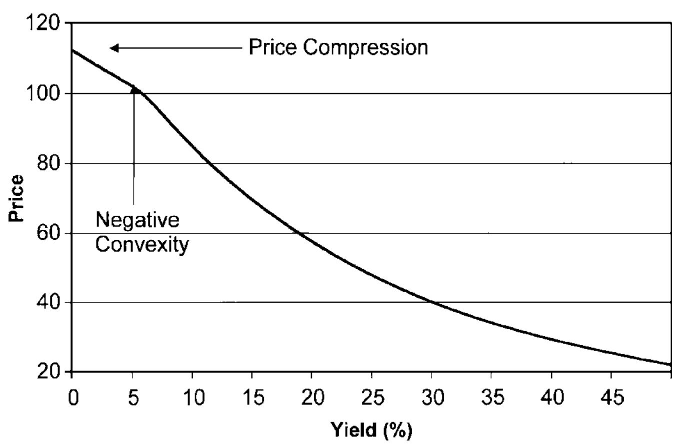
$$\text{Effective convexity} = \frac{100.1085624 + 99.49321718 - 2(99.80297176)}{99.80297176(0.001)^2}$$

$$= -41.72$$

The relationship between the shift in rates and effective duration is shown in Exhibit 9–16 and in Exhibit 9–18. As rates increase, the effective duration of

EXHIBIT 9–18

Price /Yield Relationship of the Callable Bond



the callable bond becomes larger. For example, the effective duration at very low yields (–500-bp shift) is 1.91 and increases to 3.89 at very high rates (+1,000 bps). This reflects the fact that as rates increase, the likelihood of the bond being called decreases, and as a result, the bond behaves more like an option-free bond; hence its effective duration increases. Conversely, as rates drop, this likelihood increases, and the bond and its effective duration behave more like a bond with a two-year maturity because of the call option becoming effective in two years. As rates decrease significantly, the likelihood of the issuer calling the bond in two years increases. Consequently, at very low and intermediate rates, the difference between the effective duration measure and modified duration is large, and at very high rates, the difference is small.

Effective convexity measures the curvature of the price/yield relationship of bonds. Low values for effective convexity simply mean that the relationship is becoming linear (an effective convexity of zero represents a linear relationship). As shown in Exhibit 9–16, the effective convexity values of the callable bond at extremely low interest rates (i.e., for the –250-bp and –500-bp shifts in the term structure) are very small positive numbers (4.55 and 4.67, respectively). This means that the relationship is almost linear but exhibits slight convexity. This is due to the call option being delayed by two years. At these extremely low interest rates, the callable bond exhibits slight positive convexity because the price compression at the call price is not complete for another two years.[10] If this bond were immediately callable, the price/yield relationship would exhibit positive convexity at high yields and negative convexity at low yields. At the current level of interest rates, the effective convexity is negative, as expected. At these rate levels, the embedded call option causes enough price compression to cause the curvature of the price/yield relationship to be negatively convex (i.e., concave). Exhibit 9–18 illustrates these properties. It is at these levels that the embedded option has a significant effect on the cash flows of the callable bond.

Exhibit 9–16 shows that for large positive yield curve shifts (i.e., for the +250-bp, +500-bp, and +1,000-bp shifts in the term structure), the effective convexity of the callable bond becomes positive and very close to the effective convexity values of the straight bond. For example, the effective convexity at the +250-bp shift is 20.85 for the callable bond and 20.62 for the straight bond. The only reason they are not the same is because the coupon rates of the bonds are not equal. Consequently, at very low and intermediate rates, the difference between effective convexity and standard convexity is large, and at very high rates, the difference is small. The intuition behind these findings is straightforward. At low rates, the cash flows of the callable bond are severely affected by the likelihood of the embedded call option being exercised by the issuer. At high rates, the embedded call option is

10. As noted earlier in this chapter, price compression for a callable bond refers to the property that a callable bond's price appreciation potential is severely limited as yields decline. As shown in Exhibit 9–18, as yields fall below a certain level (i.e., where the yield corresponds to the call price), the price appreciation of the callable bond is being compressed.

so far out-of-the-money that it has almost no effect on the cash flows of the callable bond, and so the callable bond behaves like an option-free bond.

Putable Bond

The effective duration for the putable bond is found by recording the price changes from shifting the term structure up (V_+) and down (V_-) by 10 bps and then substituting these values into Eq. (9–1). The prices are shown in Exhibit 9–15. Note that these prices take into account the changing cash flows resulting from the embedded put option. Consequently, the computation is

$$\text{Effective duration} = \frac{100.3819059 - 99.84237604}{2(100.1089131)(0.001)} = 2.70$$

Similarly, the calculation for effective convexity is found by substituting the corresponding prices into Eq. (9–6):

$$\text{Effective convexity} = \frac{100.3819059 + 99.84237604 - 2(100.1089131)}{100.1089131(0.001)^2}$$
$$= 64.49$$

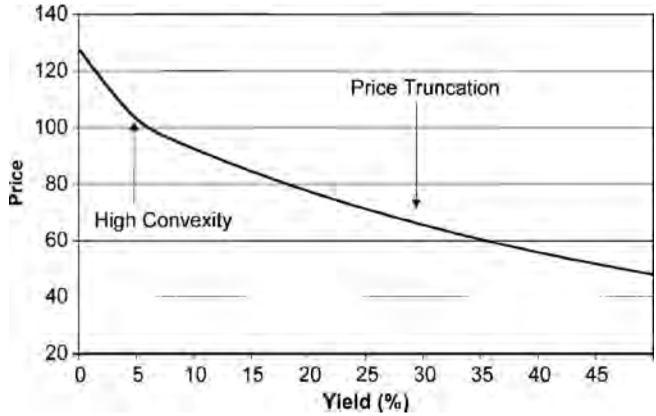
Because the putable bond behaves so differently from the other two bonds, the effective duration and effective convexity values are very different. As rates increase, the bond behaves more like a two-year bond because the owner will, in all likelihood, exercise his right to put the bond back at the put price as soon as possible. As a result, the effective duration of the putable bond is expected to decrease as rates increase. This is due to the embedded put option severely affecting the cash flows of the putable bond. Conversely, as rates fall, the putable bond behaves more like a five-year straight bond because the embedded put option is so far out-of-the-money and has little effect on the cash flows of the putable bond. Effective duration should reflect these properties. Exhibit 9–16 shows that this is indeed the case. For example, the effective duration at very low yields (–500-bp shift) is 4.46 and decreases to 1.77 at very high rates (+1,000 bps). Consequently, at very high and intermediate rates, the difference between the effective duration and modified duration measures is large, and at low rates, the difference is small.

Exhibit 9–16 shows that the effective convexity of the putable bond is positive for all rate shifts, as would be expected, but it becomes smaller as rates increase (i.e., for the +250-bp, +500-bp, and +1,000-bp shifts in the term structure). As rates increase, the putable bond price/yield relationship will become linear because of the bond's price truncation at the put price.[11] This is the reason for the small effective convexity values for the putable bond for the three positive shifts in the term structure

11. *Price truncation* for a putable bond refers to the property that the putable bond's price depreciation potential is severely limited as yields increase. As shown in Exhibit 9–19, as yields rise above a certain level (i.e., where the yield corresponds to the put price), the price depreciation of the putable bond is truncated.

EXHIBIT 9–19

Price/Yield Relationship of the Putable Bond



(7.07, 4.23, and 4.03, respectively). It is at these levels that the embedded put option has a significant effect on the cash flows of the putable bond. Consequently, at very high and intermediate rates, the difference between the effective convexity and standard convexity is very large. Exhibit 9–19 illustrates these properties.

At very low rates (i.e., for the 250-bp and 500-bp downward shifts in the term structure), the putable bond behaves like a five-year straight bond because the put option is so far out-of-the-money. Therefore, as the term structure is shifted downward, the putable bond's effective convexity values approach those of a comparable five-year option-free bond. Comparing the effective convexity measures for the putable bond and the option-free bond illustrates this characteristic. For example, the effective convexity at the –250-bp shift is 22.66 for the putable bond and 22.19 for the option-free bond. The two convexity measures are almost identical. In fact, they would be identical if their coupon rates were equal.

Exhibit 9–19 illustrates these properties. Also notice how the transition from low yields to high yields forces the price/yield relationship to have a very high convexity at intermediate levels of yields. For example, the current effective convexity of the putable bond is 64.49 compared with 21.39 for the straight bond and –41.72 for the callable bond. This is so because as yields increase, the embedded put option moves from out-of-the-money to in, and the behavior of the bond goes from that of a five-year bond to a two-year bond as a result. This corresponding price truncation causes the price/yield relationship to have to transition very quickly from the five-year (high effective duration) to the two-year (low effective duration), resulting in very high effective convexity.

Putting It All Together

Notice in Exhibit 9–16 how effective duration changes much more across yields for the callable and putable bonds than it does for the option-free bond. This is to be expected because the embedded options have such a significant influence over cash flows as yields change over a wide spectrum. Interestingly, at high (low) yields, the callable (putable) bond's effective duration is very close to the option-free bond. This is where the embedded call (put) option is so far out-of-the-money that the two securities behave similarly. The same intuition holds for the effective convexity measures.

As explained and illustrated earlier, the common use of effective duration and effective convexity is to estimate the percentage price changes in fixed income securities for assumed changes in yield. In fact, it is not uncommon for effective duration and effective convexity to be presented in terms of estimated percentage price change for a given change in yield (typically 100 bp). Exhibits 9–20 and 9–21 show this alternative presentation for a ±100-bp change in yield using Eqs. (9–2) and (9–7).

PRICE VALUE OF A BASIS POINT

Some managers use another measure of the price volatility of a bond to quantify interest-rate risk—*the price value of a basis point* (PVBP). This measure, also called the *dollar value of an 01* (DV01), is the absolute value of the change in the price of a bond for a 1 basis point change in yield. That is,

$$\text{PVBP} = |\text{ initial price} - \text{price if yield is changed by 1 basis point }|$$

Does it make a difference if the yield is increased or decreased by 1 basis point? It does not because of Property 2—the change will be about the same for a small change in basis points.

To illustrate the computation, we use the values in Exhibit 9–4. If the initial yield is 6%, we can compute the PVBP by using the prices for either the yield at 5.99% or 6.01%. The PVPB for both for each bond is shown below:

Coupon	**6.0%**	**6.0%**	**9.0%**	**9.0%**
Maturity	**5**	**20**	**5**	**20**
Initial price	$100.0000	$100.0000	$112.7953	$134.6722
Price at 5.99%	100.0427	100.1157	112.8412	134.8159
PVBP at 5.99%	$0.0427	$0.1157	$0.0459	$0.1437
Price at 6.01%	99.9574	99.8845	112.7494	134.5287
PVPB at 6.01%	$0.0426	$0.1155	$0.0459	$0.1435

The PVBP is related to duration. In fact, PVBP is simply a special case of dollar duration. We know that the duration of a bond is the approximate percentage price change for a 100 basis point change in interest rates. We also know how to compute the approximate percentage price change for any number of basis points given a bond's duration using Eq. (9–2). Given the initial price and the approximate percentage price change for 1 basis point, we can compute the change in price for a 1 basis point change in rates.

EXHIBIT 9–20

Percentage Price Changes Assuming an Increase in Yield of 100 bps and Effective Duration and Effective Convexity for Various Shifts in the Term Structure

	Option-Free Bond			***Callable Bond***			***Putable Bond***		
Term Structure Shift (bp)	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**
–500	–4.40	0.11500	–4.28500	–1.91	0.02335	–1.88665	–4.46	0.11730	–4.34270
–250	–4.30	0.11095	–4.18905	–1.88	0.02275	–1.85725	–4.37	0.11330	–4.25670
0	–4.21	0.10695	–4.10305	–3.08	–0.20860	–3.28860	–2.70	0.32245	–2.37755
250	–4.12	0.10310	–4.01690	–4.15	0.10425	–4.04575	–1.87	0.03535	–1.83465
500	–4.03	0.09935	–3.93065	–4.07	0.10050	–3.96950	–1.81	0.02115	–1.78885
1,000	–3.85	0.09210	–3.75790	–3.89	0.09330	–3.79670	–1.77	0.02015	–1.74985

EXHIBIT 9–21

Percentage Price Changes Assuming a Decrease in Yield of 100 bps and Effective Duration and Effective Convexity for Various Shifts in the Term Structure

	Option-Free Bond			*Callable Bond*			*Putable Bond*		
Term Structure Shift (bp)	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**	**% Price Change Using Effective Duration**	**% Price Change Using Effective Convexity**	**Total % Price Change**
–500	4.40	0.1150	4.5150	1.91	0.0234	1.9334	4.46	0.1173	4.5773
–250	4.30	0.1110	4.4110	1.88	0.0228	1.9028	4.37	0.1133	4.4833
0	4.21	0.1070	4.3170	3.08	–0.2086	2.8714	2.70	0.3225	3.0225
250	4.12	0.1031	4.2231	4.15	0.1043	4.2543	1.87	0.0354	1.9054
500	4.03	0.0994	4.1294	4.07	0.1005	4.1705	1.81	0.0212	1.8312
1,000	3.85	0.0921	3.9421	3.89	0.0933	3.9833	1.77	0.0202	1.7902

For example, consider the 9% 20-year bond. The duration for this bond is 10.66. Using Eq. (9–2), the approximate percentage price change for a 1 basis point increase in interest rates (i.e., $\Delta y = 0.0001$) ignoring the negative sign in Eq. (9–2) is

$$10.66 \times (0.0001) \times 100 = 0.1066\%$$

Given the initial price of 134.6722, the dollar price change estimated using duration is

$$0.1066\% \times 134.6722 = \$0.1435$$

This is the same price change as shown above for a PVPB for this bond. Below is (1) the PVPB based on a 1 basis point increase for each bond and (2) the estimated price change using duration for a 1 basis point increase for each bond:

Coupon	**6.0%**	**6.0%**	**9.0%**	**9.0%**
Maturity	**5**	**20**	**5**	**20**
PVBP for 1 bp increase	$0.0426	$0.1155	$0.0459	$0.1435
Duration of bond	4.2700	11.5600	4.0700	10.6600
Duration estimate	$0.0427	$0.1156	$0.0459	$0.1436

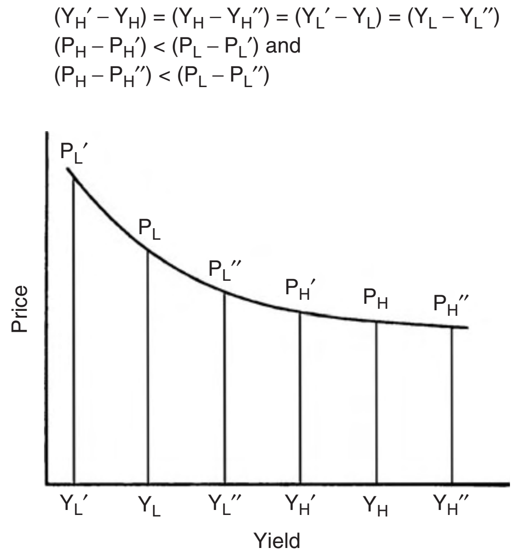
THE IMPORTANCE OF YIELD VOLATILITY

What we have not considered thus far is the volatility of interest rates. All other factors equal, the higher the coupon rate, the lower is the price volatility of a bond to changes in interest rates. In addition, the higher the level of yields, the lower is the price volatility of a bond to changes in interest rates. This is illustrated in Exhibit 9–22, which shows the price/yield relationship for an option-free bond. When the yield level is high (Y_H in the exhibit), a change in interest rates does not produce a large change in the initial price (P_H in the exhibit). However, when the yield level is low (Y_L in the exhibit), a change in interest rates of the same number of basis points as shown when the yield is high does produce a large change in the initial price (P_L in the exhibit).

This also can be cast in terms of duration properties: the higher the coupon, the lower is the duration, and the higher the yield level, the lower is the duration. Given these two properties, a 10-year non-investment-grade bond has a lower duration than a current coupon 10-year Treasury note because the former has a higher coupon rate and trades at a higher yield level. Does this mean that a 10-year non-investment-grade bond has less interest-rate risk than a current coupon 10-year Treasury note? Consider also that a 10-year Swiss government bond has a lower coupon rate than a current coupon 10-year U.S. Treasury note and trades at a lower yield level. Therefore, a 10-year Swiss government bond will have a higher duration than a current coupon 10-year Treasury note. Does this mean that a 10-year Swiss government bond has greater interest-rate risk than a current

EXHIBIT 9–22

The Effect of Yield Level on Price Volatility



coupon 10-year U.S. Treasury note? The missing link is the relative volatility of rates, which we shall call *yield volatility* or *interest-rate volatility.*

The greater the expected yield volatility, the greater is the interest-rate risk for a given duration and current value of a position. In the case of non-investment-grade bonds, while their durations are less than current coupon Treasuries of the same maturity, the yield volatility of non-investment-grade bonds is greater than that of current coupon Treasuries. For the 10-year Swiss government bond, while the duration is greater than for a current coupon 10-year U.S. Treasury note, the yield volatility of 10-year Swiss bonds is considerably less than that of 10-year U.S. Treasury notes.

A framework that ties together the price sensitivity of a bond position to rate changes and yield volatility is the value-at-risk (VaR) framework. *Risk* in this framework is defined as the maximum estimated loss in market value of a given position that is expected to happen with a specified probability.

PART
THREE

SECURITIES

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CHAPTER

TEN

U.S. TREASURY AND AGENCY SECURITIES

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U.S. Treasury securities are direct obligations of the U.S. government issued by the Department of the Treasury. They are backed by the full faith and credit of the U.S. government and therefore are considered to be free of credit risk. Agency securities, in contrast, are obligations of specific entities that are either part of or sponsored by the U.S. government. Agency securities typically do not have an explicit government backing but nevertheless are viewed as having very low credit risk. In this chapter we discuss U.S. Treasury and agency securities.

TREASURY SECURITIES

As noted, Treasury securities are obligations of the U.S. government and thus are considered to be free of credit risk. Issuance to pay off maturing debt and raise needed funds has created a stock of marketable Treasury securities that totaled \$3.7 trillion on March 31, 2004.[1] The creditworthiness and supply of the securities have resulted in a highly liquid round-the-clock secondary market with high levels of trading activity and narrow bid-ask spreads.

The views expressed in this chapter are those of the authors and not necessarily those of the Federal Reserve Bank of New York or the Federal Reserve System.

1. The stock of nonmarketable Treasury securities on the same date totaled \$3.4 trillion. Of this, \$3.0 trillion was nonpublic debt (held in government accounts), \$0.2 trillion was held by private investors in the form of U.S. Savings Bonds, and \$0.2 trillion was held in a special series by state and local governments (Monthly Statement of the Public Debt, www.publicdebt.ustreas.gov/opd/opddload.htm). This chapter focuses on marketable Treasury securities.

Because of their liquidity, Treasury securities are used commonly to price and hedge positions in other fixed income securities and to speculate on the course of interest rates. The securities' creditworthiness and liquidity also make them a widespread benchmark for risk-free rates. These same attributes make Treasury securities a key reserve asset of central banks and other financial institutions. Finally, exemption of interest income from state and local taxes helps to make the securities a popular investment asset to institutions and individuals.

As of September 30, 2003, foreign and international investors held 37% of the publicly held Treasury debt.[2] Federal Reserve Banks held an additional 17% of the debt. The remaining public debt was held by pension funds (9%), mutual funds (8%), state and local treasuries (8%), depository institutions (4%), insurance companies (4%), and other miscellaneous investors, including individuals (14%).

Types of Securities

Treasury securities are issued as either *discount* or *coupon securities*. Discount securities pay a fixed amount at maturity, called *face value* or *par value,* with no intervening interest payments. Discount securities are so called because they are issued at a price below face value, with the return to the investor being the difference between the face value and the issue price. Coupon securities are issued with a stated rate of interest, pay interest every six months, and are redeemed at par value (or *principal value*) at maturity. Coupon securities are issued at a price close to par value, with the return to the investor being primarily the coupon payments received over the security's life.

The Treasury issues securities with original maturities of one year or less as discount securities. These securities are called *Treasury bills*. The Treasury currently issues bills with original maturities of 4 weeks (one month), 13 weeks (three months), and 26 weeks (six months), as well as cash-management bills with various maturities. On March 31, 2004, Treasury bills accounted for $985 billion (26%) of the $3.7 trillion in outstanding marketable Treasury securities, as shown in Exhibit 10–1.

Securities with original maturities of more than one year are issued as coupon securities. Coupon securities with original maturities of more than 1 year but not more than 10 years are called *Treasury notes*. The Treasury currently issues notes with maturities of 2 years, 3 years, 5 years, and 10 years. On March 31, 2004, Treasury notes accounted for $2.0 trillion (53%) of the outstanding marketable Treasury securities.

2. The publicly held debt includes marketable and nonmarketable securities held in nongovernment accounts. Figures are calculated from Table 1.41 of the *Statistical Supplement to the Federal Reserve Bulletin* and Table OFS-2 of the *Treasury Bulletin*.

EXHIBIT 10–1

Marketable U.S. Treasury Securities

Issue Type	Security Type	Issues	Amount Outstanding (March 31, 2004)
Treasury bills	Discount	Cash-management, 4-week, 13-week, 26-week	$985 billion
Treasury notes	Coupon	2-year, 3-year, 5-year, 10-year	$1,983 billion
Treasury bonds	Coupon	(20-year), (30-year)	$564 billion
Treasury inflation-indexed securities	Coupon	10-year, (30-year)	$188 billion

Note: Issues no longer offered as of April 2004 are noted by parentheses.

Source: Department of the Treasury, Monthly Statement of the Public Debt (www.publicdebt.treas.gov/opd/opddload.htm) for amounts outstanding.

Coupon securities with original maturities of more than 10 years are called *Treasury bonds*. The Treasury does not currently issue any bonds, most recently suspending issuance of 30-year bonds in October 2001. Previously issued 20- and 30-year bonds are still outstanding, however, so that bonds accounted for $564 billion (15%) of the outstanding marketable Treasury securities on March 31, 2004. While several of the outstanding bonds are callable, the Treasury has not issued callable securities since 1984.

In January 1997, the Treasury began selling *inflation-indexed securities*. The principal of these securities is adjusted for inflation using the consumer price index for urban consumers. Semiannual interest payments are a fixed percentage of the inflation-adjusted principal, and the inflation-adjusted principal is paid at maturity. On March 31, 2004, Treasury inflation-indexed notes and bonds accounted for $188 billion (5%) of the outstanding marketable Treasury securities. Since these securities are discussed in detail in Chapter 15, the remainder of this section focuses on nominal (or fixed-principal) Treasury securities.

The Primary Market

Marketable Treasury securities are sold in the primary market through sealed-bid, *single-price* (or *uniform-price*) *auctions*. Each auction is announced several days in advance by means of a Treasury Department press release. The announcement provides details of the offering, including the offering amount and the term and type of security being offered, and describes some of the auction rules and procedures.

Treasury auctions are open to all entities. Bids must be made in multiples of $1,000 (with a $1,000 minimum) and submitted to a Federal Reserve Bank, to the Treasury's Bureau of the Public Debt, or through an authorized financial institution. Competitive bids must be made in terms of yield and typically must be submitted by 1 p.m. Eastern time on auction day. Noncompetitive bids typically must be submitted by noon on auction day. While most tenders (or formal offers to buy) are submitted electronically, both competitive and noncompetitive tenders can be made on paper.[3]

All noncompetitive bids from the public up to $1 million for bills and $5 million for coupon securities are accepted. The lowest-yield (i.e., highest-price) competitive bids are then accepted up to the yield required to cover the amount offered (less the amount of noncompetitive bids). The highest yield accepted is called the *stop-out yield*. All accepted tenders (competitive and noncompetitive) are awarded at the stop-out yield. There is no maximum acceptable yield, and the Treasury does not add to or reduce the size of the offering according to the strength of the bids.

Historically, the Treasury auctioned securities through *multiple-price* (or *discriminatory*) *auctions*. With multiple-price auctions, the Treasury still accepted the lowest-yielding bids up to the yield required to sell the amount offered (less the amount of noncompetitive bids), but accepted bids were awarded at the particular yields bid rather than at the stop-out yield. Noncompetitive bids were awarded at the weighted-average yield of the accepted competitive bids rather than at the stop-out yield. In September 1992, the Treasury started conducting single-price auctions for the two- and five-year notes. In November 1998, the Treasury adopted the single-price method for all auctions.

Within minutes of the 1 p.m. auction deadline, the Treasury announces the auction results. Announced results include the stop-out yield, the associated price, and the proportion of securities awarded to investors who bid exactly the stop-out yield. Also announced is the quantity of noncompetitive tenders, the median-yield bid, and the ratio of the total amount bid for by the public to the amount awarded to the public (called the *bid-to-cover ratio*). For notes and bonds, the announcement includes the coupon rate of the new security. The coupon rate is set to be that rate (in increments of 1/8 of 1%) that produces the price closest to, but not above, par when evaluated at the yield awarded to successful bidders.

3. Commercial bidders, such as broker-dealers and depository institutions, are encouraged to submit tenders electronically by computer, although paper tenders are accepted. Noncommercial bidders are encouraged to submit tenders electronically by phone or Internet, although mailed-in paper tenders are accepted. Bidding procedures are described in detail on the Bureau of the Public Debt's Web site at www.publicdebt.ustreas.gov.

Accepted bidders make payment on issue date through a Federal Reserve account or account at their financial institution, or they provide payment in full with their tender. Marketable Treasury securities are issued in book-entry form and held in the commercial book-entry system operated by the Federal Reserve Banks or in the Bureau of the Public Debt's *TreasuryDirect* book-entry system.

Primary Dealers

While the primary market is open to all investors, the *primary government securities dealers* play a special role. Primary dealers are firms with which the Federal Reserve Bank of New York interacts directly in the course of its open-market operations. They include large diversified securities firms, money center banks, and specialized securities firms and are foreign- as well as U.S.-owned. Among their responsibilities, primary dealers are expected to participate meaningfully in Treasury auctions, make reasonably good markets to the Federal Reserve Bank of New York's trading desk, and supply market information and commentary to the Fed. The dealers also must maintain certain designated capital standards. The 23 primary dealers as of April 15, 2004, are listed in Exhibit 10–2.

Historically, Treasury auction rules tended to facilitate bidding by the primary dealers. In August 1991, however, Salomon Brothers, Inc., admitted deliberate and repeated violations of auction rules. While the rules preclude any bidder from being awarded more than 35% of any issue, Salomon amassed significantly larger positions by making unauthorized bids on behalf of its customers.

EXHIBIT 10–2

Primary Government Securities Dealers as of April 15, 2004

ABN AMRO Bank, N.V., New York Branch	Dresdner Kleinwort Wasserstein Securities LLC
BNP Paribas Securities Corp.	Goldman, Sachs & Co.
Banc of America Securities LLC	Greenwich Capital Markets, Inc.
Banc One Capital Markets, Inc.	HSBC Securities (USA) Inc.
Barclays Capital Inc.	J.P. Morgan Securities, Inc.
Bear, Stearns & Co., Inc.	Lehman Brothers Inc.
CIBC World Markets Corp.	Merrill Lynch Government Securities Inc.
Citigroup Global Markets Inc.	Mizuho Securities USA Inc.
Countrywide Securities Corporation	Morgan Stanley & Co. Incorporated
Credit Suisse First Boston LLC	Nomura Securities International, Inc.
Daiwa Securities America Inc.	UBS Securities LLC
Deutsche Bank Securities Inc.	

Source: Federal Reserve Bank of New York (www.newyorkfed.org/markets/pridealers_current.html).

EXHIBIT 10–3

Auction Schedule for U.S. Treasury Securities

Issue	Auction Frequency	Offering Amount
4-week bill	Weekly	$8–22 billion
13-week bill	Weekly	$17–19 billion
26-week bill	Weekly	$15–17 billion
2-year note	Monthly	$26 billion
3-year note	Quarterly	$24 billion
5-year note	Monthly	$16 billion
10-year note	Quarterly	$16 billion

Note: Auction frequency and offering amount are reported for regularly issued Treasury securities as of the first quarter of 2004. New 10-year notes are auctioned quarterly, but additional amounts of the notes are auctioned one month later. Offering amounts exclude amounts issued to refund maturing securities of Federal Reserve Banks.

Source: Department of the Treasury.

For the five-year note auctioned on February 21, 1991, for example, Salomon bid for 105% of the issue (including two unauthorized customer bids) and was awarded 57% of the issue. Rule changes enacted later that year allowed any government securities broker or dealer to submit bids on behalf of customers and facilitated competitive bidding by nonprimary dealers.[4]

Auction Schedule

To minimize uncertainty surrounding auctions and thereby reduce borrowing costs, the Treasury offers securities on a regular, predictable schedule, as shown in Exhibit 10–3. Four-, 13-, and 26-week bills are offered weekly. Four-week bills typically are announced for auction on Monday, auctioned the following Tuesday, and issued the following Thursday. Thirteen- and 26-week bills typically are announced for auction on Thursday, auctioned the following Monday, and issued the following Thursday (one week after they are announced for auction). Cash-management bills are issued when required by the Treasury's short-term cash-flow needs and not on a regular schedule.

Two- and five-year notes are offered monthly. Two-year notes usually are announced for auction on a Monday, auctioned the following Wednesday, and issued on the last day of the month. Five-year notes usually are auctioned on a

4. For further information on the auction violations and subsequent rule changes, see the *Joint Report on the Government Securities Market,* published by the Department of the Treasury, the Securities and Exchange Commission, and the Board of Governors of the Federal Reserve System in January 1992.

Wednesday, announced several days before that, and issued on the fifteenth of the month.

Three- and 10-year notes are issued as a part of the Treasury's *quarterly refunding* in February, May, August, and November. The Treasury holds a press conference on the first Wednesday of the refunding month (or on the last Wednesday of the preceding month) at which it announces details of the upcoming auctions. The auctions then typically take place on the following Tuesday (3-year) and Thursday (10-year), with issuance on the fifteenth of the refunding month.

While the Treasury seeks to maintain a regular issuance cycle, its borrowing needs change over time. The improved fiscal situation in the late 1990s reduced the Treasury's borrowing needs, resulting in decreased issuance and a declining stock of outstanding Treasury securities. To maintain large, liquid issues, the Treasury suspended issuance of 3-year notes in 1998 and 52-week bills and 30-year bonds in 2001. More recently, the worsened fiscal situation has increased the Treasury's borrowing needs, resulting in increased issuance and a rising stock of outstanding Treasury securities. The three-year note thus was reintroduced in 2003.

In addition to maintaining a regular issuance cycle, the Treasury tries to maintain a stable issue size for issues of a given maturity. As shown in Exhibit 10–3, public offering amounts as of the first quarter of 2004 were $8 billion to $22 billion for 4-week bills, $17 billion to $19 billion for 13-week bills, $15 billion to $17 billion for 26-week bills, $26 billion for 2-year notes, $24 billion for 3-year notes, and $16 billion for 5- and 10-year notes. Issue sizes also have changed in recent years in response to the government's changing funding needs. Issue sizes for 2-year notes, for example, declined from over $18 billion in 1996 to $10 billion in late 2000, before increasing to $26 billion in early 2004.

Reopenings

While the Treasury regularly offers new securities at auction, it often offers additional amounts of outstanding securities. Such additional offerings are called *reopenings*. Current Treasury practice is to reopen 10-year notes one month after their initial issuance, in March, June, September, and December. Moreover, shorter-term bills typically are fungible with previously issued and outstanding bills so that every 13-week bill is a reopening of a previously issued 26-week bill and every 4-week bill is a reopening of a previously issued 13- and 26-week bill. The Treasury also reopens securities on an *ad hoc* basis from time to time.

Buybacks

To maintain the sizes of its new issues and to help manage the maturity of its debt, the Treasury launched a debt buyback program in January 2000. Under the program, the Treasury redeems outstanding unmatured Treasury securities by purchasing them in the secondary market through reverse auctions. Buyback operations are announced one day in advance. Each announcement contains details of the operation, including the operation size, the eligible securities, and some of the operation rules and procedures.

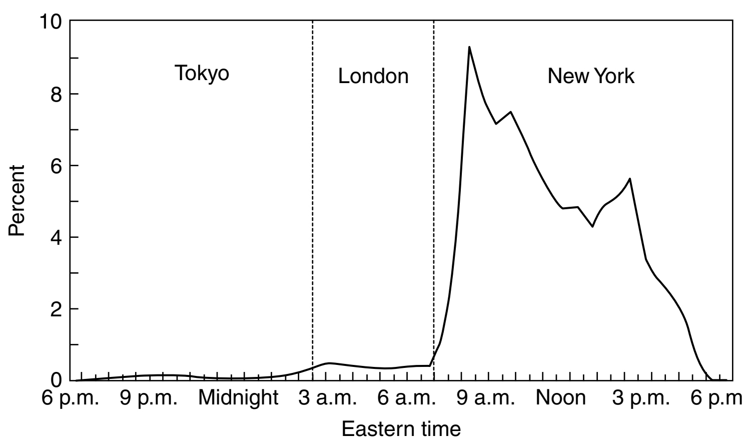
The Treasury conducted 45 buyback operations between March 2000 and April 2002 (as of April 2004, there were no operations since April 2002). Operation sizes ranged from $750 million par to $3 billion par, with all but three between $1 billion and $2 billion. The number of eligible securities in the operations ranged from 6 to 26 but more typically was in the 10 to 13 range. Eligible securities were limited to those with original maturities of 30 years, consistent with the Treasury's goal of using buybacks to prevent an increase in the average maturity of the public debt.

The Secondary Market

Secondary trading in Treasury securities occurs in a multiple-dealer over-the-counter market rather than through an organized exchange. Trading takes place around the clock during the week from the three main trading centers of Tokyo, London, and New York. As shown in Exhibit 10–4, the vast majority of trading takes place during New York trading hours, roughly 7:30 a.m. to 5 p.m. Eastern time. The primary dealers are the principal market makers, buying and selling securities from customers for their own accounts at their quoted bid and ask prices.

EXHIBIT 10–4

Trading Volume of U.S. Treasury Securities by Half Hour



Note: Mean half-hourly trading volume as a percent of mean daily trading volume is plotted for April 4 to August 19, 1994. The times on the horizontal axis indicate the beginning of intervals.

Source: Chart 2 in Michael J. Fleming, "The Round-the-Clock Market for U.S. Treasury Securities," Federal Reserve Bank of New York *Economic Policy Review* (July 1997).

For the first quarter of 2004, primary dealers reported daily trading activity in the secondary market that averaged $482 billion per day.[5]

Interdealer Brokers

In addition to trading with their customers, the dealers trade among themselves through *interdealer brokers*. The brokers offer the dealers proprietary electronic screens or electronic trading platforms that post the best bid and offer prices of the dealers, along with the associated quantities bid or offered (minimums are $5 million for bills and $1 million for notes and bonds). The dealers execute trades by notifying the brokers (by phone or electronically), who then post the resulting trade price and size. In compensation for their services, the brokers charge a small fee.

Interdealer brokers thus facilitate information flows in the market while providing anonymity to the trading dealers. For the most part, the brokers act only as agents and serve only the primary dealers and a number of nonprimary dealers. The brokers include BrokerTec, Cantor Fitzgerald/eSpeed, Garban-Intercapital, Hilliard Farber, and Tullett Liberty.

Federal Reserve

The Federal Reserve is another important participant in the secondary market for Treasury securities by virtue of its security holdings, open market operations, and surveillance activities. The Federal Reserve Banks held $656 billion in Treasury securities as of September 30, 2003, or 17% of the publicly held stock. The Federal Reserve Bank of New York buys and sells Treasury securities through open market operations as one of the tools used to implement the monetary policy directives of the Federal Open Market Committee (FOMC). Finally, the New York Fed follows and analyzes the Treasury market and communicates market developments to other government agencies, including the Federal Reserve Board and the Treasury Department.

Trading Activity

While the Treasury market is extremely active and liquid, much of the activity is concentrated in a small number of the roughly 175 issues outstanding. The most recently issued securities of a given maturity, called *on-the-run securities,* are particularly active. Analysis of 1998 data from GovPX, Inc., a firm that tracks interdealer trading volume, shows that on-the-run issues account for 70% of trading activity. Older issues of a given maturity are called *off-the-run securities*.

5. Federal Reserve Bank of New York (www.newyorkfed.org/markets/statrel.html). Since the data are collected from all the primary dealers but no other entities, trades between primary dealers are counted twice, and trades between nonprimary dealers are not counted at all. The figure excludes financing transactions, such as repurchase agreements and reverse repurchase agreements.

EXHIBIT 10–5

Daily Trading Volume of U.S. Treasury Securities

Issue	When-Issued	On-the-Run	Off-the-Run
13-week bill	627	1,265	160
26-week bill	441	919	79
2-year note	2,093	7,320	97
3-year note	1,743	2,529	71
5-year note	1,095	6,629	18
10-year note	584	4,538	7

Note: Mean daily interdealer trading volume is reported by issue for when-issued, on-the-run, and off-the-run Treasury securities. The when-issued figures are estimated only over days on which the securities traded when-issued. The off-the-run figures are per-security averages, estimated over all off-the-run securities of a given issue. Figures are in millions of dollars.

Source: Authors' calculations, based on 1998 data from GovPX.

While nearly all Treasury securities are off-the-run, they account for only 24% of interdealer trading.

The remaining 6% of interdealer trading occurs in *when-issued securities*. When-issued securities are securities that have been announced for auction but not yet issued. When-issued trading facilitates price discovery for new issues and can serve to reduce uncertainty about bidding levels surrounding auctions. The when-issued market also enables dealers to sell securities to their customers in advance of the auctions and thereby bid competitively with relatively little risk. While most Treasury market trades settle the following day, trades in the when-issued market settle on the issue date of the new security.

There are also notable differences in trading activity by issue type, as shown in Exhibit 10–5. According to 1998 data from GovPX, on-the-run Treasury notes are the most actively traded securities, with average daily trading of $7.3 billion for the 2-year, $6.6 billion for the 5-year, and $4.5 billion for the 10-year notes.[6] Trading activity in when-issued securities is similarly concentrated in the notes, with average daily trading of $2.1 billion for the 2-year, $1.7 billion for the 3-year, and $1.1 billion for the 5-year notes. In contrast, off-the-run trading is concentrated in the more frequently issued shorter-term issues, with the most active being the 3-month bill ($160 million per issue), the 2-year note ($97 million per issue), and the 26-week bill ($79 million per issue). Trading in longer-term off-the-run securities is

6. GovPX tracks trading activity among several of the interdealer brokers and thus covers much, but not all, of the interdealer market. Total interdealer trading volume therefore exceeds the figures given in the text and Exhibit 10–5 (particularly for longer-term securities).

extremely thin, with mean daily per-issue trading of just $18 million for the 5-year note and $7 million for the 10-year note.

Quoting Conventions for Treasury Bills

The convention in the Treasury market is to quote bills on a discount rate basis. The rate on a discount basis is computed as

$$Y_d = \frac{(F - P)}{F} \times \frac{360}{t}$$

where

Y_d = rate on a discount basis
F = face value
P = price
t = number of days to maturity

For example, the 26-week bill auctioned April 5, 2004, sold at a price P of $99.479 per $100 face value F. At issue, the bill had 182 days to maturity t. The rate on a discount basis then is calculated as

$$Y_d = \frac{(\$100 - \$99.479)}{\$100} \times \frac{360}{182} = 1.03\%$$

Conversely, given the rate on a discount basis, the price can be computed as

$$P = F - \left(F \times Y_d \times \frac{t}{360} \right)$$

For our example,

$$P = \$100 - \left(\$100 \times 1.03\% \times \frac{182}{360} \right) = \$99.479$$

The discount rate differs from more standard return measures for two reasons. First, the measure compares the dollar return to the face value rather than to the price. Second, the return is annualized based on a 360-day year rather than a 365-day year. Nevertheless, the discount rate can be converted to a bond-equivalent yield (as discussed in Chapter 5), and such yields are often reported alongside the discount rate.

Treasury bill discount rates typically are quoted to two decimal places in the secondary market, so a quoted discount rate might be 1.18%. For more active issues, the last digit is often split into halves, so a quoted rate might be 1.175%.

Typical bid-ask spreads in the interdealer market for the on-the-run bills are 0.5 basis points, as shown in Exhibit 10–6. A basis point equals one one-hundredth of a percentage point, so quotes for a half basis point spread might be 1.175%/1.17%. Exhibit 10–6 also shows that spreads vary with market conditions, ranging from 0 to about 2 basis points most of the time. A zero spread

EXHIBIT 10–6

Bid-Ask Spreads for U.S. Treasury Securities

Issue	Median Spread	95% Range
4-week bill	0.5 basis points	0–2.5 basis points
13-week bill	0.5 basis points	0–2.0 basis points
26-week bill	0.5 basis points	0–1.5 basis points
2-year note	1/128 point	0–1/64 point
3-year note	1/128 point	0–3/128 point
5-year note	1/128 point	0–1/32 point
10-year note	1/64 point	0–2/32 point

Note: Statistics for the spread between the best bid and the best offer in the interdealer market are reported for the on-the-run securities of each issue. Bill spreads are reported in yield terms in basis points, and coupon spreads are reported in price terms in points.

Source: Authors' calculations, based on 2003 (for bills) and 1998 (for notes) data from GovPX.

is called a *locked market* and can persist in the interdealer market because of the transaction fee paid to the broker who mediates a trade. Bid-ask spreads typically are wider outside the interdealer market and for less active issues.

Quoting Conventions for Treasury Coupon Securities

In contrast to Treasury bills, Treasury notes and bonds are quoted in the secondary market on a price basis in points, where one point equals 1% of par.[7] The points are split into units of thirty-seconds, so a price of 97-14, for example, refers to a price of 97 and $^{14}/_{32}$, or 97.4375. The thirty-seconds are themselves split by the addition of a plus sign or a number, with a plus sign indicating that half a thirty-second (or $^{1}/_{64}$) is added to the price and a number indicating how many eighths of thirty-seconds (or 256ths) are added to the price. A price of 97-14+ therefore refers to a price of 97 and $14^{1}/_{2}$ thirty-seconds, or 97.453125, whereas a price of 97-142 refers to a price of 97 and $14^{2}/_{8}$ thirty-seconds, or 97.4453125. The yield to maturity, discussed in Chapter 5, typically is reported alongside the price.

Typical bid-ask spreads in the interdealer market for the on-the-run coupon issues range from $^{1}/_{128}$ point for the 2-year note to $^{1}/_{64}$ point for the 10-year note, as shown in Exhibit 10–6. A 2-year note thus might be quoted as 99-082/99-08+, whereas a 10-year note might be quoted as 95-23/95-23+. As with bills, the spreads vary with market conditions and usually are wider outside the interdealer market and for less active issues.

7. Notes and bonds are quoted in yield terms in when-issued trading because coupon rates for new notes and bonds are not set until after these securities are auctioned.

Zero-Coupon Treasury Securities

Zero-coupon Treasury securities are created from existing Treasury notes and bonds through coupon stripping (the Treasury does not issue them). *Coupon stripping* is the process of separating the coupon payments of a security from the principal and from one another. After stripping, each piece of the original security can trade by itself, entitling its holder to a particular payment on a particular date. A newly issued 10-year Treasury note, for example, can be split into its 20 semiannual coupon payments (called *coupon strips*) and its principal payment (called the *principal strip*), resulting in 21 individual securities. Since the components of stripped Treasury securities consist of single payments (with no intermediate coupon payments), they are often called *zero coupons* or *zeros* as well as strips.

Since they make no intermediate payments, zeros sell at discounts to their face value and frequently at deep discounts owing to their often long maturities. On March 26, 2004, for example, the closing bid price for the February 2031 principal strip was just $26.50 (per $100 face value). Since zeros have known cash values at specific future dates, they enable investors to closely match their liabilities with Treasury cash flows and thus are popular with pension funds and insurance companies. Zeros also appeal to speculators because their prices are more sensitive to changes in interest rates than coupon securities with the same maturity date.

The Treasury introduced its Separate Trading of Registered Interest and Principal Securities (STRIPS) program in February 1985 to improve the liquidity of the zero-coupon market. The program allows the individual components of eligible Treasury securities to be held separately in the Federal Reserve's book-entry system. Institutions with book-entry accounts can request that a security be stripped into its separate components by sending instructions to a Federal Reserve Bank. Each stripped component receives its own cusip (or identification) number and then can be traded and registered separately. The components of stripped Treasury securities remain direct obligations of the U.S. government. The STRIPS Program was limited originally to new coupon security issues with maturities of 10 years or longer but was expanded to include all new coupon issues in September 1997.

Since May 1987, the Treasury also has allowed the components of a stripped Treasury security to be reassembled into their fully constituted form. An institution with a book-entry account assembles the principal component and all remaining interest components of a given security and then sends instructions to a Federal Reserve Bank requesting the reconstitution.

As of March 31, 2004, $177 billion of fixed-rate Treasury notes and bonds were held in stripped form, representing 7% of the $2.5 trillion in eligible fixed-rate coupon securities.[8] There is wide variation across issue types and across

8. Figures are from Table V of the Treasury's Monthly Statement of the Public Debt (www.publicdebt.ustreas.gov/opd/opddload.htm).

issues of a particular type in the rate of stripping. As of March 31, 2004, 32% of eligible bonds were stripped, but only 1% of eligible notes were stripped. Among the notes, one issue was 21% stripped, whereas 34 eligible note issues were not stripped at all. On a flow basis, securities were stripped at a rate of $16.4 billion per month in the first quarter of 2004 and reconstituted at a rate of $14.8 billion per month.

AGENCY SECURITIES

Agency securities are direct obligations of federal government agencies or government-sponsored enterprises. *Federal agencies* are entities of the U.S. government, such as the Tennessee Valley Authority. G*overnment-sponsored enterprises* are publicly chartered but privately owned and operated entities, such as the Federal National Mortgage Association ("Fannie Mae"), the Federal Home Loan Mortgage Corporation ("Freddie Mac"), the Federal Home Loan Banks, and the Farm Credit Banks. The agencies issue debt securities to finance activities supported by public policy, including home ownership, farming, and education.[9]

Agency securities typically are not backed by the full faith and credit of the U.S. government, as is the case with Treasury securities. Agency securities therefore are not considered to be risk-free instruments but rather trade with some credit risk. Nevertheless, agency securities are considered to be of very high credit quality because of the strong fundamentals of their underlying businesses and because of the agencies' government affiliation. Several of the agencies have authority to borrow directly from the Treasury. Additionally, there is a perception among some market participants that the government implicitly backs the agency issues and would be reluctant to let an agency default on its obligations. Agency issues are also attractive to investors because their interest income is exempt from state and local taxation for many of the issuers (albeit not for Fannie Mae or Freddie Mac issues).

Types of Securities

Agency securities are issued in a variety of types and maturities. *Discount notes* are short-term obligations issued at a discount from par with maturities ranging from one day to 365 days. *Medium-term notes* are fixed- or floating-rate coupon securities and are offered with a range of maturities. More generally, the agencies offer a wide variety of securities with various attributes, including callable and noncallable securities; fixed-rate, floating-rate, indexed, and zero-coupon securities; and securities denominated in U.S. dollars or in other currencies.

9. Several of the agencies also guarantee and/or issue asset-backed securities. Agency mortgage-backed securities are discussed in Chapter 22.

An important development in the agency securities market in the late 1990s was the introduction of agency benchmark programs, including Fannie Mae's *Benchmark Notes* program and Freddie Mac's *Reference Notes* program. These programs provide for the regular issuance of securities in large sizes for a wide range of maturities. The programs are intended to produce a yield curve for liquid agency securities and thereby appeal to investors who typically might buy Treasury securities. The initial benchmark programs were limited to noncallable notes but later were extended to noncallable bills and bonds, as well as callable securities.

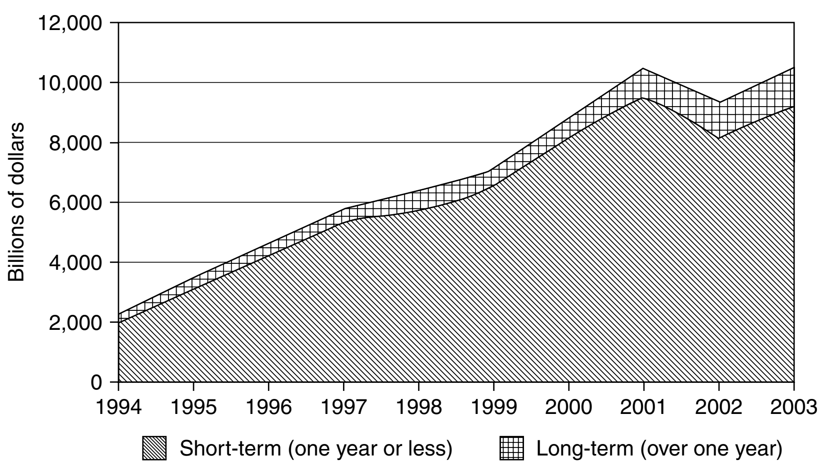
The Primary Market

The agencies use a variety of methods to distribute their securities, including allocation to dealers, competitive dealer bidding, direct sales to investors, and sales to investors through dealers. A common distribution mechanism for agency securities is to allocate them among members of a selling group or syndicate of dealers. The syndicate provides market and trading information to the issuing agency before and during the allocation and may support secondary trading in the issue after allocation. In compensation for their services, the syndicate members retain a percentage of the proceeds from the sold securities.

The quantity of agency securities sold in the primary market has increased rapidly in recent years, as shown in Exhibit 10–7. In 1994, the agencies issued \$2.3 trillion in debt securities, \$2.1 trillion in short-term debt (securities with a

EXHIBIT 10–7

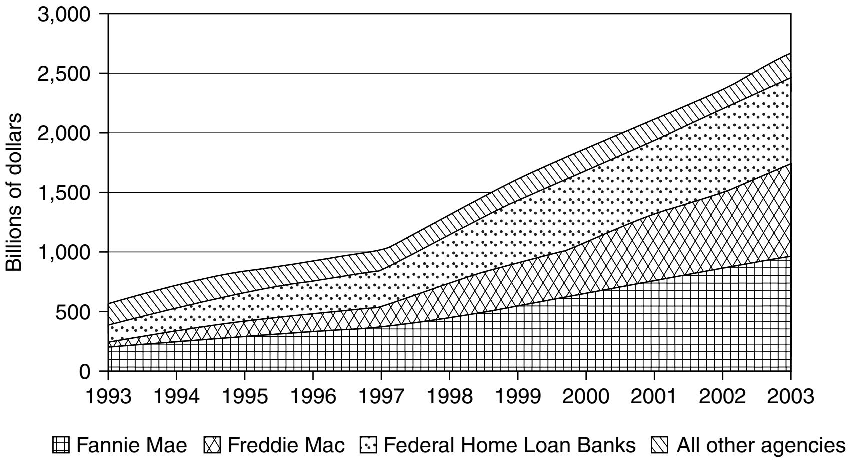
Agency Debt Issuance, 1994–2003



Source: The Bond Market Association (www.bondmarkets.com/research/faiss.shtml).

EXHIBIT 10–8

Agency Debt Outstanding, 1993–2003



Note: Figures for 2003 as of September 30; figures for other years as of December 31.

Sources: Farmer Mac, Freddie Mac, Table 1.44, *Federal Reserve Bulletin*, and Table 1.44, *Statistical Supplement to the Federal Reserve Bulletin*.

maturity of one year or less), and $158 billion in long-term debt. In 2003, the agencies issued $10.5 trillion in debt securities, $9.2 trillion in short-term debt, and $1.3 trillion in long-term debt.

Rising issuance has resulted in a growing stock of agency debt outstanding, as shown in Exhibit 10–8. The outstanding debt of the agencies stood at $2.7 trillion on September 30, 2003, up from $571 billion on December 31, 1993.[10] The growth in agency debt is attributable to three issuers, Fannie Mae, Freddie Mac, and the Federal Home Loan Banks, which together accounted for 92% of outstanding agency debt as of September 30, 2003.

The Secondary Market

Like Treasury securities, agency securities trade in a multiple-dealer over-the-counter secondary market. Also like Treasury securities, trading among dealers is screen-based, through interdealer brokers. Trading volume is significantly lower than that in the Treasury market, but it is still reasonably high relative to that in

10. Note that agency debt issuance in 2003 ($10.5 trillion) significantly exceeded the stock of debt outstanding on September 30, 2003 ($2.7 trillion). This is so because most agency debt issued is of such a short term that it turns over many times within a year.

other fixed income markets. Daily trading by primary dealers in the first quarter of 2004 averaged $78 billion per day, with $51 billion in discount notes and $27 billion in coupon securities.[11]

Issuing Agencies

As mentioned previously, agency securities are direct obligations of federal agencies or government-sponsored enterprises. Federal agencies are entities of the federal government. They include the Export-Import Bank of the United States, the Federal Housing Administration, the Government National Mortgage Association ("Ginnie Mae"), the Tennessee Valley Authority (TVA), and the Small Business Administration. Historically, a number of federal agencies issued their own debt securities. In 1974, the Federal Financing Bank was set up to consolidate agency borrowing and thereby reduce borrowing costs. The TVA still issues its own debt securities, however, and accounts for nearly all the outstanding debt issued directly by federal agencies.

Government-sponsored enterprises (GSEs) are privately owned and operated entities chartered by Congress to decrease the cost of funding for certain sectors of the economy. The GSEs are granted certain privileges to help them achieve their public purposes and, in turn, are limited to certain activities. As mentioned, the agencies' securities are thought to have an implicit government guarantee, and agency security interest income is exempt from state and local taxation for many of the issuers. The agencies themselves are exempt from state and local income taxes and are exempt from Securities and Exchange Commission (SEC) registration fees.

The largest GSEs were chartered to provide credit to the housing sector. They include Fannie Mae, Freddie Mac, and the Federal Home Loan Banks. Another set of GSEs was established to provide credit to the agricultural sector. It includes the Farm Credit Banks, the Farm Credit System Financial Assistance Corporation, and the Federal Agricultural Mortgage Corporation ("Farmer Mac"). One GSE, the Student Loan Marketing Association ("Sallie Mae"), was established to provide funds to support higher education. Two other GSEs, the Financing Corporation and the Resolution Funding Corporation, were established to recapitalize the savings and loan industry.

The remainder of this section provides a brief overview of each of the agencies that have debt securities outstanding. The information is summarized in Exhibit 10–9.

Federal National Mortgage Association (Fannie Mae)

Fannie Mae is a stockholder-owned corporation chartered in 1938 to develop a secondary market for residential mortgages. Fannie Mae buys home loans from

11. Federal Reserve Bank of New York (www.newyorkfed.org/markets/statrel.html).

EXHIBIT 10–9

Agencies

Agency	Purpose	Debt Outstanding (September 30, 2003)
Federal National Mortgage Association (Fannie Mae)	Promote liquid secondary market for residential mortgages	$975.7 billion
Federal Home Loan Mortgage Corporation (Freddie Mac)	Promote liquid secondary market for residential mortgages	$774.0 billion
Federal Home Loan Banks	Supply credit for residential mortgages	$718.7 billion
Farm Credit Banks	Supply credit to agricultural sector	$90.1 billion
Farm Credit System Financial Assistance Corporation	Finance recapitalization of Farm Credit System institutions	$1.3 billion
Federal Agricultural Mortgage Corporation (Farmer Mac)	Promote liquid secondary market for agricultural and rural housing loans	$3.8 billion
Student Loan Marketing Association (Sallie Mae)	Increase availability of student loans	$54.3 billion
Financing Corporation	Finance recapitalization of Federal Savings and Loan Insurance Corporation	$8.2 billion
Resolution Funding Corporation	Finance recapitalization of savings and loan industry	$30.0 billion
Tennessee Valley Authority	Promote development of Tennessee River and adjacent areas	$27.0 billion

Sources: Farmer Mac, Freddie Mac, and Table 1.44, *Statistical Supplement to the Federal Reserve Bulletin* for debt outstanding.

banks and other mortgage lenders in the primary market and holds the mortgages until they mature or issues securities backed by pools of the mortgages. In addition to promoting a liquid secondary market for mortgages, Fannie Mae is charged with providing access to mortgage finance for low-income families and underserved areas. Fannie Mae's housing mission is overseen by the U.S. Department of Housing and Urban Development (HUD), and its safety and soundness are overseen by the Office of Federal Housing Enterprise Oversight (OFHEO).

Fannie Mae issues a variety of securities, including discount notes and medium-term notes. In January 1998, Fannie Mae initiated its *Benchmark Notes* debt issuance program, followed by the introduction of its *Benchmark Bills* program in November 1999. These programs provide for the regular and predictable issuance of large-sized issues and are meant to enhance security efficiency, liquidity, and tradability. Benchmark Bills are issued via auction, with three- and six-month bills offered weekly and one-year bills offered biweekly. Minimum issue sizes are $4 billion for three-month bills, $1.5 billion for six-month bills, and $1 billion for one-year bills. Benchmark Notes are issued via an underwriting syndicate of dealers following a yearly issuance calendar, with minimum issue sizes of $4 billion. Total Fannie Mae debt issuance in 2003 was $2.6 trillion, with $2.2 trillion in short-term debt and $348 billion in long-term debt.[12] On September 30, 2003, Fannie Mae had debt securities outstanding of $976 billion.

Federal Home Loan Mortgage Corporation (Freddie Mac)

Freddie Mac is a stockholder-owned corporation chartered in 1970 to improve the liquidity of the secondary mortgage market. Freddie Mac purchases mortgage loans from individual lenders and sells securities backed by the mortgages to investors or holds the mortgages until they mature. Like Fannie Mae, Freddie Mac is charged with providing access to mortgage finance for low-income families and underserved areas. Also like Fannie Mae, Freddie Mac is regulated by HUD for its housing mission and by OFHEO for safety and soundness.

Freddie Mac issues a variety of debt securities, including discount notes and medium-term notes. In April 1998, Freddie Mac established its own benchmark securities program called *Reference Notes,* followed by *Reference Bills* in November 1999. Reference Bills are issued via auction, with one-, three-, and six-month bills offered weekly and 12-month bills offered every four weeks. Minimum issue sizes for all Reference Bills are $1 billion. Reference Notes are offered via auction and dealer syndicate according to a yearly issuance calendar, with minimum issue sizes of $3 billion. Total Freddie Mac debt issuance in 2003 was $1.1 trillion, $779 billion in short-term securities and $277 billion in long-term securities. On September 30, 2003, Freddie Mac had $774 billion in outstanding debt.

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12. Debt issuance in 2003 for each of the agencies is from the Bond Market Association (www.bondmarkets.com/research/faiss.shtml), while debt outstanding on September 30, 2003 is from Farmer Mac, Freddie Mac, and Table 1.44 of the *Statistical Supplement to the Federal Reserve Bulletin*.

Federal Home Loan Bank System

The Federal Home Loan Bank System (FHLBank System) is a GSE established in 1932 to increase credit to the housing sector. It consists of 12 federally chartered privately owned Federal Home Loan Banks that are charged with supporting residential mortgage, small business, rural, and agricultural lending by over 8,000 member-stockholder institutions. It does this by making loans to the member institutions, which in turn make loans to homebuyers, small businesses, and others. The Federal Housing Finance Board regulates the FHLBank System for mission, as well as safety and soundness issues.

FHLBank debt issuance is conducted through the system's fiscal agent, the Office of Finance. The FHLBanks sell a variety of debt securities, including discount notes and medium-term notes. In July 1999, the FHLBanks initiated their own benchmark securities program called the *Tap Issue Program*. The program reopens coupon securities of four common maturities on a daily basis for three months via competitive auction. In 2003, the FHLBanks issued $5.7 trillion in debt securities, $5.2 trillion in short-term debt, and $569 billion in long-term debt. The FHLBanks had $719 billion in outstanding debt as of September 30, 2003.

Farm Credit System

The Farm Credit System (FCS) is a GSE established in 1916 to provide credit to the agricultural sector. The FCS consists of four Farm Credit Banks, one Agricultural Credit Bank, and about 100 related Production Credit Associations, Federal Land Credit Associations, and Agricultural Credit Associations. Products and services offered by FCS institutions include real estate loans, operating loans, rural home mortgage loans, crop insurance, and various financial services. The FCS is regulated by the Farm Credit Administration.

The Federal Farm Credit Banks Funding Corporation is the system's fiscal entity, providing funds to system institutions through the issuance of debt securities. The FCS issues discount notes, medium-term notes, and other debt securities. In March 1999, the FCS introduced its *Designated Bonds* program. The bonds are issued through a dealer syndicate with a minimum issue size of $1 billion and generally have a two- to five-year original maturity. In 2003, the FCS issued $310 billion in debt securities, $257 billion in short-term debt, and $53 billion in long-term debt. On September 30, 2003 the FCS had $90 billion in outstanding debt.

Farm Credit System Financial Assistance Corporation

The Farm Credit Financial Assistance Corporation was chartered in 1988 to finance the recapitalization of FCS institutions. Between 1988 and 1990, the corporation raised $1.3 billion through the issuance of debt securities, which it provided to system institutions in return for preferred stock. Unlike most GSEs, debt securities of this corporation are fully guaranteed by the U.S. Treasury. On September 30, 2003, the full $1.3 billion in issued debt securities was outstanding.

Federal Agricultural Mortgage Corporation (Farmer Mac)

Farmer Mac is a stockholder-owned corporation chartered in 1988 to promote a liquid secondary market for agricultural real estate and rural housing loans. It does this by buying qualified loans from lenders and grouping the loans into pools against which it issues securities. Farmer Mac thus performs a role for the agricultural mortgage market similar to that performed by Fannie Mae and Freddie Mac for the residential mortgage market. Farmer Mac issues discount notes and medium-term notes and had debt securities outstanding of $3.8 billion on September 30, 2003.

Student Loan Marketing Association (Sallie Mae)

Sallie Mae is a stockholder-owned corporation established in 1972 to increase the availability of student loans. Sallie Mae purchases insured student loans from lenders and makes loans to lenders secured by student loans. Sallie Mae was reorganized in 1997 in a step toward privatization and is scheduled to be phased out as a GSE by 2006.

Sallie Mae issues discount notes, medium-term notes, and other debt securities. It issued $310 billion in debt securities in 2003, $251 billion in short-term debt and $53 billion in long-term debt. As of September 30, 2003, Sallie Mae had debt securities outstanding of $54 billion.

Financing Corporation

The Financing Corporation (FICO) was established in 1987 to finance the recapitalization of the Federal Savings and Loan Insurance Corporation (FSLIC). Between 1987 and 1989, FICO issued debt obligations with an aggregate principal value of $8.2 billion. The FHLBank System provided capital to purchase zero-coupon Treasury securities to repay the principal. Interest payments were to be funded by an assessment on FSLIC-insured institutions, although assessments eventually were expanded to include banks as well as savings and loans. The full $8.2 billion in issued debt securities was outstanding as of September 30, 2003.

Resolution Funding Corporation

The Resolution Funding Corporation (REFCorp) was established in 1989 as the funding arm of the Resolution Trust Corporation to finance the recapitalization of the savings and loan industry. REFCorp issued $30 billion in debt securities between 1989 and 1991. Interest payments on REFCorp bonds are guaranteed by the U.S. government, and the principal is protected by the purchase of zero-coupon bonds with a face value equal to those of REFCorp bonds. The full $30 billion in issued debt securities was outstanding on September 30, 2003.

Tennessee Valley Authority (TVA)

The TVA is a government-owned corporation established in 1933 to promote development of the Tennessee River and adjacent areas. The TVA manages the river system for flood control, navigation, power generation, and other purposes and is the nation's largest public power company.

The TVA issues discount notes as well as longer-term coupon securities called *Power Bonds*. Interest and principal on Power Bonds are paid from the proceeds of TVA's power program. The TVA issued $25 billion in debt securities in 2003, $22 billion in short-term debt and $2 billion in long-term debt. The TVA had debt securities outstanding of $27 billion on September 30, 2003.

SUMMARY

U.S. Treasury securities are obligations of the U.S. government issued by the Department of the Treasury. They trade in a highly liquid secondary market and are used by market participants as a pricing and hedging instrument, risk-free benchmark, reserve asset, and investment asset. The regular and predictable issuance of Treasury securities has been disrupted in recent years by the government's changing funding needs. Between the late 1990s and 2001, the Treasury suspended issuance of several securities, reduced issuance frequencies and sizes, and launched a debt buyback program. Since 2001, the Treasury has increased issuance sizes and frequencies, reintroduced a security, and suspended use of debt buybacks.

Agency securities are obligations of entities that are either part of or sponsored by the U.S. government. Agency securities are viewed as having very low credit risk, although they are not risk-free. Agency security issuance and amount outstanding have grown strongly in recent years owing to the growth of the housing GSEs: Fannie Mae, Freddie Mac, and the FHLBank System. The agencies introduced benchmark security programs in the late 1990s to appeal to investors who typically might buy Treasury securities.

CHAPTER

ELEVEN

MUNICIPAL BONDS

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The U.S. bond market can be divided into two major sectors: the taxable bond market and the tax-exempt bond market. The former sector includes bonds issued by the U.S. government, U.S. government agencies and sponsored enterprises, and corporations. The tax-exempt bond market is one in which the interest from bonds that are issued and sold is exempt from federal income taxation. Interest may or may not be taxable at the state and local levels. The interest on U.S. Treasury securities is exempt from state and local taxes, but the distinction in classifying a bond as tax-exempt is the tax treatment at the federal income tax level.

The Federal Reserve Board estimates that the size of the tax-exempt bond market as of January 2004 totals $1.8 trillion. This makes the municipal bond market about 11% of the domestic bond market, which makes municipal debt the fourth largest sector. U.S. Treasuries and agencies account for a dominant 38% of the domestic bond market. The mortgage-backed security sector (MBS) has the second largest representation, whereas U.S. corporate debt ranks third. The municipal sector is certainly one of the larger components of the domestic bond market, but it is clearly different from the 89% of the bond market that is taxable.

The majority of tax-exempt securities are issued by state and local governments and by their creations, such as "authorities" and special districts. Consequently, the terms *municipal market* and *tax-exempt market* are often used interchangeably. Although not all municipal bonds are tax-exempt securities, most are.

The major motivation for investing in municipal bonds is their tax advantage. The primary owners of municipal bonds are individual investors; the remainder of the investors consist of mutual funds, commercial banks, and property and casualty insurance companies. Although certain institutional investors such as pension funds have no need for tax-advantaged investments, there have been instances where such institutional investors have crossed into the municipal bond market to take advantage of higher yields. These investors also have purchased municipal bonds when municipal bonds were expected to outperform taxable bonds. Institutional investors that are natural purchasers of taxable bonds but at times purchase municipal debt are known as crossover buyers.

Traditionally, the household sector has owned the largest portion of the municipal bond market. Another substantial owner has been the mutual fund industry. However, examination of Federal Reserve Board data indicates that there have been three major changes among holders. First, the percentage holdings of commercial banks has dropped significantly since 1986. In general, the Tax Reform Act of 1986 reduced the benefits commercial banks received by owning municipal bonds. Commercial banks responded to this change by reducing their municipal bond holdings and investing in assets that provided greater benefits.

Households account for the next substantial ownership change. In 1990, household ownership of municipal bonds reached a peak of 49% for the 20-year period. However, by 2004, household ownership declined to 36%. If commercial banks and households both decreased their holdings, then other groups had to increase their ownership. Federal Reserve Board data indicate that mutual funds dramatically increased their holdings. In 1979, mutual funds held 1% of the municipal market; by 2004, money market funds and closed-end funds combined increased their share to 36%.

Insurance companies and personal bank trust accounts have had relatively stable ownership of municipal bonds. Insurance companies typically adjust their holdings of municipal bonds according to profitability and the relative value municipal bonds offer compared to taxable bonds. Trust accounts are relatively stable purchasers of municipal bonds. A typical trust account will purchase bonds near par, collect the tax-exempt income, and hold the bonds to maturity.

It should be noted that when municipal bond yields are attractive compared with taxable bonds, traditional bond buyers, hedge funds, and arbitrageurs are active and at times have become significant participants in the municipal market.

In the past, investing in municipal bonds was considered second in safety only to that of U.S. Treasury securities; however, there have now developed among investors ongoing concerns about the credit risks of municipal bonds. This is true regardless of whether or not the bonds are given investment-grade credit ratings by the commercial rating companies. There are several reasons for this: (1) the financial crisis of several major municipal issuers beginning with the City of New York billion-dollar financial crisis in 1975 and more recently with the bankruptcy filing of Orange County, California, (2) the federal bankruptcy law (which became effective October 1979) that makes it easier for municipal bond issuers to seek protection from bondholders by filing for bankruptcy, (3) the proliferation of innovative financing techniques and legally untested security structures, highlighted by the default of the Washington Public Power Supply System (WPPSS) in the early 1980s, (4) the cutbacks in federal grant and aid programs that will affect the ability of certain municipal issuers to meet their obligations, and (5) fundamental changes in the American economy that may cause economic hardship for municipal issuers in some regions of the country and thus difficulty in meeting their obligations.

FEATURES OF MUNICIPAL SECURITIES

In Chapter 1 the various features of fixed income securities were described. These include call and refunding provisions, sinking-fund provisions, and put provisions. Such provisions also can be included in municipal securities. In one type of municipal structure discussed below, a revenue bond, there is a special call feature wherein the issuer must call the entire issue if the facility is destroyed.

Coupon Features

The coupon rate on a municipal issue can be fixed throughout the life of the issue, or it can be reset periodically. When the coupon rate is reset periodically, the issue is referred to as a *floating-rate* or *variable-rate* issue. In general form, the coupon reset formula for a floating-rate issue is

$$\text{Percent of reference rate} \pm \text{spread}$$

Typically, when the reference rate is a municipal index, the coupon reset formula is

$$\text{Reference rate} \pm \text{spread}$$

Reference rates that have been used for municipal issues include the J. J. Kenny Municipal Index, LIBOR, Bond Market Association "BMA" rate, and Treasury bills. The coupon rate on a floating-rate issue need not change in the same direction as the reference rate. There are derivative municipal bonds whose coupon rate changes in the opposite direction to the change in the reference rate. That is, if the reference rate increases from the previous coupon reset date, the coupon rate on the issue declines. Such issues are referred to as *inverse floating-rate issues.* Some municipal issues have a fixed coupon rate and are issued at a discount from their maturity value. Issues whose original-issue price is less than its maturity value are referred to as *original-issue discount bonds* (OIDs). The difference between the par value and the original-issue price represents tax-exempt interest that the investor realizes by holding the issue to maturity.

Two types of municipal issues do not distribute periodic interest to the investor. The first type is called a *zero-coupon bond.* The coupon rate is zero, and the original issue price is below the maturity value. Zero-coupon bonds are therefore OIDs. The other type of issue that does not distribute periodic interest is one in which a coupon rate is stated but the coupon is not distributed to the investor. Instead, the interest is accrued, and all interest is paid to the investor at the maturity date along with the maturity value. Later in this chapter we will discuss the important aspects an investor should be aware of when considering the purchase of OIDs in the secondary market.

Maturity Date

The maturity date is the date on which the issuer is obligated to pay the par value. Corporate issuers of debt generally schedule their bonds to mature in one or two different years in the future. Municipal issuers, on the other hand, frequently schedule their bonds to mature serially over many years. Such bonds are called *serial bonds.* It is common for a municipal issue to have 10 or more different maturities.

After the last of the serial maturities, some municipal issues lump together large sums of debt into one or two years—much the way corporate bonds are issued. These bonds, called *term bonds,* have become increasingly popular in the municipal market because active secondary markets for them can develop if the term issue is of sufficient size.

The Legal Opinion

Municipal bonds have legal opinions. The relationship of the legal opinion to the safety of municipal bonds for both general obligation and revenue bonds is threefold. First, bond counsel should check to determine if the issuer is indeed legally able to issue the bonds. Second, bond counsel is to see that the issuer has properly prepared for the bond sale by having enacted the various required ordinances, resolutions, and trust indentures and without violating any other laws and regulations. This preparation is particularly important in the highly technical areas of determining if the bond issue is qualified for tax exemption under federal law and if the issue has not been structured in such a way as to violate federal arbitrage regulations. Third, bond counsel is to certify that the security safeguards and remedies provided for the bondholders and pledged either by the bond issuer or by third parties, such as banks with letter-of-credit agreements, are actually supported by federal, state, and local government laws and regulations.

The popular notion is that much of the legal work done in a bond issue is boilerplate in nature, but from the bondholder's point of view, the legal opinions and document reviews should be the ultimate security provisions. The reason is that if all else fails, the bondholder may have to go to court to enforce security rights. Therefore, the integrity and competence of the lawyers who review the documents and write the legal opinions that are usually summarized and stated in the official statements are very important.

TYPES OF MUNICIPAL OBLIGATIONS

The number of municipal bond issuers is remarkable. One broker-dealer's estimate places the total at 60,055. Also, Bloomberg Financial Markets' (Bloomberg) database[1] contains 55,000 active issuers. Even more noteworthy is the number of different issues. As of 2004, FT Interactive Data[2] provides daily prices for over 1.4 million individual issues in its database of over 2.6 million records. Bloomberg's database contains over 3.7 million cusips (including matured bonds). Of the 1.18 million cusips still active, Bloomberg has updated about 1 million description pages. The number of different issues to choose from is staggering. Considering all the different types of issuers in the market—states, state agencies, cities, airports, colleges and universities, hospitals, school districts, toll roads and bridges, public power facilities, seaport facilities, water and sewer authorities, solid waste facilities, and other special purpose districts—your investment choices are overwhelming. Some of the issuers are extremely large and issue billions of dollars of debt. Some are extremely small and may only have $1 to $2 million in outstanding debt. Obviously, the characteristics of these issuers and their debt are very different, and both require independent and careful analysis. However, municipal bonds can be categorized into two broad security structures. In terms of municipal bond security structures, there are basically two different types. The first type is the general obligation bond, and the second is the revenue bond.

General Obligation Bonds

General obligation bonds are debt instruments issued by states, counties, special districts, cities, towns, and school districts. They are secured by the issuer's general taxing powers. Usually, a general obligation bond is secured by the issuer's unlimited taxing power. For smaller governmental jurisdictions, such as school districts and towns, the only available unlimited taxing power is on property. For larger general obligation bond issuers, such as states and big cities, the tax revenues are more diverse and may include corporate and individual income

1. Bloomberg Financial Markets is a multimedia distributor of information services that combines news, data, and analysis for global financial markets and business. The Bloomberg, the company's core business, is a computer network that delivers real-time financial information and links the world's financial markets and financial professionals.
2. FT Interactive Data is a securities information provider that specializes in data collection and internally authored evaluations. Data are delivered electronically to financial institutions and authorized redistribution vendors. Fixed income coverage encompasses the municipal and taxable bond markets. FT Interactive is the major operating division of Interactive Data Corporation, approximately 60% owned by Pearson PLC. A second pricing service is Standard & Poor's Securities Evaluation Service.

taxes, sales taxes, and property taxes. The security pledges for these larger issuers such as states sometimes are referred to as being *full faith and credit obligations.*

Additionally, certain general obligation bonds are secured not only by the issuer's general taxing powers to create monies accumulated in the general fund but also from certain identified fees, grants, and special charges, which provide additional revenues from outside the general fund. Such bonds are known as being *double barreled* in security because of the dual nature of the revenue sources. Also, not all general obligation bonds are secured by unlimited taxing powers. Some have pledged taxes that are limited as to revenue sources and maximum property-tax millage amounts. Such bonds are known as *limited-tax general obligation bonds*.

Revenue Bonds

The second basic type of security structure is found in a revenue bond. Such bonds are issued for either project or enterprise financings in which the bond issuers pledge to the bondholders the revenues generated by the operating projects financed. Below are examples of the specific types of revenue bonds that have been issued over the years.

Airport Revenue Bonds

The revenues securing airport revenue bonds usually come from either traffic-generated sources—such as passenger charges, landing fees, concession fees, and airline apron-use and fueling fees—or lease revenues from one or more airlines for the use of a specific facility such as a terminal or hangar.

College and University Revenue Bonds

The revenues securing college and university revenue bonds usually include dormitory room rental fees, tuition payments, and sometimes the general assets of the college or university as well.

Hospital Revenue Bonds

The security for hospital revenue bonds is usually dependent on federal and state reimbursement programs (such as Medicaid and Medicare), third-party commercial payers (such as Blue Cross and private insurance), health maintenance organizations (HMOs), and individual patient payments.

Single-Family Mortgage Revenue Bonds

Single-family mortgage revenue bonds usually are secured by the mortgages and mortgage loan repayments on single-family homes. Security features vary but can include Federal Housing Administration (FHA), Federal Veterans Administration (VA), and private mortgage insurance.

Multifamily Revenue Bonds

These revenue bonds usually are issued for multifamily housing projects for senior citizens and low-income families. Some housing revenue bonds are secured by mortgages that are federally insured; others receive federal government operating subsidies, such as under section 8, or interest-cost subsidies, such as under section 236; and still others receive only local property-tax reductions as subsidies.

Industrial Development and Pollution Control Revenue Bonds

Bonds have been issued for a variety of industrial and commercial activities that range from manufacturing plants to shopping centers. They usually are secured by payments to be made by the corporations or businesses that use the facilities.

Public Power Revenue Bonds

Public power revenue bonds are secured by revenues to be produced from electrical operating plants and distribution systems. Some bonds are for a single issuer, who constructs and operates power plants and then sells the electricity. Other public power revenue bonds are issued by groups of public and private investor-owned utilities for the joint financing of the construction of one or more power plants. This last arrangement is known as a *joint power* financing structure. During the past several years, this sector started to undergo the most dramatic changes since electricity was invented. In many states the electric utility industry is transforming to a deregulated industry. In a deregulated environment, customers will have the ability to choose an electric provider; therefore, electric providers will face competition. This means that this sector will experience new and different challenges, and investors will need to analyze this sector differently.

Resource Recovery Revenue Bonds

A resource recovery facility converts refuse (solid waste) into commercially salable energy, recoverable products, and a residue to be landfilled. The major revenues for a resource recovery revenue bond usually are (1) the "tipping fees" per ton paid by those who deliver the garbage to the facility for disposal, (2) revenues from steam, electricity, or refuse-derived fuel sold to either an electrical power company or another energy user, and (3) revenues from the sale of recoverable materials such as aluminum and steel scrap.

Seaport Revenue Bonds

The security for seaport revenue bonds can include specific lease agreements with the benefiting companies or pledged marine terminal and cargo tonnage fees.

Sewer Revenue Bonds

Revenues for sewer revenue bonds come from hookup fees and user charges. For many older sewer bond issuers, substantial portions of their construction budgets have been financed with federal grants.

Sports Complex and Convention Center Revenue Bonds

Sports complex and convention center revenue bonds usually receive revenues from sporting or convention events held at the facilities and, in some instances, from earmarked outside revenues such as local motel and hotel room taxes.

Toll Road and Gas Tax Revenue Bonds

There are generally two types of highway revenue bonds. The bond proceeds of the first type are used to build such specific revenue-producing facilities as toll roads, bridges, and tunnels. For these pure enterprise-type revenue bonds, the pledged revenues usually are the monies collected through the tolls. The second type of highway bond is one in which the bondholders are paid by earmarked revenues outside toll collections, such as gasoline taxes, automobile registration payments, and driver's license fees.

Water Revenue Bonds

Water revenue bonds are issued to finance the construction of water treatment plants, pumping stations, collection facilities, and distribution systems. Revenues usually come from connection fees and charges paid by the users of the water systems.

Hybrid and Special Bond Securities

Although having certain characteristics of general obligation and revenue bonds, the following types of municipal bonds have more unique security structures as well.

Refunded Bonds

Although originally issued as either revenue or general obligation bonds, municipals are sometimes *refunded.* A refunding usually occurs when the original bonds are escrowed or collateralized either by direct obligations guaranteed by the U.S. government or by other types of securities. The maturity schedules of the securities in the escrow fund are such that they pay when due the bond's maturity value, coupon, and premium payments (if any) on the refunded bonds. Once this cash-flow match is in place, the refunded bonds are no longer secured as either general obligation or revenue bonds. The bonds are now supported by the securities held in the escrow fund. Such bonds, if escrowed with securities guaranteed by the U.S. government, have little, if any, credit risk. They are the safest municipal bond investments available.

Usually, an escrow fund is an irrevocable trust established by the original bond issuer with a commercial bank or state treasurer's office. Government securities are deposited in an escrow fund that will be used to pay debt service on the refunded bonds. A *pure* escrow fund is one in which the deposited securities are solely direct or guaranteed obligations of the U.S. government, whereas a *mixed* escrow fund is one in which the permitted securities, as defined by the trust indenture, are not exclusively limited to direct or guaranteed U.S. government securities. Other securities that could be placed in mixed escrow funds include federal agency bonds, certificates of deposit from banks, other municipal bonds, and even annuity policies from commercial insurance companies. The escrow agreement should indicate what is in the escrow fund and if substitutions of lower-credit-quality investments are permitted.

Still another type of refunded bond is a *crossover refunded bond.* Typically, proceeds from crossover refunding bonds are used to purchase securities that are placed in an escrow account. Usually, the crossover refunding bonds are secured by maturing principal and interest from the escrowed securities *only until the crossover date,* and the bonds to be refunded continue to be secured by the issuer's own revenues until the crossover date, which is usually the first call date of the bonds to be refunded. On that date, the crossover occurs, and the bonds to be refunded are redeemed from maturing securities in the escrow fund, which could include U.S. government securities or other investments, such as certificates of deposit. In turn, the security for the refunding bonds reverts back to the issuer's own revenues.

Here we focus primarily on the pure escrow-backed bonds, not the mixed escrow or crossover bonds. The escrow fund for a refunded municipal bond can be structured so that the refunded bonds are to be called at the first possible date or a subsequent call date established in the original bond indenture. The call price usually includes a premium of from 1 to 3% above par. This type of structure usually is used for those refundings that either reduce the issuer's interest payment expenses or change the debt maturity schedule. Such bonds are known in the industry as *prerefunded* municipal bonds. Prerefunded municipal bonds usually are to be retired at their first or subsequent respective callable dates, but some escrow funds for refunding bonds have been structured differently. In such refundings, the maturity schedules of the securities in the escrow funds match the regular debt-service requirements on the bonds as originally stated in the bond indentures. Such bonds are known as *escrowed-to-maturity,* or ETM, bonds. It should be noted that under the Tax Reform Law of 1986, such ETM refundings still can be done. In the secondary market there are ETM refunded municipal bonds outstanding. However, we note that the investor or trader should determine whether all earlier calls have been legally defeased before purchasing an ETM bond.

"Dedicated Tax-Backed" and "Structured Asset-Backed" Bonds

More recently, states and local governments have issued increasing amounts of bonds where the debt service is to be paid from so-called dedicated revenues such as sales taxes, tobacco settlement payments, fees, and penalty payments. Many are structured to mimic the asset-backed bonds that are common in the taxable market. The "assets" providing the security for the municipal bonds are the "dedicated" revenues instead of credit card receivables, home equity loans, and auto loan repayments that are commonly used to secure the taxable asset-backed bonds.

Insured Bonds

Insured bonds, in addition to being secured by the issuer's revenues, are also backed by insurance policies written by commercial insurance companies. The insurance, usually structured as an insurance contract, is supposed to provide prompt payment to the bondholders if a default should occur. These bonds are discussed in more detail later in this chapter.

Lease-Backed Bonds

Lease-backed bonds usually are structured as revenue-type bonds with annual payments. In some instances the payments may come only from earmarked tax revenues, student tuition payments, or patient fees. In other instances the underlying lessee governmental unit makes annual appropriations from its general fund.

Letter of Credit–Backed Bonds

Some municipal bonds, in addition to being secured by the issuer's cash-flow revenues, also are backed by commercial bank letters of credit. In some instances the letters of credit are irrevocable and, if necessary, can be used to pay the bondholders. In other instances the issuers are required to maintain investment-quality worthiness before the letters of credit can be drawn on.

Life Care Revenue Bonds

Life care or continuing care retirement community (CCRC) bonds are issued to construct long-term residential facilities for older citizens. Revenues usually are derived from initial lump-sum payments made by the residents and operating revenues.

Moral Obligation Bonds

A moral obligation bond is a security structure for state-issued bonds that indicates that if revenues are needed for paying bondholders, the state legislature involved is legally authorized, though not required, to make an appropriation out of general state tax revenues.

Municipal Utility District Revenue Bonds

Municipal utility district revenue bonds usually are issued to finance the construction of water and sewer systems, as well as roadways, in undeveloped areas. The security is usually dependent on the commercial success of the specific development project involved, which can range from the sale of new homes to the renting of space in shopping centers and office buildings.

New Housing Authority Bonds

New housing authority bonds are secured by a contractual pledge of annual contributions from the Department of Housing and Urban Development (HUD). Monies from Washington are paid directly to the paying agent for the bonds, and the bondholders are given specific legal rights to enforce the pledge. These bonds can no longer be issued.

Tax-Allocation Bonds

These bonds are usually issued to finance the construction of office buildings and other new buildings in formerly blighted areas. They are secured by property taxes collected on the improved real estate.

"Territorial" Bonds

These are bonds issued by U.S. territorial possessions such as Puerto Rico, the Virgin Islands, and Guam. The bonds are tax-exempt throughout most of the country. Also, the economies of these issuers are influenced by positive special features of the U.S. corporate tax codes that are not available to the states.

"Troubled City" Bailout Bonds

There are certain bonds that are structured to appear as pure revenue bonds but in essence are not. Revenues come from general-purpose taxes and revenues that otherwise would have gone to a state's or city's general fund. Their bond structures were created to bail out underlying general obligation bond issuers from severe budget deficits. Examples are the New York State Municipal Assistance Corporation for the City of New York Bonds (MAC) and the state of Illinois Chicago School Finance Authority Bonds.

Money Market Products

Tax-exempt money products include notes, commercial paper, variable-rate demand obligations, and a hybrid of the last two products.

Notes

Municipal notes include tax anticipation notes (TANs), revenue anticipation notes (RANs), grant anticipation notes (GANs), and bond anticipation notes (BANs). These are temporary borrowings by states, local governments, and special jurisdictions. Usually, notes are issued for a period of 12 months, although it is not uncommon for notes to be issued for periods of as short as 3 months and for as long as 3 years. TANs and RANs (also known as TRANs) are issued in anticipation of the collection of taxes or other expected revenues. These are borrowings to even out the cash flows caused by the irregular flows of income into the treasuries of the states and local units of government. BANs are issued in anticipation of the sale of long-term bonds.

Tax-exempt money market products generally have some type of credit support. This may come in the form of an irrevocable letter of credit, a line of credit, a municipal bond insurance policy, an escrow agreement, a bond purchase agreement, or a guaranteed investment contract. With a bond purchase agreement, a bank obligates itself to purchase the debt if the remarketing agent cannot resell the instrument or make a timely payment. In the case of a guaranteed investment contract, either an insurance company or a bank invests sufficient proceeds so that the cash flow generated from a portfolio of supporting assets can meet the obligation of the issue.

Commercial Paper

As with commercial paper issued by corporations, tax-exempt commercial paper is used by municipalities to raise funds on a short-term basis ranging from one to 270 days. The dealer sets interest rates for various maturity dates, and the investor then selects the desired date. Thus the investor has considerable choice in selecting a maturity to satisfy investment objectives. Provisions in the 1986 Tax Act, however, have restricted the issuance of tax-exempt commercial paper. Specifically, this act limits the new issuance of municipal obligations that is tax exempt, and as a result, every maturity of a tax-exempt commercial issuance is considered a new debt issuance. Consequently, very limited issuance of tax-exempt commercial paper exists. Instead, issuers use one of the next two products to raise short-term funds.

Variable-Rate Demand Obligations (VRDOs)

Variable-rate demand obligations are floating-rate obligations that have a nominal long-term maturity but have a coupon rate that is reset either daily or every 7 days. The investor has an option to put the issue back to the trustee at any time with 7 days' notice. The put price is par plus accrued interest.

Commercial Paper/VRDO Hybrid

The commercial paper/VRDO hybrid is customized to meet the cash-flow needs of an investor. As with tax-exempt commercial paper, there is flexibility in structuring the maturity because the remarketing agent establishes interest rates for a range of maturities. Although the instrument may have a long nominal maturity, there is a put provision as with a VRDO. Put periods can range from one day to over 360 days. On the put date, the investor can put back the bonds, receiving principal and interest, or the investor can elect to extend the maturity at the new interest rate and put date posted by the remarketing agent at that time. Thus the investor has two choices when initially purchasing this instrument: the interest rate and the put date. Interest generally is paid on the put date if the date is within 180 days. If the put date is more than 180 days forward, interest is paid semiannually. Some commercial paper dealers market these products under a proprietary name. Lehman markets these simply as money market municipals. Goldman Sachs refers to these securities as flexible-rate notes, and Citigroup markets them as Reset Option Certificates (ROCs).

Municipal Derivative Securities

In recent years, a number of municipal products have been created from the basic fixed-rate municipal bond. This has been done by splitting up cash flows of newly issued bonds as well as bonds existing in the secondary markets. These products have been created by dividing the coupon interest payments and principal payments into two or more bond classes, or *tranches.* The resulting bond classes may have far different yield and price volatility characteristics than the underlying fixed-rate municipal bond from which they were created. By expanding the risk/return profile available in the municipal marketplace, institutional investors have more flexibility in structuring municipal bond portfolios either to satisfy a specific asset/liability objective or to make an interest rate or yield curve bet more efficiently.

The name *derivative securities* has been attributed to these bond classes because they derive their value from the underlying fixed-rate municipal bond. Much of the development in this market has paralleled that of the taxable and, specifically, the mortgage-backed securities market. The ability of investment bankers to create these securities has been enhanced by the development of the municipal swap market.

A common type of derivative security is one in which two classes of securities, a *floating-rate security* and an *inverse floating-rate bond,* are created from a fixed-rate bond. Two types of inverse floaters dominate the market: auction rate securities and the later-developed TOB (Tender Option Bond) product. TOB programs, in various forms, have existed since the beginning to middle 1980s. Widespread use did not occur until the 1990s.

Initially, inverse floaters took the form of auction rate securities. Citigroup's proprietary auction rate product is called ARS (Auction Rate Securities) and IRS (Inverse Rate Securities). Lehman's proprietary product is called RIBS (Residual Interest Bonds) and SAVRS (Select Auction Variable Rate Securities), and Goldman's proprietary product is called PARS (Periodic Auction Rate Securities) and INFLOS, which are inverse floaters.

With these auction rate securities, the coupon rate on the floating-rate security is reset based on the results of a Dutch auction. The auction can take place anywhere between seven days and six months (but the frequency is for a given security). The coupon rate on the floating-rate security changes in the same direction as market rates. The inverse floating-rate bond receives the residual interest; that is, the coupon interest paid on this bond is the difference between the fixed rate on the underlying bond and the floating-rate security. Thus the coupon rate on the inverse floating-rate bond changes in the opposite direction of interest rates.

The sum of interest paid on the auction rate floater and inverse floater (plus fees associated with the auction) always must equal the sum of the fixed-rate bond from which they were created. A floor (a minimum interest rate) is established on the inverse floater. Typically, the floor is zero. As a result, a cap (maximum interest rate) will be imposed on the floater such that the combined floor of zero on the inverse floater and the cap on the floater is equal to the total interest rate on the fixed-rate bond from which they were created.

New issuance of auction rate derivatives, however, has been largely supplanted by TOB programs as the primary vehicle to create inverse floaters. Functionally, TOBs are similar to the auction rate product. Both derivatives are inverse floaters. Auction rate floaters, however, are sold primarily to corporations, whereas TOB floaters are sold to money market funds. Auction floaters are ineligible to be sold to money market funds. When corporations have less use for tax-exempt income, the demand and liquidity in auction rate securities can decrease substantially. Tax-exempt money market funds, unlike corporations, have a continuous need for tax-exempt interest. This demand provides a more stable buying base for the TOB floaters. To take advantage of this money market demand, TOBs feature a liquidity facility, which makes these floating-rate derivatives putable and therefore money market eligible. These liquidity facilities typically last 364 days and are provided by highly rated banks or broker-dealers.

TOBs are created through trusts. Given this structure, certain provisions must exist for the unwinding of a TOB. For example, if the remarketing agent fails to sell out the floating-rate class or the underlying bond falls below a minimum collateral value, a mandatory tender event is triggered. When a mandatory tender event occurs, the liquidity provider pays the floater holder par plus accrued interest. The trustee simultaneously terminates the trust and liquidates the bonds. The proceeds from this sale are used to first pay par plus accrued interest to the liquidity provider and then any accrued fees. Finally, the inverse floating-rate investor receives the residual value.

Several proprietary programs have been developed to market and sell plain-vanilla TOBs, which are used by mutual bond funds and insurance companies. Additionally, TOBs are used in more exotic combination trades by a few Wall Street structured products areas. Citigroup's proprietary program is referred to as "ROCs & ROLs." The short-term certificates are called *ROCs* or *Residual Option Certificates*. The inverse-floaters are called the *ROLs* or *Residual Option Longs*. Lehman's is called RIBS and Trust Receipts, and Morgan Stanley's proprietary program is called Municipal Trust Certificates.

THE COMMERCIAL CREDIT RATING OF MUNICIPAL BONDS

Of the municipal bonds that were rated by a commercial rating company in 1929 and plunged into default in 1932, 78% had been rated double-A or better, and 48% had been rated triple-A. Since then, the ability of rating agencies to assess the creditworthiness of municipal obligations has evolved to a level of general industry acceptance and respectability. In most instances, they adequately describe the financial conditions of the issuers and identify the credit-risk factors. However, a small but significant number of relatively recent instances have caused market participants to reexamine their reliance on the opinions of the rating agencies.

As examples, the troubled bonds of the Washington Public Power Supply System (WPPSS) and Orange County, California, should be mentioned. Two major commercial rating companies, Moody's and Standard & Poor's, gave their highest ratings to the WPPSS bonds in the early 1980s. Moody's gave the WPPSS Projects 1, 2, and 3 bonds its very highest credit rating of Aaa and the Projects 4 and 5 bonds its rating of Al. This latter investment-grade rating is defined as having the strongest investment attributes within the upper medium grade of creditworthiness. Standard & Poor's also had given the WPPSS Projects 1, 2, and 3 bonds its highest rating of AAA and Projects 4 and 5 bonds its rating of A+. While these high-quality ratings were in effect, WPPSS sold over $8 billion in long-term bonds. By 1990, over $2 billion of these bonds were in default.

Orange County, California, also had very strong credit ratings before its filing for bankruptcy protection on December 6, 1994. This would be the largest municipal bankruptcy filing in U.S. history. The Orange County debacle was unique. The county's problem was not caused by local economic problems, like Philadelphia's crisis in the early 1990s, nor was it caused by budget problems, like New York City's situation in 1975. Orange County's problem was created by the county Treasurer–Tax Collector's investment strategy for the Orange County Investment Pool. The investment pool was highly leveraged and contained a large percentage of inverse floaters. As interest rates rose in 1994, the value of the investments decreased, and the institutions that provided the financial leverage decided to terminate those financial agreements. The problem was that if the investment pool were liquidated, the amount of assets would be insufficient to cover all the loans. Since the pool did not have sufficient assets to cover its debt, the county chose to seek the safety of bankruptcy protection.

The county's voluntary bankruptcy filing was unprecedented. It was a signal to investors that the county did not necessarily intend to repay all its obligations. In most other cases of severe financial hardship, the municipalities tried to meet all their obligations and did not even suggest that they might wish not to fulfill their obligations. What troubled most investors was that Orange County was a vibrant and economically strong area and in all likelihood could fulfill its obligations. This created a different situation for investors and brought the question of an issuer's ability to pay versus its willingness to pay. This was something that municipal investors rarely, if ever, questioned before Orange County.

Another area investors rarely questioned prior to Orange County was the investment strategies that were being used to manage operating fund investments and other state and local investment funds or pools. It was a common perception that state and local government finance officials invested conservatively and followed policies that emphasized safety of principal and maintenance of liquidity. Immediately following the onset of the Orange County debacle, large investors started to question state and local officials on their investment policies and their use of financial leverage and derivative securities. Because Orange County received high-quality credit ratings prior to its problems, investors started to question the reliability of the commercial credit-rating agencies.

The Washington Public Power Supply System and Orange County, California, are the more notable issuers that had high-quality ratings prior to their problems, but they are not isolated instances. In fact, since 1975, all the major municipal defaults in the industry initially had been given investment-grade ratings by Moody's and Standard & Poor's. Of course, it should be noted that in the majority of instances, ratings of the commercial rating companies adequately reflect the condition of the credit. However, unlike 30 years ago when the commercial rating companies would not rate many kinds of revenue bond issues, today they seem to view themselves as assisting in the capital formation process.

Today, many large institutional investors, underwriters, and traders use the ratings of the commercial rating agencies as starting points and rely on their own in-house municipal credit analysts for determining the creditworthiness of municipal bonds. However, other investors do not perform their own credit-risk analysis but instead rely entirely on credit-risk ratings by Moody's and Standard & Poor's. In this section we discuss the rating categories of these two commercial rating companies.

We note that there is also a third, and smaller, commercial rating company, Fitch. It has enhanced its market presence and is particularly known in the industry for its health care and CCRC ratings, among others.

Moody's Investors Service

The municipal bond rating system used by Moody's grades the investment quality of municipal bonds in a nine-symbol system that ranges from the highest investment quality, which is Aaa, to the lowest credit rating, which is C. The respective nine alphabetical ratings and their definitions are found in Exhibit 11–1.

Municipal bonds in the top four categories (Aaa, Aa, A, and Baa) are considered to be of investment-grade quality. Additionally, bonds in the Aa through Caa categories are refined by numeric modifiers 1, 2 and 3, with 1 indicating the top third of the rating category, 2 the middle third, and 3 the bottom third. Moody's also may use the prefix *Con*. before a credit rating to indicate that the bond security is dependent on (1) the completion of a construction project, (2) earnings of a project with little operating experience, (3) rentals being paid once the facility is constructed, or (4) some other limiting condition.

The municipal note rating system used by Moody's is designated by investment-grade categories of Moody's Investment Grade (MIG), as shown in Exhibit 11–2.

Moody's also provides credit ratings for tax-exempt commercial paper. These are promissory obligations not having an original maturity in excess of nine months. Moody's uses three designations, all considered to be of investment grade, for indicating the relative repayment capacity of the rated issuers, as shown in Exhibit 11–3.

Standard & Poor's

The municipal bond rating system used by Standard & Poor's grades the investment quality of municipal bonds in a 10-symbol system that ranges from the

EXHIBIT 11–1

Moody's Municipal Bond Ratings

Rating	Definition
Aaa	Best quality; carry the smallest degree of credit risk
Aa	High quality; margins of protection not quite as large as the Aaa bonds
A	Upper medium grade; security adequate but could be susceptible to impairment
Baa	Medium grade; neither highly protected nor poorly secured—lack outstanding investment characteristics and sensitive to changes in economic circumstances
Ba	Speculative; protection is very moderate
B	Highly speculative; sensitive to day-to-day economic circumstances
Caa	Poor standing; may be in default but with recovery prospects
Ca	Likely to be in default with poor recovery prospects
C	In default with no recovery expected

EXHIBIT 11–2

Moody's Municipal Note Ratings*

Rating	Definition
MIG 1	Best quality
MIG 2	High quality
MIG 3	Adequate quality

*A short issue having a demand feature (i.e., payment relying on external liquidity and usually payable on demand rather than fixed maturity dates) is differentiated by Moody's with the use of the symbols *VMIG1* through *VMIG3*.

EXHIBIT 11–3

Moody's Tax-Exempt Commercial Paper Ratings

Rating	Definition
Prime 1 (P-1)	Superior capacity for repayment
Prime 2 (P-2)	Strong capacity for repayment
Prime 3 (P-3)	Acceptable capacity for repayment

EXHIBIT 11–4

Standard & Poor's Municipal Bond Ratings

Rating	Definition
AAA	Highest rating; extremely strong security
AA	Very strong security; differs from AAA in only a small degree
A	Strong capacity but more susceptible to adverse economic effects than two above categories
BBB	Adequate capacity but adverse economic conditions more likely to weaken capacity
BB	Lowest degree of speculation; risk exposure
B	Speculative; risk exposure
CCC	Speculative; major risk exposure
CC	Highly vulnerable to nonpayment
C	Bankruptcy petition may be filed
D	Bonds in default with interest and/or repayment of principal in arrears

highest investment quality, which is AAA, to the lowest credit rating, which is D. Bonds within the top four categories (AAA, AA, A, and BBB) are considered by Standard & Poor's as being of investment-grade quality. The respective 10 alphabetical ratings and definitions are shown in Exhibit 11–4.

Standard & Poor's also uses a plus (+) or minus (–) sign to show relative standing within the rating categories ranging from AA to CCC. Additionally, Standard & Poor's uses the letter *p* to indicate a provisional rating that is intended to be removed on the successful and timely completion of the construction project. The r denotes issues that Standard & Poor's believes may experience high volatility in expected return due to noncredit risks. Such issues could be derivatives or hybrid securities.

The municipal note rating system used by Standard & Poor's grades the investment quality of municipal notes in a four-symbol system that ranges from highest investment quality, SP-1+, to the lowest credit rating, SP-3. Notes within the top three categories (i.e., SP-1+, SP-1, and SP-2) are considered by Standard & Poor's as being of investment-grade quality. The respective ratings and summarized definitions are shown in Exhibit 11–5.

Standard & Poor's also rates tax-exempt commercial paper in the same four categories as taxable commercial paper. The four tax-exempt commercial paper rating categories are shown in Exhibit 11–6.

Fitch

A third, and smaller, rating company is Fitch. The alphabetical ratings and definitions used by Fitch are given in Exhibit 11–7. Plus (+) and minus (–) signs are

EXHIBIT 11–5

Standard & Poor's Municipal Note Ratings

Rating	Definition
SP-1	Strong capacity to pay principal and interest. Those issues determined to possess overwhelming safety characteristic will be given a plus (+) designation.
SP-2	Satisfactory capacity to pay principal and interest.
SP-3	Speculative capacity to pay principal and interest.

EXHIBIT 11–6

Standard & Poor's Tax-Exempt Commercial Paper Ratings

Rating	Definition
A-1+	Extremely strong degree of safety
A-1	Strong degree of safety
A-2	Satisfactory degree of safety
A-3	Adequate degree of safety
B	Speculative capacity for timely payment
C	Doubtful capacity for payment
D	Used when principal or interest payments are not made on the due date

EXHIBIT 11–7

Fitch Municipal Bond Ratings

Rating	Definition
AAA	Highest credit quality
AA	Very high credit quality
A	High credit quality
BBB	Good
BB	Speculative
B	Highly speculative
CCC	High default risk
CC	High default risk
C	High default risk
DDD, DD, D	In default

used with a rating to indicate the relative position of a credit within the rating category. Plus and minus signs are not used for the AAA category.

MUNICIPAL BOND INSURANCE

Using municipal bond insurance is one way to help reduce credit risk within a portfolio. Insurance on a municipal bond is an agreement by an insurance company to pay debt service that is not paid by the bond issuer. Municipal bond insurance contracts insure the payment of debt service on a municipal bond to the bondholder. That is, the insurance company promises to pay the issuer's obligation to the bondholder if the issuer does not do so.

The insurance usually is for the life of the issue. If the trustee or investor has not had his bond paid by the issuer on its due date, he notifies the insurer and presents the defaulted bond and coupon. Under the terms of the insurance contract, the insurer generally is obligated to pay sufficient monies to cover the value of the defaulted insured principal and coupon interest when they come due.

Because municipal bond insurance reduces the credit risk for the investor, the marketability of certain municipal bonds can be greatly expanded. Municipal bonds that benefit most from the insurance would include lower-quality bonds, bonds issued by smaller governmental units not widely known in the financial community, bonds that have a sound though complex and difficult-to-understand security structure, and bonds issued by infrequent local government borrowers who do not have a general market following among investors.

Of course, a major factor for an issuer to obtain bond insurance is that its creditworthiness without the insurance is substantially lower than what it would be with the insurance. That is, the interest cost savings are only of sufficient magnitude to offset the cost of the insurance premium when the underlying creditworthiness of the issuer is lower. There are two major groups of municipal bond insurers. The first includes the "monoline" companies that are primarily in the business of insuring financial securities, including municipal bonds. Almost all the companies that are now insuring municipal bonds can be characterized as monoline in structure. The second group of municipal bond insurers includes the "multiline" property and casualty companies that usually have a wide base of business, including insurance for fires, collisions, hurricanes, and health problems. Most new issues in the municipal bond market today are insured by the monoline insurers described below. By the year 2004, over 50% of all new issues came with bond insurance.

The monoline companies are primarily in the business of insuring financial securities, and their respective assets, as determined in various state statutes and administrative rulings, are dedicated to paying bond principal and interest claims. The active insurers are AMBAC Assurance Corporation (AMBAC), Financial Guaranty Insurance Company (FGIC), Financial Security Assurance (FSA), MBIA Insurance Corporation, and XL Capital Assurance, Inc.

It is commonly understood that when referring to insured bonds, you are also referring to bonds that receive a triple-A rating owing to the presence of the insurance coverage. However, in the future, the marketplace might need to refine this notion. In 1997, ACA Financial Guaranty Corp. was started and became the first A-rated bond insurer. ACA focuses mostly on the domestic finance and asset-backed sectors. This event has the potential to change the market in terms of broadening the quality range of issuers that can use insurance as a credit enhancement. Sub-investment-grade, particularly double-B rated, issuers and nonrated issuers now have access to insurance and greater access to the capital markets. Radian Asset Assurance, Inc., (double-A) also has provided underwriting capacity to non-investment-grade and nonrated issuers.

VALUATION METHODS

The traditional method for evaluating municipal bonds is relatively straightforward. First, an investor determines the maturity of the bond, considers the offered price (discount, par, or premium), evaluates any call features or sinking funds and then considers credit quality. If it is a premium bond and callable, then the investor places more emphasis on the call dates. If the bond is callable and sells at a discount, then the calls are not much of a factor, and the bond is valued using its maturity date. Basically, the investor is determining the relative attractiveness of the bond based on a yield-to-worst calculation. The credit quality is quantified, and the appropriate yield premium for the specific credit quality is added to the base yield-to-worst calculation. Since investors do not perform an option-adjusted spread analysis (OAS), the yield premium that is applied is a nominal yield premium. The benchmark yields that are used to value the bonds come from a variety of sources, such as yield levels from the primary market, trading levels of similar bonds in the secondary market, and benchmark (triple-A GO, generic sector, state-specific) interest-rate curves.

An investor interested in purchasing a municipal bond must be able to compare the promised yield on a municipal bond with that of a comparable taxable bond. Employing the yield computed with traditional approaches, the following general formula is used to determine the *equivalent taxable yield* for a tax-exempt bond:

$$\text{Equivalent taxable yield} = \frac{\text{tax-exempt yield}}{(1 - \text{marginal tax rate})}$$

For example, suppose that an investor in the 40% marginal tax bracket is considering the acquisition of a tax-exempt bond that offers a tax-exempt yield of 6%. The equivalent taxable yield is 10%, as shown below:

$$\text{Equivalent taxable yield} = \frac{0.06}{(1 - 0.40)} = 0.10 = 10\%$$

When computing the equivalent taxable yield, the traditionally computed yield-to-maturity is not the tax-exempt yield if the issue is selling below par (i.e., selling at a discount) because only the coupon interest is exempt from federal income taxes. Instead, the yield-to-maturity after an assumed capital gains tax is computed and used in the numerator of the formula.

The yield-to-maturity after an assumed capital gains tax is calculated in the same manner as the traditional yield-to-maturity. However, instead of using the redemption value in the calculation, the net proceeds after an assumed tax on any capital gain are used.

There is a major drawback in employing the equivalent taxable yield formula to compare the relative investment merits of a taxable and tax-exempt bond. Recall from the discussion in Chapter 4 that the yield-to-maturity measure assumes that the entire coupon interest can be reinvested at the computed yield. Consequently, taxable bonds with the same yield-to-maturity cannot be compared because the total dollar returns may differ from the computed yield. The same problem arises when attempting to compare taxable and tax-exempt bonds, especially because only a portion of the coupon interest on taxable bonds can be reinvested, although the entire coupon payment is available for reinvestment in the case of municipal bonds. The total return framework that should be employed to compare taxable and tax-exempt bonds is discussed in Chapter 4.

The traditional method of evaluating a municipal bond leaves much to be desired. The basic problem is that the call risk is not analyzed properly. The yield-to-worst calculation ignores the fact that interest rates can change in the future, and the actual timing of the cash flows may not be the same as what was projected. If an investor evaluates a bond to its maturity date, then this investor will be surprised if the bonds are called several years earlier. Conversely, if the investor evaluates a bond to a specific call date and the bond is not called, then this investor will realize a stream of cash flows that is different from what was anticipated. The result of the traditional methodology is that most callable municipal bonds are priced too richly, and the cost of noncallable bonds with extra convexity is cheap. This is especially true for longer-dated bonds. More information about OAS analysis can be found in Chapter 37.

TAX PROVISIONS AFFECTING MUNICIPALS

Federal tax rate levels affect municipal bond values and strategies employed by investors. There are three provisions in the Internal Revenue Code that investors in municipal securities should recognize. These provisions deal with the tax treatment of OIDs, alternative minimum tax, and the deductibility of interest expense incurred to acquire municipal securities. Moreover, there are state and local taxes that an investor must be aware of.

Tax Treatment of OIDs

When purchasing OIDs in the secondary market, investors should analyze the bond carefully owing to the complex tax treatment of OIDs. Few investors think about tax implications when investing in municipal debt. After all, the interest earned on most municipal bonds is exempt from federal taxes and in many cases state and local taxes. If investors do think about taxes, they probably think about selling bonds at a higher price than the original tax cost. Most investors believe that this would create a capital gain and absent this situation there should be no tax impact. Sounds straightforward, but the municipal world isn't simplistic. Several years ago the marketplace was introduced to the Revenue Reconciliation Act of 1993, and since then, investing in municipals has become more complex. Currently, profit from bonds purchased in the secondary market after April 30, 1993, could be free from any tax implications or taxed at the capital gains rate, ordinary income rate, or a combination of the two rates. To understand this situation, it is essential to understand the rule of de minimis.

In basic terms, the *rule of de minimis* states that a bond is to be discounted up to 0.25% from the face value for each remaining year of a bond's life before it is affected by ordinary income taxes. This price is commonly referred to as the "market discount cutoff price." If the bond is purchased at a market discount but the price is higher than the market discount cutoff price, then any profits will be taxed at the capital gains rate. If the purchase price is lower than the market discount cutoff price, then any profits may be taxed as ordinary income or a combination of the ordinary income rate and the capital gains rate. The exact tax burden depends on several factors.

The rule of de minimis is especially complicated for OID bonds. For these bonds, a revised issue price must be calculated, as well as the market discount cutoff price. The revised issue price does change over time because the OID must be accreted over the life of the bond. The rule of de minimis does not apply to the OID segment, but it does apply to the market discount segment. The market discount segment is equal to the purchase price (secondary market price) minus the revised issue price. If an OID bond is purchased in the secondary market at a price greater than the revised issue price, the bond is considered to have an acquisition premium, and the rule of de minimis does not apply. If the OID bond is purchased at a price below the revised issue price and above the market discount cutoff price, then the OID bond is purchased at a market discount, and any profits will be taxed at the capital gains rate. Finally, if the purchase price of the OID bond is lower than the market discount cutoff price, then any profits may be taxed as ordinary income or a combination of the ordinary income rate and the capital gains rate. The exact tax burden depends on several factors. The OID topic is complicated. More specific details can be found in the Internal Revenue Service (IRS) Publications 550 and 1212.[3]

3. Also, several articles on the topic, such as Bloomberg's "Taxing Tax-Exempt Bonds" (May 1995), are available.

Alternative Minimum Tax

Alternative minimum taxable income (AMTI) is a taxpayer's taxable income with certain adjustments for specified tax preferences designed to cause AMTI to approximate economic income. For both individuals and corporations, a taxpayer's liability is the greater of (1) the tax computed at regular tax rates on taxable income and (2) the tax computed at a lower rate on AMTI. This parallel tax system, the alternative minimum tax (AMT), is designed to prevent taxpayers from avoiding significant tax liability as a result of taking advantage of exclusions from gross income, deductions, and tax credits otherwise allowed under the Internal Revenue Code.

There are different rules for determining AMTI for individuals and corporations. The latter are required to calculate their minimum tax liability using two methods. Moreover, there are special rules for property and casualty companies.

One of the tax preference items that must be included is certain tax-exempt municipal interest. As a result of the AMT, the value of the tax-exempt feature is reduced. However, the interest of some municipal issues is not subject to the AMT. Under the current tax code, tax-exempt interest earned on all private activity bonds issued after August 7, 1986, must be included in AMTI. There are two exceptions. First, interest from bonds that are issued by 501(c)(3) organizations (i.e., not-for-profit organizations) is not subject to AMTI. The second exception is interest from bonds issued for the purpose of refunding if the original bonds were issued before August 7, 1986. The AMT does not apply to interest on governmental or nonprivate activity municipal bonds. An implication is that the issues subjected to the AMT will trade at a higher yield than those exempt from AMT.

Deductibility of Interest Expense Incurred to Acquire Municipals

Some investment strategies involve the borrowing of funds to purchase or carry securities. Ordinarily, interest expense on borrowed funds to purchase or carry investment securities is tax deductible. There is one exception that is relevant to investors in municipal bonds. The IRS specifies that interest paid or accrued on "indebtedness incurred or continued to purchase or carry obligations, the interest on which is wholly exempt from taxes," is not tax deductible. It does not make any difference if any tax-exempt interest is actually received by the taxpayer in the taxable year. In other words, interest is not deductible on funds borrowed to purchase or carry tax-exempt securities.

Special rules apply to commercial banks. At one time, banks were permitted to deduct all the interest expense incurred to purchase or carry municipal securities. Tax legislation subsequently limited the deduction first to 85% of the interest expense and then to 80%. The 1986 tax law eliminated the deductibility of the interest expense for bonds acquired after August 6, 1986. The exception to this nondeductibility of interest expense rule is for *bank-qualified issues.* These are tax-exempt obligations sold by small issuers after August 6, 1986, and purchased by the bank for its investment portfolio.

An issue is bank-qualified if (1) it is a tax-exempt issue other than private activity bonds, but including any bonds issued by 501(c)(3) organizations, and (2) it is designated by the issuer as bank-qualified and the issuer or its subordinate entities reasonably do not intend to issue more than $10 million of such bonds. A nationally recognized and experienced bond attorney should include in the opinion letter for the specific bond issue that the bonds are bank-qualified.

State and Local Taxes

The tax treatment of municipal bonds varies by state. There are three types of taxes that can be imposed: (1) an income tax on coupon income, (2) a tax on realized capital gains, and (3) a personal property tax.

Many states levy an individual income tax. Coupon interest from obligations by in-state issuers is exempt from state individual income taxes in most states. A few states levy individual income taxes on coupon interest whether the issuer is in state or out of state.

State taxation of realized capital gains is often ignored by investors when making investment decisions. In many states, a tax is levied on a base that includes income from capital transactions (i.e., capital gains or losses). In many states where coupon interest is exempt if the issuer is in state, the same exemption will not apply to capital gains involving municipal bonds.

Some states levy a personal property tax on municipal bonds. The tax resembles more of an income tax than a personal property tax. Before 1995, some state and local governments levied this tax on residents who owned municipal bonds where the issuer of the bond was located outside the investor's home state. While residents owning municipal bonds where the issuer was located within the investor's home state's boundaries were exempt from such tax, this tax was declared unconstitutional by the U.S. Supreme Court because it violated the federal commerce clause by favoring in-state businesses over out-of-state business. The determining case was *Fulton Corporation* v. *Janice H. Faulkner, Secretary of Revenue of North Carolina,* No. 94-1239 (U.S. S.C. Feb. 21, 1996). After the court ruled on this case, many state and local governments that levied a similar tax repealed the tax or chose not to collect it.

In determining the effective tax rate imposed by a particular state, an investor must consider the impact of the deductibility of state taxes on federal income taxes. Moreover, in some states, *federal* taxes are deductible in determining state income taxes.

YIELD RELATIONSHIPS WITHIN THE MUNICIPAL BOND MARKET

Differences within an Assigned Credit Rating

Bond buyers primarily use the credit ratings assigned by the commercial rating companies, Standard & Poor's and Moody's, as a starting point for pricing an issue. The final market-derived bond price is determined by the assigned credit rating and adjustments by investors to reflect their own analysis of creditworthiness and perception of marketability. For example, insured municipal bonds tend to have yields that are substantially higher than noninsured superior-investment-quality municipal bonds, even though most insured bonds are given triple-A ratings by the commercial rating companies. Additionally, many investors have geographic preferences among bonds despite identical credit quality and otherwise comparable investment characteristics.

Differences between Credit Ratings

With all other factors constant, the greater the credit risk perceived by investors, the higher is the return expected by investors. The spread between municipal bonds of different credit quality is not constant over time. Reasons for the change in spreads are (1) the outlook for the economy and its anticipated impact on issuers, (2) federal budget financing needs, and (3) municipal market supply-and-demand factors. During periods of relatively low interest rates, investors sometimes increase their holdings of issues of lower credit quality in order to obtain additional yield. This narrows the spread between high-grade and lower-grade credit issues. During periods in which investors anticipate a poor economic climate, there is often a "flight to quality" as investors pursue a more conservative credit-risk exposure. This widens the spread between high-grade and lower-grade credit issues.

Another factor that causes shifts in the spread between issues of different quality is the temporary oversupply of issues within a market sector. For example, a substantial new issue volume of high-grade state general obligation bonds may tend to decrease the spread between high-grade and lower-grade revenue bonds. In a weak market environment, it is easier for high-grade municipal bonds to come to market than for weaker credits. Therefore, it is not uncommon for high grades to flood weak markets at the same time that there is a relative scarcity of medium- and low-grade municipal bond issues.

Differences between In-State and General Market

Bonds of municipal issuers located in certain states (e.g., New York, California, Arizona, Maryland, and Pennsylvania) usually yield considerably less than issues of identical credit quality that come from other states that trade in the "general market." There are three reasons for the existence of such spreads. First, states often exempt interest from in-state issues from state and local personal income taxes. Interest from out-of-state issues is generally not exempt. Consequently, in states with high income taxes (e.g., New York and California), strong investor demand for in-state issues will reduce their yields relative to bonds of issues located in states where state and local income taxes are not important considerations (e.g., Illinois and Wisconsin). Second, in some states, public funds deposited in banks must be collateralized by the bank accepting the deposit. This requirement is referred to as "pledging." Acceptable collateral for pledging typically will include issues of certain in-state issuers. For those qualifying issues, pledging tends to increase demand (particularly for the shorter maturities) and reduce yields relative to nonqualifying comparable issues. The third reason is that investors in some states exhibit extreme reluctance to purchase issues from issuers outside their state or region. In-state parochialism tends to decrease relative yields of issues from states in which investors exhibit this behavior.

Differences between Maturities

One determinant of the yield on a bond is the number of years remaining to maturity. As explained in Chapter 7, the yield curve depicts the relationship at a given point in time between yields and maturity for bonds that are identical in every way except maturity. When yields increase with maturity, the yield curve is said to be *normal* or *have a positive slope.* Therefore, as investors lengthen their maturity, they require a greater yield. It is also possible for the yield curve to be *inverted,* meaning that long-term yields are less than short-term yields. If short-, intermediate-, and long-term yields are roughly the same, the yield curve is said to be *flat*.

In the taxable bond market, it is not unusual to find all three shapes for the yield curve at different points in the business cycle. However, in the municipal bond market, the yield curve typically is normal or upward-sloping. Consequently, in the municipal bond market, long-term bonds generally offer higher yields than short- and intermediate-term bonds.

Insured Municipal Bonds

In general, although insured municipal bonds sell at yields lower than they would without the insurance, they tend to have yields that are higher than other Aaa/AAA-rated bonds, such as deep-discount refunded bonds. Of course, supply-and-demand forces and in-state taxation factors can distort market trading patterns from time to time. Insured bonds as a generic group may not be viewed as having the same superior degree of safety as either refunded bonds secured with escrowed U.S. Treasuries or those general obligation bonds of states that have robust and growing economies, fiscally conservative budgetary operations, and very low debt burdens.

PRIMARY AND SECONDARY MARKETS

The municipal market can be divided into the primary market and the secondary market. The primary market is where all new issues of municipal bonds are sold for the first time. The secondary market is the market where previously issued municipal securities are traded.

Primary Market

A substantial number of municipal obligations are brought to market each week. A state or local government can market its new issue by offering bonds publicly to the investing community or by placing them privately with a small group of investors. When a public offering is selected, the issue usually is underwritten by investment bankers or municipal bond departments of commercial banks. Public offerings may be marketed by either competitive bidding or direct negotiations with underwriters. When an issue is marketed via competitive bidding, the issue is awarded to the bidder submitting the best bid.

Most states mandate that general obligation issues be marketed through competitive bidding, but generally this is not required for revenue bonds. Usually state and local governments require a competitive sale to be announced in a recognized financial publication, such as *The Bond Buyer,* which is the trade publication for the municipal bond industry. *The Bond Buyer* also provides information on upcoming competitive sales and most negotiated sales, as well as the results of previous weeks.

Secondary Market

Municipal bonds are traded in the over-the-counter markets supported by municipal bond dealers across the country. Markets are maintained on smaller issuers (referred to as *local credits)* by regional brokerage firms, local banks, and some of the larger Wall Street firms. Larger issuers (referred to as *general market names)* are supported by the larger brokerage firms and banks, many of which have investment banking relationships with these issuers. There are brokers who serve as intermediaries in the sale of large blocks of municipal bonds among dealers and large institutional investors. Additionally, beginning in 2000, bonds in the secondary market, as well as some new issue competitive and negotiated bond issues, began to be auctioned and sold over the Internet by large and small broker-dealers to institutional and individual investors.

In the municipal bond markets, an odd lot of bonds is $25,000 or less in par value for retail investors. For institutions, anything below $100,000 in par value is considered an odd lot. Dealer spreads depend on several factors. For the retail investor, the spread can range from as low as one-quarter of one point ($12.50 per $5,000 of par value) on large blocks of actively traded bonds to four points ($200 per $5,000 of par value) for odd-lot sales of an inactive issue. For retail investors, the typical commission should be between $1\frac{1}{2}$ and $2\frac{1}{2}$ points. For institutional investors, the dealer spread rarely exceeds one-half of 1 point ($25 per $5,000 of par value).

The convention for both corporate and Treasury bonds is to quote prices as a percentage of par value, with 100 equal to par. Municipal bonds, however, generally are traded and quoted in terms of yield (yield-to-maturity or yield-to-call). The price of the bond in this case is called a *basis price.* Certain long-maturity revenue bonds are exceptions. A bond traded and quoted in dollar prices (actually, as a percentage of par value) is called a *dollar bond.*

It should be noted that many institutional investors, for trading and bond purchasing purposes, price bonds off the MMD scale. This is a daily index of generic "AAA's" prices covering the full yield curve provided by Thomson Financial and available to subscribers over the Internet. Also, the Municipal Securities Rulemaking Board (MSRB) in Washington, D.C., reports on a daily basis for no charge actual trades and prices of specific bonds. The Internet address is www.investinginbonds.com, which is the home page of the Bond Market Association (BMA), the trade association for the sell side.

BOND INDEXES

The major provider of total return–based indexes to institutional investors is Lehman Brothers. Investors use the Lehman Brothers Municipal Index to measure relative total return performance and to enhance a fund manager's ability to outperform the market. Lehman began publishing municipal indexes in January of 1980 and by 2005 compiles returns and statistics on over 2,500 benchmarks. They are broad-based performance measures for the tax-exempt bond market. Similar to all bond indexes provided by Lehman Brothers, the municipal indexes are rules based and market value weighted. As of January 2005, the Lehman Investment Grade Municipal Bond Index contained more than 33,000 bonds with a market value of about $850 billion. To be included in the index, bonds must have a minimum credit rating of Baa/BBB. They must have an outstanding par value of at least $7 million and be part of a transaction of $75 million or greater. The bonds must have been issued after December 31, 1990, and have a remaining maturity of at least one year.

In addition to investment-grade indexes, Lehman Brothers offers total return benchmarks for the non-investment-grade tax-exempt market. To ensure statistically significant, representative benchmarks for the lower capitalized states, Lehman provides state-specific municipal benchmarks with reduced liquidity requirements.

Many investors use Lehman indexes as performance measures for a given market or market segment. The benchmarks are also employed to identify and quantify portfolio bets versus the general market and/or a given peer group.

Indexes also are used to identify relative value opportunities as well as a proxy for the outstanding market. Given the consistent methodologies, the Lehman indexes are used often when comparing tax-exempt and taxable fixed income markets.

OFFICIAL STATEMENT

An official statement describing the issue and the issuer is prepared for new offerings. Often a preliminary official statement is issued prior to the final official statement. These statements are known as the OS and POS. These statements provide potential investors with a wealth of information. The statements contain basic information about the amount of bonds to be issued, maturity dates, coupons, the use of the bond proceeds, the credit ratings, a general statement about the issuer, and the name of the underwriter and members of the selling group. Much of this information can be found on the cover page or in the first few pages of the official statement. It also contains detailed information about the security and sources of payments for the bonds, sources and uses of funds, debt-service requirements, relevant risk factors, issuer's financial statements, a summary of the bond indenture, relevant agreements, notice of any known existing or pending litigation, the bond insurance policy specimen (if insured), and the form of opinion of bond counsel. The official statement contains most of the information an investor will need to make an informed and educated investment decision.

REGULATION OF THE MUNICIPAL SECURITIES MARKET

As an outgrowth of abusive stock market practices, Congress passed the Securities Act of 1933 and the Securities Exchange Act of 1934. The 1934 act created the Securities and Exchange Commission (SEC), granting it regulatory authority over the issuance and trading of *corporate* securities. Congress specifically exempted municipal securities from both the registration requirements of the 1933 act and the periodic reporting requirements of the 1934 act. However, antifraud provisions did apply to offerings of or dealings in municipal securities.

The exemption afforded municipal securities appears to have been due to (1) the desire for governmental comity, (2) the absence of recurrent abuses in transactions involving municipal securities, (3) the greater level of sophistication of investors in this segment of the securities markets (i.e., institutional investors dominated the market), and (4) the fact that there were few defaults by municipal issuers. Consequently, from the enactment of the two federal securities acts in the early 1930s to the early 1970s, the municipal securities market can be characterized as relatively free from federal regulation.

In the early 1970s, however, circumstances changed. As incomes rose, individuals participated in the municipal securities market to a much greater extent. As a result, public outcries over selling practices occurred with greater frequency. For example, in the early 1970s, the SEC obtained seven injunctions against 72 defendants for fraudulent municipal trading practices. According to the SEC, the abusive practices involved both disregard by the defendants as to whether the particular municipal bonds offered to individuals were in fact appropriate investment vehicles for the individuals to whom they were offered, and misrepresentation—failure to disclose information necessary for individuals to assess the credit risk of the municipal issuer, especially in the case of revenue bonds. Moreover, the financial problems of some municipal issuers, notably New York City, made market participants aware that municipal issuers have the potential to experience severe and bankruptcy-type financial difficulties.

Congress passed the Securities Act Amendment of 1975 to broaden regulation in the municipals market. The legislation brought brokers and dealers in the municipal securities market, including banks that underwrite and trade municipal securities, within the regulatory scheme of the Securities Exchange Act of 1934. In addition, the legislation mandated that the SEC establish a 15-member Municipal Securities Rulemaking Board (MSRB) as an independent, self-regulatory agency whose primary responsibility is to develop rules governing the activities of banks, brokers, and dealers in municipal securities. Rules adopted by the MSRB must be approved by the SEC. The MSRB has no enforcement or inspection authority. This authority is vested with the SEC, the National Association of Securities Dealers, and certain regulatory banking agencies such as the Federal Reserve banks. The Securities Act Amendment of 1975 does *not* require that municipal issuers comply with the registration requirement of the 1933 act or the periodic-reporting requirement of the 1934 act. There have been, however, several legislative proposals to mandate financial disclosure. Although none has been passed, there is clearly pressure to improve disclosure. Even in the absence of federal legislation dealing with the regulation of financial disclosure, underwriters began insisting on greater disclosure as it became apparent that the SEC was exercising stricter application of the antifraud provisions. Moreover, underwriters recognized the need for improved disclosure to sell municipal securities to an investing public that has become much more concerned about credit risk by municipal issuers. On June 28, 1989, the SEC formally approved the first bond disclosure rule, effective January 1, 1990. The following paragraphs summarize its contents. The rule applies to all new issue municipal securities offerings of $1 million or more. Exemptions have been added for securities offered in denominations of $100,000 or more, if such securities

- Are sold to no more than 35 “sophisticated investors”
- Have a maturity of nine months or less
- Are variable-rate demand instruments

Before bidding on or purchasing an offering, underwriters must obtain and review official statements that are deemed final by the issuer, with the omission of no more than the following information:

- Offering price
- Interest rate

- Selling compensation
- Aggregate principal amount
- Principal amount per maturity
- Delivery dates
- Other terms or provisions required by an issuer of such a security to be specified in a competitive bid, ratings, other terms of the securities depending on such matters, and the identity of the underwriters

The underwriters shall contract with an issuer or its designated agent to receive copies of a final official statement within seven business days after any final agreement to purchase, offer, or sell any offering and in sufficient time to accompany any confirmation that requests payment from any customer.

Except for competitively bid offerings, the underwriters shall send, no later than the next business day, to any potential customer, on request, a single copy of the most recent preliminary official statement, if any.

Underwriters are required to distribute the final official statement to any potential customer, on request, within 90 days, or 25 days if the final official statement is available from a repository.

Material Event Disclosure under SEC Rule 15c2-12

The first phase of the implementation of amendments to Rule 15c2-12, which took effect on July 3, 1995, required dealers to determine that issuers before issuing new municipal bonds made arrangements to disclose in the future financial information *at least* annually as well as notices of the occurrence of any of 11 material events as specified in the rule. This resulted in the creation of state information depositories (SIDs) and municipal securities information repositories (NRMSIRs) to which issuers are to deliver annual information and notices. The SIDs and NRMSIRs make this information available to the public. The second phase went into effect on January 1, 1996, and required dealers to have in-house procedures in place to provide reasonable assurance that they will receive prompt notice of the any material that is required to be disclosed by the issuers.

The SEC and High-Yield Bond Price Data

In March 2004 it was reported that the Office of Compliance, Inspections and Examinations of the SEC has been demanding from high-yield municipal bond fund managers information concerning pricing practices and details of relationships with pricing services and broker-dealers. The investigation began after "pricing failures" occurred at two Heartland Advisors, Inc., high-yield municipal bond funds in 2001. In the Heartland case, the SEC contends that illiquid bonds were overvalued and securities mispriced to the detriment of investors.[4]

The National Federation of Municipal Analysts

The National Federation of Municipal Analysts (NMFA) was established in 1983 and by 2004 had a membership of 1,000 municipal professionals, drawing in part from the institutional investors in municipal bonds who advocated increased and timely information for investors. By mid-2004, its committees have developed detailed disclosure guidelines and risk factors in municipal securities ranging from specific credit sectors to swap structures. They are recommended for municipal bond issuers to use in providing ongoing financial and operating information to investors.

4. "SEC Seeks High-Yield Price Data" *The Bond Buyer* (March 18, 2004), pp. 1, 36.

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CHAPTER
TWELVE

PRIVATE MONEY MARKET INSTRUMENTS

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Historically, the *money market* has been defined as the market for assets maturing in one year or less. The assets traded in this market include Treasury bills, commercial paper, some medium-term notes, bankers acceptances, federal agency discount paper, short-term municipal obligations, certificates of deposit, repurchase agreements, floating-rate instruments, and federal funds. Although several of these assets have maturities greater than one year, they are still classified as part of the money market.

In Chapter 10, Treasury bills are discussed. In this chapter we will cover private money market instruments: commercial paper, bankers acceptances, certificates of deposit, repurchase agreements, and federal funds. Medium-term notes have maturities ranging from nine months to 30 years. These securities are discussed in Chapter 14.

COMMERCIAL PAPER

A corporation that needs long-term funds can raise those funds in either the equity or bond market. If, instead, a corporation needs short-term funds, it may attempt to acquire those funds via bank borrowing. An alternative to bank borrowing is commercial paper. *Commercial paper* is short-term unsecured promissory notes issued in the open market as an obligation of the issuing entity.

The commercial paper market once was limited to entities with strong credit ratings, but in recent years, some lower-credit-rated corporations have issued commercial paper by obtaining credit enhancements or other collateral to allow them to enter the market as issuers. Issuers of commercial paper are not restricted to U.S. corporations. Non-U.S. corporations and sovereign issuers also issue commercial paper.

Although the original purpose of commercial paper was to provide short-term funds for seasonal and working capital needs, it has been issued for other purposes in recent years, frequently for "bridge financing." For example, suppose that a corporation needs long-term funds to build a plant or acquire equipment. Rather than raising long-term funds immediately, the issuer may elect to postpone the offering until more favorable capital market conditions prevail. The funds raised by issuing commercial paper are used until longer-term securities are sold. Commercial paper has been used as bridge financing to finance corporate takeovers.[1]

The maturity of commercial paper is typically less than 270 days; the most common maturity is less than 45 days.[2] There are reasons for this. First, the Securities Act of 1933 requires that securities be registered with the Securities and Exchange Commission (SEC). Special provisions in the 1933 act exempt commercial paper from registration so long as the maturity does not exceed 270 days. To avoid the costs associated with registering issues with the SEC, issuers rarely issue commercial paper with a maturity exceeding 270 days. To pay off holders of maturing paper, issuers generally issue new commercial paper. Another consideration in determining the maturity is whether the paper would be eligible collateral by a bank if it wanted to borrow from the Federal Reserve Bank's discount window. In order to be eligible, the maturity of the paper may not exceed 90 days. Because eligible paper trades at a lower cost than paper that is not eligible, issuers prefer to issue paper whose maturity does not exceed 90 days.

The risk that the investor faces is that the borrower will be unable to issue new paper at maturity. As a safeguard against "rollover risk," commercial paper issuers secure backup lines of credit sometimes called *liquidity enhancements*. Most commercial issuers maintain 100% backing because the credit rating agencies that rate commercial paper (Fitch, Moody's, and Standard & Poor's) usually require a bank line of credit as a precondition for a rating.

Investors in commercial paper are institutional investors. Money market mutual funds purchase roughly one-third of all the commercial paper issued. Pension funds, commercial bank trust departments, state and local governments, and nonfinancial corporations seeking short-term investments purchase the balance. The minimum round-lot transaction is $100,000. Some issuers will sell commercial paper in denominations of $25,000.

1. Commercial paper also has been used as an integral part of an interest-rate swap transaction. We discuss interest-rate swaps in Chapter 55.
2. See Frank J. Fabozzi, Steven V. Mann, and Moorad Choudhry, *The Global Money Market* (Hoboken, NJ: John Wiley & Sons, 2002).

Issuers of Commercial Paper

Corporate issuers of commercial paper can be divided into financial companies and nonfinancial companies. The majority of commercial paper outstanding was issued by financial companies. As of June 1997, financial firms issued 78% of all commercial paper outstanding.[3]

There are three types of financial companies: captive finance companies, bank-related finance companies, and independent finance companies. Captive finance companies are subsidiaries of equipment-manufacturing companies. Their primary purpose is to secure financing for the customers of the parent company. Major automobile manufacturers, for example, have captive finance companies: General Motors Acceptance Corporation (GMAC), Ford Motor Credit, and American Honda Finance. GMAC is by the far the largest issuer of commercial paper in the United States. Another captive finance company, General Electric Capital Corporation, is a major issuer of commercial paper. Bank holding companies may have a finance company subsidiary that provides loans to individuals and businesses to acquire a wide range of products. Independent finance companies are those that are not subsidiaries of equipment-manufacturing firms or bank holding companies.

Although the typical issuers of commercial paper are those with high credit ratings, smaller and less well-known companies with lower credit ratings have been able to issue paper in recent years. They have been able to do so by means of credit support from a firm with a high credit rating (such paper is called *credit-supported commercial paper*) or by collateralizing the issue with high-quality assets (such paper is called *asset-backed commercial paper*). An example of credit-supported commercial paper is an issue supported by a letter of credit. The terms of such a letter of credit specify that the bank issuing it guarantees that the bank will pay off the paper when it comes due if the issuer fails to. Banks charge a fee for letters of credit. From the issuer's perspective, the fee enables it to enter the commercial paper market and obtain funding at a lower cost than bank borrowing. Paper issued with this credit enhancement is referred to as *LOC paper.* The credit enhancement also may take the form of a surety bond from an insurance company.[4] Asset-backed commercial paper is issued by large corporations through special-purpose vehicles that pool the assets and issue the securities. The assets underlying these securities consist of credit card receivables, auto and equipment leases, healthcare receivables, and even small business loans.

Directly Placed versus Dealer-Placed Paper

Commercial paper is classified as either direct paper or dealer paper. *Direct paper* is sold by the issuing firm directly to investors without using a securities dealer

3. See Dusan Stojanovic and Mark D. Vaughan, "Who's Minding the Shop?" *The Regional Economist,* St. Louis Federal Reserve, April 1998, pp. 1–8.

4. A surety bond is a policy written by an insurance company to protect another party against loss or violation of a contract.

as an intermediary. A large majority of the issuers of direct paper are financial companies. Because they require a continuous source of funds in order to provide loans to customers, they find it cost-effective to establish a sales force to sell their commercial paper directly to investors.

In the case of dealer-placed commercial paper, the issuer uses the services of a securities firm to sell its paper. Commercial paper sold in this way is referred to as *dealer paper.* Competitive pressures have forced dramatic reductions in the underwriting fees charged by dealer firms.

Historically, the dealer market has been dominated by large investment banking firms because commercial banks were prohibited from underwriting commercial paper by the Glass-Steagall Act. In June 1987, however, the Fed granted subsidiaries of bank holding companies permission to underwrite commercial paper. Although investment banking firms still dominate the dealer market, commercial banks are making inroads.

The Secondary Market

Commercial paper is one of the largest segments (just over $1.3 trillion) of the money market, exceeding even U.S. Treasury bills as of April 2001. Despite this fact, secondary trading activity is much smaller. The typical investor in commercial paper is an entity that plans to hold it until maturity, given that an investor can purchase commercial paper with the specific maturity desired. Should an investor's economic circumstances change such that there is a need to sell the paper, it can be sold back to the dealer, or in the case of directly placed paper, the issuer will repurchase it.

Yields on Commercial Paper

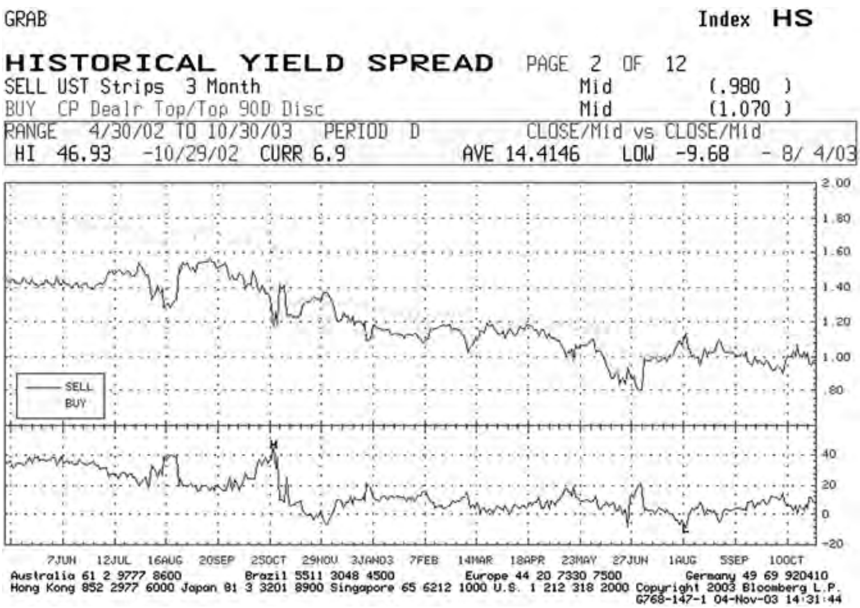
Like Treasury bills, commercial paper is a discount instrument. That is, it is sold at a price less than its maturity value. The difference between the maturity value and the price paid is the interest earned by the investor, although some commercial paper is issued as an interest-bearing instrument. For commercial paper, a year is treated as having 360 days.

The yield offered on commercial paper tracks that of other money market instruments. Exhibit 12–1 is a Bloomberg time-series plot of daily observations of three-month commercial paper yields and three-month U.S. Treasury bill yields for the period April 30, 2002, to October 30, 2003. The average spread between the two yields over this period was 14.41 basis points.

The commercial paper rate is higher than that on Treasury bills for three reasons. First, the investor in commercial paper is exposed to credit risk. Second, interest earned from investing in Treasury bills is exempt from state and local income taxes. As a result, commercial paper has to offer a higher yield to offset this tax advantage. Finally, commercial paper is less liquid than Treasury bills. The liquidity premium demanded is probably small, however, because investors typically follow a buy-and-hold strategy with commercial paper and so are less concerned with

EXHIBIT 12–1

Bloomberg Time-Series Plot of Three-Month Commercial Paper Yields and Three-Month Bill Yields



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liquidity. The rate on commercial paper is higher by a few basis points than the rate on certificates of deposit, which we discuss later in this chapter. The higher yield available on commercial paper is attributable to the poorer liquidity relative to certificates of deposit.

BANKERS ACCEPTANCES

Simply put, a bankers acceptance is a vehicle created to facilitate commercial trade transactions. The instrument is called a *bankers acceptance* because a bank accepts the ultimate responsibility to repay a loan to its holder. The use of bankers acceptances to finance a commercial transaction is referred to as *acceptance financing.*

The transactions in which bankers acceptances are created include (1) the importing of goods into the United States, (2) the exporting of goods from the United States to foreign entities, (3) the storing and shipping of goods between two foreign countries where neither the importer nor the exporter is a U.S. firm,[5] and (4) the storing and shipping of goods between two entities in the United States.

5. Bankers acceptances created from these transactions are called *third-country acceptances.*

Bankers acceptances are sold on a discounted basis just as Treasury bills and commercial paper. The major investors in bankers acceptances are money market mutual funds and municipal entities. Bankers acceptances have declined in importance in recent years in favor of other forms of financing.

Illustration of the Creation of a Bankers Acceptance

The best way to explain the creation of a bankers acceptance is by an illustration. Several entities are involved in our transaction:

- Car Imports Corporation of America ("Car Imports"), a firm in New Jersey that sells automobiles
- Germany Autos, Inc. ("GAI"), a manufacturer of automobiles in Germany
- Hoboken Bank of New Jersey ("Hoboken Bank"), a commercial bank in Hoboken, New Jersey
- Berlin National Bank ("Berlin Bank"), a bank in Germany
- High-Caliber Money Market Fund, a mutual fund in the United States that invests in money market instruments

Car Imports and GAI are considering a commercial transaction. Car Imports wants to import 15 cars manufactured by GAI. GAI is concerned with the ability of Car Imports to make payment on the 15 cars when they are received.

Acceptance financing is suggested as a means for facilitating the transaction. Car Imports offers $300,000 for the 15 cars. The terms of the sale stipulate payment to be made to GAI 60 days after it ships the 15 cars to Car Imports. GAI determines whether it is willing to accept the $300,000. In considering the offering price, GAI must calculate the present value of the $300,000 because it will not be receiving the payment until 60 days after shipment. Suppose that GAI agrees to these terms.

Car Imports arranges with its bank, Hoboken Bank, to issue a letter of credit. The letter of credit indicates that Hoboken Bank will make good on the payment of $300,000 that Car Imports must make to GAI 60 days after shipment. The letter of credit, or time draft, will be sent by Hoboken Bank to GAI's bank, Berlin Bank. On receipt of the letter of credit, Berlin Bank will notify GAI, who will then ship the 15 cars. After the cars are shipped, GAI presents the shipping documents to Berlin Bank and receives the present value of $300,000. GAI is now out of the picture.

Berlin Bank presents the time draft and the shipping documents to Hoboken Bank. The latter will then stamp "accepted" on the time draft. By doing so, the Hoboken Bank has created a bankers acceptance. This means that Hoboken Bank agrees to pay the holder of the bankers acceptance $300,000 at the maturity date. Car Imports will receive the shipping documents so that it can procure the 15 cars once it signs a note or some other type of financing arrangement with Hoboken Bank.

At this point, the holder of the bankers acceptance is the Berlin Bank. It has two choices. It can retain the bankers acceptance as an investment in its loan portfolio, or it can request that the Hoboken Bank make a payment of the present value of $300,000. Let's assume that Berlin Bank requests payment of the present value of $300,000.

Now the holder of the bankers acceptance is Hoboken Bank. It has two choices: retain the bankers acceptance as an investment as part of its loan portfolio or sell it to an investor. Suppose that Hoboken Bank chooses the latter and that High-Caliber Money Market Fund is seeking a high-quality investment with the same maturity as that of the bankers acceptance. The Hoboken Bank sells the bankers acceptance to the money market fund at the present value of $300,000. Rather than sell the instrument directly to an investor, Hoboken Bank could sell it to a dealer who would then resell it to an investor such as a money market fund. In either case, at the maturity date, the money market fund presents the bankers acceptance to Hoboken Bank, receiving $300,000, which the bank in turn recovers from Car Imports.

Credit Risk

Investing in bankers acceptances exposes the investor to credit risk. This is the risk that neither the borrower nor the accepting bank will be able to pay the principal due at the maturity date. Accordingly, bankers acceptances will offer a higher yield than Treasury bills of the same maturity.

Eligible Bankers Acceptance

An accepting bank that has decided to retain a bankers acceptance in its portfolio may be able to use it as collateral for a loan at the discount window of the Federal Reserve. The reason we say that it *may* is that bankers acceptances must meet certain eligibility requirements established by the Federal Reserve. One requirement for eligibility is maturity, which with few exceptions cannot exceed six months. The other requirements for eligibility are too detailed to review here, but the basic principle is simple: The bankers acceptance should be financing a self-liquidating commercial transaction. Conversely, *finance bills* are acceptances that are not related to specific transactions and are generally ineligible.

Eligibility is also important because the Federal Reserve imposes a reserve requirement on funds raised via bankers acceptances that are ineligible. Bankers acceptances sold by an accepting bank are potential liabilities of the bank, but no reserve requirements are imposed for eligible bankers acceptances. Consequently, most bankers acceptances satisfy the various eligibility criteria. Finally, the Federal Reserve also imposes a limit on the amount of eligible bankers acceptances that may be issued by a bank.

Rates Banks Charge on Bankers Acceptances

To calculate the rate to be charged the customer for issuing a bankers acceptance, the bank determines the rate for which it can sell its bankers acceptance in the open market. To this rate it adds a commission. In the case of ineligible bankers acceptances, a bank will add an amount to offset the cost of the reserve requirements imposed.

LARGE-DENOMINATION NEGOTIABLE CDs

A *certificate of deposit* (CD) is a certificate issued by a bank or thrift that indicates that a specified sum of money has been deposited at the issuing depository institution. CDs are issued by banks and thrifts to raise funds for financing their business activities. A CD bears a maturity date and a specified interest rate, and it can be issued in any denomination. CDs issued by banks are insured by the Federal Deposit Insurance Corporation (FDIC) but only for amounts up to $100,000. As for maturity, there is no limit on the maximum, but by Federal Reserve regulations CDs cannot have a maturity of less than seven days.

A CD may be nonnegotiable or negotiable. In the former case, the initial depositor must wait until the maturity date of the CD to obtain the funds. If the depositor chooses to withdraw funds prior to the maturity date, an early withdrawal penalty is imposed. In contrast, a negotiable CD allows the initial depositor (or any subsequent owner of the CD) to sell the CD in the open market prior to the maturity date.

Negotiable CDs were introduced in the early sixties. At that time, the interest rate that banks could pay on various types of deposits was subject to ceilings administered by the Federal Reserve (except for demand deposits, defined as deposits of less than one month that by law could pay no interest). For complex historical reasons, these ceiling rates started very low, rose with maturity, and remained below market rates up to some fairly long maturity. Before introduction of the negotiable CD, those with money to invest for, say, one month had no incentive to deposit it with a bank because they would get a below-market rate, unless they were prepared to tie up their capital for a much longer period of time. When negotiable CDs came along, those investors could buy a three-month or longer negotiable CD yielding a market interest rate and recoup all or more than the investment (depending on market conditions) by selling it in the market.

This innovation was critical in helping banks to increase the amount of funds raised in the money market, a position that had languished in the earlier postwar period. It also motivated competition among banks, ushering in a new era. There are now two types of negotiable CDs. The first is the large-denomination CD, usually issued in denominations of $1 million or more. These are the negotiable CDs whose history we just described.

In 1982, Merrill Lynch entered the retail CD business by opening up a primary and secondary market in small-denomination (less than $100,000) CDs. While it made the CDs of its numerous banking and savings institution clients available to retail customers, Merrill Lynch also began to give these customers the negotiability enjoyed by institutional investors by standing ready to buy back CDs prior to maturity. Today, several retail-oriented brokerage firms offer CDs that are salable in a secondary market. These are the second type of negotiable CD.

Our focus in this chapter, though, is on the large-denomination negotiable CD, and we refer to them simply as CDs throughout the chapter.

The largest group of CD investors consists of investment companies, and money market funds make up the bulk of them. Far behind are banks and bank trust departments, followed by municipal entities and corporations.

CD Issuers

CDs can be classified into four types, based on the issuing bank. First are CDs issued by domestic banks. Second are CDs denominated in U.S. dollars but issued outside the United States. These CDs are called *Eurodollar CDs* or *Euro CDs.* Euro CDs are U.S. dollar–denominated CDs issued primarily in London by U.S., Canadian, European, and Japanese banks. Branches of large U.S. banks once were the major issuers of Euro CDs. A third type of CD is the *Yankee CD,* which is a CD denominated in U.S. dollars and issued by a foreign bank with a branch in the United States. Finally, *thrift CDs* are those issued by savings and loan associations and savings banks.

Yields on CDs

Unlike Treasury bills, commercial paper, and bankers acceptances, yields on domestic CDs are quoted on an interest-bearing basis. CDs with a maturity of one year or less pay interest at maturity. For purposes of calculating interest, a year is treated as having 360 days. Term CDs issued in the United States normally pay interest semiannually, again with a year taken to have 360 days.

The yields posted on CDs vary depending on three factors: (1) the credit rating of the issuing bank, (2) the maturity of the CD, and (3) the supply and demand for CDs. With respect to the third factor, banks and thrifts issue CDs as part of their liability management strategy, so the supply of CDs will be driven by the demand for bank loans and the cost of alternative sources of capital to fund these loans. Moreover, bank loan demand will depend on the cost of alternative funding sources such as commercial paper. When loan demand is weak, CD rates decline. When demand is strong, the rates rise. The effect of maturity depends on the shape of the yield curve.

Credit risk has become more of an issue. At one time, domestic CDs issued by money center banks traded on a no-name basis. Recent financial crises in the banking industry, however, have caused investors to take a closer look at issuing banks. Prime CDs (those issued by high-rated domestic banks) trade at a lower yield than nonprime CDs (those issued by lower-rated domestic banks). Because of the unfamiliarity investors have with foreign banks, generally Yankee CDs trade at a higher yield than domestic CDs.

Euro CDs offer a higher yield than domestic CDs. There are three reasons for this. First, there are reserve requirements imposed by the Federal Reserve on CDs issued by U.S. banks in the United States that do not apply to issuers of Euro CDs.

The reserve requirement effectively raises the cost of funds to the issuing bank because it cannot invest all the proceeds it receives from the issuance of a CD, and the amount that must be kept as reserves will not earn a return for the bank. Because it will earn less on funds raised by selling domestic CDs, the domestic issuing bank will pay less on its domestic CD than a Euro CD. Second, the bank issuing the CD must pay an insurance premium to the FDIC, which again raises the cost of funds. Finally, Euro CDs are dollar obligations that are payable by an entity operating under a foreign jurisdiction, exposing the holders to a risk (called *sovereign risk*) that their claim may not be enforced by the foreign jurisdiction. As a result, a portion of the spread between the yield offered on Euro CDs and domestic CDs reflects what can be termed a *sovereign-risk premium.* This premium varies with the degree of confidence in the international banking system.

Since the 1990s, the liquidity of the Eurodollar CDs has increased dramatically, and the perception of higher risk has diminished considerably. Exhibit 12–2 is a Bloomberg time-series plot of daily observations for three-month LIBOR rates and three-month CD rates for the period April 30, 2002, to October 30, 2003. The average spread between the two rates over this period was 1.95 basis points. These results suggest that Eurodollar CDs have risk/liquidity characteristics equivalent to or even slightly better than domestic CDs.

EXHIBIT 12–2

Bloomberg Time-Series Plot of Three-Month LIBOR Rates and Three-Month CD Rates

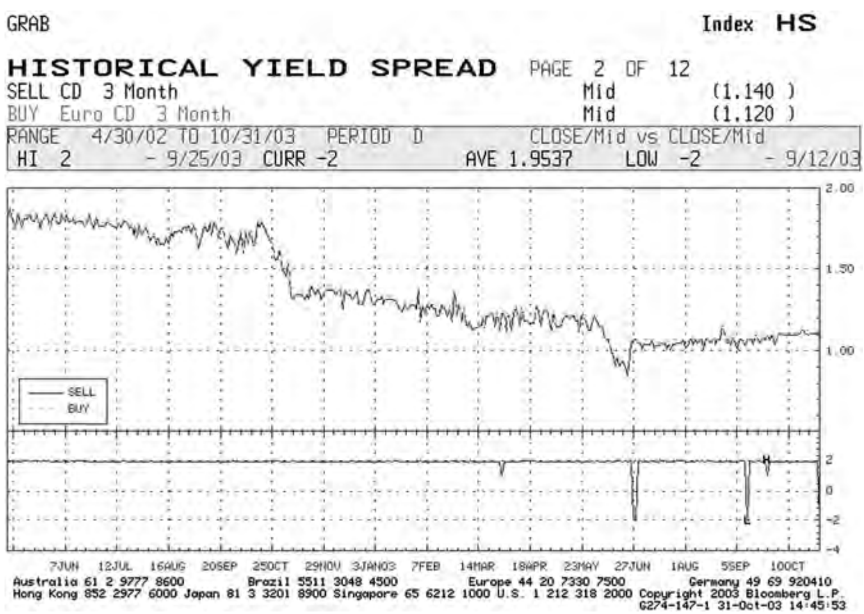
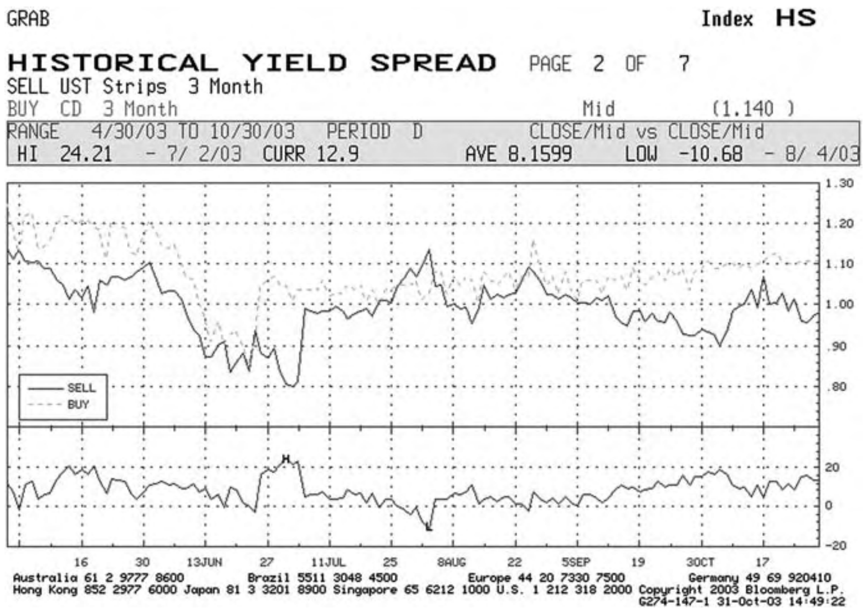


EXHIBIT 12–3

Bloomberg Time-Series Plot of Three-Month Domestic CD Yields and Three-Month-Bill Yields



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CD yields are higher than yields on Treasury securities of the same maturity. Exhibit 12–3 is a Bloomberg time-series plot of daily observations for the yields on three-month domestic CDs and the yields on three-month U.S. Treasury bills for the period April 30, 2002, to October 30, 2003. The average spread between the two yields over this period was 8.16 basis points. The spread is due mainly to the credit risk that a CD investor is exposed to and the fact that CDs offer less liquidity. The spread due to credit risk will vary with economic conditions and confidence in the banking system, increasing when there is a flight to quality or when there is a crisis in the banking system.

At one time, there were more than 30 dealers who made markets in CDs. The presence of that many dealers provided good liquidity to the market. Today, fewer dealers are interested in making markets in CDs, and the market can be characterized as an illiquid one.

REPURCHASE AGREEMENTS

A *repurchase agreement* is the sale of a security with a commitment by the seller to buy the security back from the purchaser at a specified price at a designated future date. Basically, a repurchase agreement is a collateralized loan, where the collateral is a security. The agreement is best explained with an illustration.

Suppose that on October 22, 2003, a government securities dealer purchases a 4.25% coupon on-the-run 10-year U.S. Treasury note that matures on August 15, 2013. The face amount of the position is $1 million, and the note's full price (i.e., flat price plus accrued interest) is $1,007,384.51. Further, suppose that the dealer wants to hold the position until the end of the next business day, which is Thursday, October 23, 2003. Where does the dealer obtain the funds to finance this position? Of course, the dealer can finance the position with its own funds or by borrowing from a bank. Typically, however, the dealer uses the repurchase agreement or "repo" market to obtain financing. In the repo market, the dealer can use the Treasury security as collateral for a loan. The term of the loan and the interest rate that the dealer agrees to pay (called the *repo rate*) are specified. When the term of the loan is one day, it is called an *overnight repo;* a loan for more than one day is called a *term repo.* Alternatively, *open-maturity* repos give both counterparties the option to terminate the repo each day. This structure reduces the settlement costs if counterparties choose to continuously roll over overnight repos.

The transaction is referred to as a "repurchase agreement" because it calls for the sale of the security and its repurchase at a future date. Both the sale price and the purchase price are specified in the agreement. The difference between the purchase (repurchase) price and the sale price is the dollar interest cost of the loan.

Let us return to the dealer who needs to finance the purchase of $1 million par value position in a 10-year note. Suppose that one of the dealer's customers has excess funds in the amount of $1,007,384.51 and is the amount of money loaned in the repo agreement. Thus, on October 22, 2003, the dealer would agree to deliver ("sell") $1,007,384.51 worth of 10-year U.S. Treasury notes to the customer and buy the same 10-year notes back for an amount determined by the repo rate the next business day, on October 23, 2003.

Suppose that the repo rate in this transaction is 0.97%. Then, as will be explained below, the dealer would agree to deliver the 10-year U.S. Treasury notes for $1,007,411.65 the next day. The $27.14 difference between the "sale" price of $1,007,384.51 and the "repurchase" price of $1,007,411.65 is the dollar interest on the financing. From the customer's perspective, the agreement is called a *reverse* repo.

The following formula is used to calculate the dollar interest on a repo transaction:

$$\text{Dollar interest} = (\text{dollar principal}) \times (\text{repo rate}) \times \left(\frac{\text{repo term}}{360}\right)$$

Notice that the interest is computed on a 360-day basis. In our illustration, using a repo rate of 0.97% and a repo term of one day, the dollar interest is $27.14, as shown below:

$$\$1{,}007{,}384.51 \times 0.0097 \times (1/360) = \$27.14$$

The advantage to the dealer of using the repo market for borrowing on a short-term basis is that the rate is less than the cost of bank financing. We will explain why later in this section. From the customer's perspective, the repo market offers an attractive yield on a short-term secured transaction that is highly liquid.

The example illustrates financing a dealer's long position in the repo market, but dealers also can use the market to cover a short position. For example, suppose a government dealer shorted $10 million of Treasury securities two weeks ago and must now cover the position—that is, deliver the securities. The dealer can do a reverse repo (agree to buy the securities and sell them back). Of course, the dealer eventually would have to buy the Treasury securities in the market in order to cover its short position.

There is a good deal of Wall Street jargon describing repo transactions. To understand it, remember that one party is lending money and accepting security as collateral for the loan; the other party is borrowing money and giving collateral to borrow money. When someone lends securities in order to receive cash (i.e., borrow money), that party is said to be *reversing out* securities. A party that lends money with the security as collateral is said to be *reversing in* securities. The expressions *to repo securities* and *to do repo* are also used. The former means that someone is going to finance securities using the security as collateral; the latter means that the party is going to invest in a repo. Finally, the expressions *selling collateral* and *buying collateral* are used to describe a party financing a security with a repo on the one hand, and lending on the basis of collateral on the other.

The collateral in a repo is not limited to government securities. Money market instruments, federal agency securities, and mortgage-backed securities are also used. Moreover, repos can include *substitution clauses* that permit the counterparty to substitute alternative securities as collateral over the repo's life.

Credit Risks

Despite the fact that there may be high-quality collateral underlying a repo transaction, both parties to the transaction are exposed to credit risk. The failure of a few small government securities dealer firms involving repo transactions in the 1980s has made market participants more cautious about the creditworthiness of the counterparty to a repo.[6]

Why does credit risk occur in a repo transaction? Consider our initial example, in which the dealer used $10 million of government securities as collateral to borrow. If the dealer cannot repurchase the government securities, the customer may keep the collateral; if interest rates on government securities have increased subsequent to the repo transaction, however, the market value of the government securities will decline, and the customer will own securities with a market value less than the amount it loaned to the dealer. If the market value of the security

6. Failed firms include Drysdale Government Securities, Lion Capital, RTD Securities, Inc., Belvill Bressler & Schulman, Inc., and ESM Government Securities, Inc.

rises instead, the dealer firm will be concerned with the return of the collateral, which then has a market value higher than the loan.

Repos are now structured more carefully to reduce credit risk exposure. The amount loaned is less than the market value of the security used as collateral, which provides the lender with some cushion should the market value of the security decline. The amount by which the market value of the security used as collateral exceeds the value of the loan is called *margin*.[7] The amount of margin is generally between 1% and 3%. For borrowers of lower creditworthiness or when less liquid securities are used as collateral, the margin can be 10% or more.

Another practice to limit credit risk is to mark the collateral to market on a regular basis. When market value changes by a certain percentage, the repo position is adjusted accordingly. Suppose that a dealer firm has borrowed $20 million using collateral with a market value of $20.4 million. The margin is 2%. Suppose further that the market value of the collateral drops to $20.1 million. A repo agreement can specify either (1) a margin call or (2) repricing of the repo. In the case of a margin call, the dealer firm is required to put up additional collateral with a market value of $300,000 to bring the margin up to $400,000. If repricing is agreed on, the principal amount of the repo will be changed from $20 million to $19.7 million (the market value of $20.1 million divided by 1.02). The dealer would then send the customer $300,000.

One concern in structuring a repo is delivery of the collateral to the lender. The most obvious procedure is for the borrower to deliver the collateral to the lender. At the end of the repo term, the lender returns the collateral to the borrower in exchange for the principal and interest payment. This procedure may be too costly, though, particularly for short-term repos, because of the costs associated with delivering the collateral. The cost of delivery would be factored into the transaction by a lower repo rate offered by the borrower. The risk of the lender not taking possession of the collateral is that the borrower may sell the security or use the same security as collateral for a repo with another party.

As an alternative to delivering the collateral, the lender may agree to allow the borrower to hold the security in a segregated customer account. Of course, the lender still faces the risk that the borrower uses the collateral fraudulently by offering it as collateral for another repo transaction.

Another method is for the borrower to deliver the collateral to the lender's custodial account at the borrower's clearing bank. The custodian then has possession of the collateral that it holds on behalf of the lender. This practice reduces the cost of delivery because it is merely a transfer within the borrower's clearing bank. If, for example, a dealer enters into an overnight repo with customer A, the next day the collateral is transferred back to the dealer. The dealer can then enter into a repo with customer B for, say, five days without having to redeliver the collateral. The clearing bank simply establishes a custodian account for customer B and holds the collateral in that account.

7. Margin is also referred to as the "haircut."

There have been a number of well-publicized losses by nondealer institutional investors—most notably Orange County, California—that have resulted from the use of repurchase agreements. Such losses did not occur as a result of credit risk. Rather, it was the use of repos to make a leverage bet on the movement of interest rates. That is, the repo was not used as a money market instrument but as a leveraging vehicle. This can be accomplished by mismatching the maturity of repos and reverse repos. For example, if one has a view that rates will rise, one could borrow money via a term repo (say, three months) and lend money overnight. Conversely, if rates are expected to fall, one could reverse the maturity mismatch. Leverage can be increased many times if market participants are able to borrow and lend a single piece of collateral multiple times.

Participants in the Market

Because it is used by dealer firms (investment banking firms and money center banks acting as dealers) to finance positions and cover short positions, the repo market has evolved into one of the largest sectors of the money market. Financial and nonfinancial firms participate in the markets as both sellers and buyers, depending on the circumstances they face. Thrifts and commercial banks are typically *net sellers* of collateral (i.e., net borrowers of funds); money market funds, bank trust departments, municipalities, and corporations are typically *net buyers* of collateral (i.e., providers of funds).

Although a dealer firm uses the repo market as the primary means for financing its inventory and covering short positions, it also will use the repo market to run a matched book, where it takes on repos and reverse repos with the same maturity. The firm will do so to capture the spread at which it enters into the repo and reverse repo agreement. For example, suppose that a dealer firm enters into a term repo of 10 days with a money market fund and a reverse repo rate with a thrift for 10 days in which the collateral is identical. This means that the dealer firm is borrowing funds from the money market fund and lending money to the thrift. If the rate on the repo is 7.5% and the rate on the reverse repo is 7.55%, the dealer firm is borrowing at 7.5% and lending at 7.55%, locking in a spread of 0.05% (5 basis points).

Another participant is the repo broker. To understand the role of the repo broker, suppose that a dealer firm has shorted $50 million of a security. It will then survey its regular customers to determine if it can borrow via a reverse repo the security it shorted. Suppose that it cannot find a customer willing to do a repo transaction (repo from the customer's point of view, reverse repo from the dealer's). At that point, the dealer firm will use the services of a repo broker. When the collateral is difficult to acquire, it is said to be a *hot* or *special* issue.

The Fed and the Repo Market

The Federal Reserve influences short-term interest rates through its open market operations—that is, by the outright purchase or sale of government securities. This is not the common practice followed by the Fed, however. It uses the repo market instead to implement monetary policy by purchasing or selling collateral. By buying collateral (i.e., lending funds), the Fed injects money into the financial markets, thereby exerting downward pressure on short-term interest rates. When the Fed buys collateral for its own account, this is called a *system repo.* The Fed also buys collateral on behalf of foreign central banks in repo transactions that are called *customer repos.* It is primarily through system repos that the Fed attempts to influence short-term rates. By selling securities for its own account, the Fed drains money from the financial markets, thereby exerting upward pressure on short-term interest rates. This transaction is called a *matched sale.*

Note the language that is used to describe the transactions of the Fed in the repo market. When the Fed lends funds based on collateral, we call it a *system* or *customer repo,* not a reverse repo. Borrowing funds using collateral is called a *matched sale,* not a repo. The jargon is confusing, which is why we used the terms of *buying collateral* and *selling collateral* to describe what parties in the market are doing.

Determinants of the Repo Rate

There is no one repo rate; rates vary from transaction to transaction depending on several factors:

Quality. The higher the credit quality and liquidity of the collateral, the lower is the repo rate.

Term of the repo. The effect of the term of the repo on the rate depends on the shape of the yield curve.

Delivery requirement. As noted earlier, if delivery of the collateral to the lender is required, the repo rate will be lower. If the collateral can be deposited with the bank of the borrower, a higher repo rate is paid.

Availability of collateral. The more difficult it is to obtain the collateral, the lower is the repo rate. To understand why this is so, consider the case when the borrower (or equivalently, the seller of the collateral) has a security that is a hot or special issue. The party that needs the collateral will be willing to lend funds at a lower repo rate to obtain the collateral.

These factors determine the repo rate on a particular transaction; the federal funds rate discussed below determines the general level of repo rates. The repo rate will be a rate below the federal funds rate. The reason is that a repo involves collateralized borrowing, whereas a federal funds transaction is unsecured borrowing. Panel *a* of Exhibit 12–4 presents a Bloomberg screen (MMR) that contains repo and reverse repo rates for maturities of one day, one week, two weeks, three weeks, one month, two months, and three months using U.S. Treasuries as collateral on October 22, 2003. Panel *b* presents repo and reverse repo rates with agency securities as collateral. Note how the rates differ by maturity and type of

EXHIBIT 12–4 (*a*)

Bloomberg Screens Presenting Repo and Reverse Repo Rates for Various Maturities and Collateral: (*a*) U.S. Treasuries; (*b*) Agency Securities

GRAB M-Mkt **MMR**

14:47 **REPO/REVERSE RP O/N & TERM** Page 1 / 3

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SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
GOVERNMENT							
Repo							
Dealer pays int							
4)RPGT01D	14:46	.95	+.02	.95	.95	.95	.93
5)RPGT01W	14:46	.95	+.03	.95	.95	.95	.92
6)RPGT02W	14:46	.94	-.01	.94	.94	.94	.95
7)RPGT03W	14:46	.95	--	.95	.95	.95	.95
8)RPGT01M	14:46	.96	--	.96	.96	.96	.96
9)RPGT02M	14:46	.96	--	.96	.96	.96	.96
10)RPGT03M	14:46	.97	--	.97	.97	.97	.97
Reverse Repo							
Dealer earns int							
13)RVGT01D	14:46	.98	+.01	.98	.98	.98	.97
14)RVGT01W	14:46	.99	+.02	.99	.99	.99	.97
15)RVGT02W	14:46	.99	--	.99	.99	.99	.99
16)RVGT03W	14:46	1.00	--	1.00	1.00	1.00	1.00
17)RVGT01M	14:46	1.00	--	1.00	1.00	1.00	1.00
18)RVGT02M	14:46	1.01	--	1.01	1.01	1.01	1.01
19)RVGT03M	14:46	1.01	--	1.01	1.01	1.01	1.01
PAGE FOR MTGE REPO							

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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collateral. For example, the repo rates are higher when agency securities are used as collateral versus governments.

FEDERAL FUNDS

The rate determined in the federal funds market is the major factor that influences the rate paid on all the other money market instruments described in this chapter. When the Federal Reserve formulates and executes monetary policy, it sets a target level for the federal funds rate. Announcements of changes in monetary policy specify the changes in the Fed's target for this rate. The Federal Reserve influences the level of the federal funds rate through open market operations. Exhibit 12–5 presents a Bloomberg time-series plot of daily observations for the effective federal funds rate for the period April 30, 2002, to October 30, 2003.

Depository institutions (commercial banks and thrifts) are required to maintain reserves. The reserves are deposits at their district Federal Reserve Bank, which are called federal funds. The level of the reserves that a bank

EXHIBIT 12–4 (*b*)

(Continued)

GRAB M-Mkt **MMR**

14:49 **REPO/REVERSE RP O/N & TERM** Page 3 / 3

94<GO> View News.

SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
AGENCY							
Repo							
3)RPAGO1D	14:46	.98	--	.98	.98	.98	.98
4)RPAGO1W	14:46	1.00	+.03	1.00	1.00	1.00	.97
5)RPAGO3W	14:46	1.01	-.01	1.01	1.01	1.01	1.02
6)RPAGO1M	14:46	1.02	+.01	1.02	1.02	1.02	1.01
7)RPAGO2M	14:46	1.03	+.01	1.03	1.03	1.03	1.02
8)RPAGO3M	14:46	1.04	+.01	1.04	1.04	1.04	1.03
Reverse Repo							
11)RVAGO1D	14:46	1.01	-.01	1.01	1.01	1.01	1.02
12)RVAGO1W	14:46	1.05	+.03	1.05	1.05	1.05	1.02
13)RVAGO2W	14:46	1.06	+.02	1.06	1.06	1.06	1.04
14)RVAGO3W	14:46	1.06	--	1.06	1.06	1.06	1.06
15)RVAGO1M	14:46	1.07	+.01	1.07	1.07	1.07	1.06
16)RVAGO2M	14:46	1.08	+.01	1.08	1.08	1.08	1.07
17)RVAGO3M	14:46	1.08	--	1.08	1.08	1.08	1.08

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000
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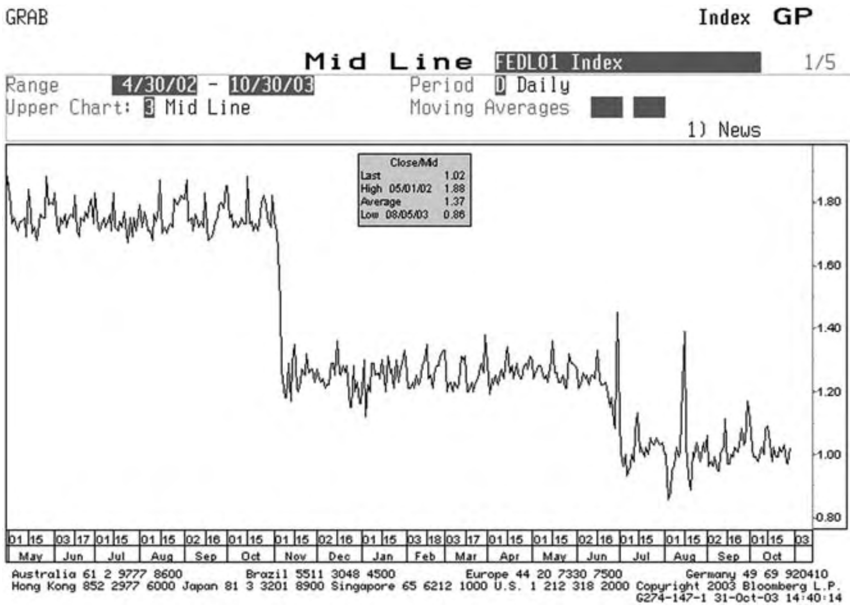
must maintain is based on its average daily deposits over the previous 14 days. Of all depository institutions, commercial banks are by far the largest holders of federal funds.

No interest is earned on federal funds. Consequently, a depository institution that maintains federal funds in excess of the amount required incurs an opportunity cost—the loss of interest income that could be earned on the excess reserves. At the same time, there are depository institutions whose federal funds are less than the amount required. Typically, smaller banks have excess reserves, whereas money center banks find themselves short of reserves and must make up the shortfall. Banks maintain federal funds desks whose managers are responsible for the bank's federal funds position.

One way that banks with less than the required reserves can bring reserves to the required level is to enter into a repo with a nonbank customer. An alternative is for the bank to borrow federal funds from a bank that has excess reserves. The market in which federal funds are bought (borrowed) by banks that need these funds and sold (lent) by banks that have excess federal funds is called the *federal funds market.* The equilibrium interest rate, which is determined by the supply and demand for federal funds, is the *federal funds rate.*

EXHIBIT 12–5

Bloomberg Time-Series Plot of the Daily Effective Federal Funds Rate



Source: © 2003 Bloomberg L.P. Reprinted with permission. All rights reserved.

The federal funds rate and the repo rate are tied together because both are a means for a bank to borrow. The federal funds rate is higher because the lending of federal funds is done on an unsecured basis; this differs from the repo, in which the lender has a security as collateral. The spread between the two rates varies depending on market conditions; typically, the spread is approximately 25 basis points.

The term of most federal funds transactions is overnight, but there are longer-term transactions that range from one week to six months. Trading typically takes place directly between the buyer and seller—usually between a large bank and one of its correspondent banks. Some federal funds transactions require the use of a broker.

SUMMARY

Money market instruments are debt obligations that at issuance have a maturity of one year or less. Commercial paper is a short-term unsecured promissory note issued in the open market that represents the obligation of the issuing entity. It is sold on a discount basis. To avoid SEC registration, the maturity of commercial paper is less than 270 days. Generally, commercial paper maturity is less than 90 days so that it will qualify as eligible collateral for the bank to borrow from the Federal Reserve Bank's discount window. Financial and nonfinancial corporations issue commercial paper, with the majority issued by the former. Direct paper is sold by the issuing firm directly to investors without using a securities dealer as an intermediary; with dealer-placed commercial paper, the issuer uses the services of a securities firm to sell its paper. There is little liquidity in the commercial paper market.

A bankers acceptance is a vehicle created to facilitate commercial trade transactions, particularly international transactions. They are called bankers acceptances because a bank accepts the responsibility to repay a loan to the holder of the vehicle created in a commercial transaction in case the debtor fails to perform. Bankers acceptances are sold on a discounted basis, as are Treasury bills and commercial paper.

Certificates of deposit (CDs) are issued by banks and thrifts to raise funds for financing their business activities. Unlike Treasury bills, commercial paper, and bankers acceptances, yields on domestic CDs are quoted on an interest-bearing basis. A floating-rate CD is one whose coupon interest rate changes periodically in accordance with a predetermined formula.

A repurchase agreement is a lending transaction in which the borrower uses a security as collateral for the borrowing. The transaction is referred to as a repurchase agreement because it specifies the sale of a security and its subsequent repurchase at a future date. The difference between the purchase (repurchase) price and the sale price is the dollar interest cost of the loan. An overnight repo is for one day; a loan for more than one day is called a term repo. The collateral in a repo may be a Treasury security, money market instrument, federal agency security, or mortgage-backed security. The parties to a repo are exposed to credit risk, limited by margin and mark-to-market practices included in a repo agreement. Dealers use the repo market to finance positions and cover short positions, and to run a matched book so that they can earn spread income. The Fed uses the repo market to implement monetary policy. Factors that determine the repo rate are the federal funds rate, the quality of the collateral, the term of the repo, the delivery requirement, and the availability of the collateral.

The federal funds market is the market where depository institutions borrow (buy) and sell (lend) federal funds. The federal funds rate, which is the rate at which all money market interest rates are anchored, is determined in this market. The federal funds rate is higher than the repo rate because borrowing done in the federal funds market is unsecured borrowing.

CHAPTER
THIRTEEN

CORPORATE BONDS

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In its simplest form, a corporate bond is a debt instrument that obligates the issuer to pay a specified percentage of the bond's par value on designated dates (the coupon payments) and to repay the bond's par or principal value at maturity. Failure to pay the interest and/or principal when due (and to meet other of the debt's provisions) in accordance with the instrument's terms constitutes legal default, and court proceedings can be instituted to enforce the contract. Bondholders as creditors have a prior legal claim over common and preferred shareholders as to both the corporation's income and assets for cash flows due them and may have a prior claim over other creditors if liens and mortgages are involved. This legal priority does not insulate bondholders from financial loss. Indeed, bondholders are fully exposed to the firm's prospects as to the ability to generate cash flow sufficient to pay its obligations.

Corporate bonds usually are issued in denominations of $1,000 and multiples thereof. In common usage, a corporate bond is assumed to have a par value of $1,000 unless otherwise explicitly specified. A security dealer who says that she has five bonds to sell means five bonds each of $1,000 principal amount. If the promised rate of interest (coupon rate) is 6%, the annual amount of interest on each bond is $60, and the semiannual interest is $30.

Although there are technical differences between bonds, notes, and debentures, we will use Wall Street convention and call fixed income debt by the general term—*bonds.*

Previous versions of this chapter were coauthored with Harry Sauvain, John Ritchie, Jr., and Richard Todd.

THE CORPORATE TRUSTEE

The promises of corporate bond issuers and the rights of investors who buy them are set forth in great detail in contracts generally called *indentures*. If bondholders were handed the complete indenture, some may have trouble understanding the legalese and have even greater difficulty in determining from time to time if the corporate issuer is keeping all the promises made. These problems are solved for the most part by bringing in a *corporate trustee* as a third party to the contract. The indenture is made out to the corporate trustee as a representative of the interests of bondholders; that is, the trustee acts in a fiduciary capacity for investors who own the bond issue.

A corporate trustee is a bank or trust company with a corporate trust department and officers who are experts in performing the functions of a trustee. This is no small task. The corporate trustee must, at the time of issue, authenticate the bonds issued—that is, keep track of all the bonds sold, and make sure that they do not exceed the principal amount authorized by the indenture. It must then be a watchdog for the bondholders by seeing to it that the issuer complies with all the covenants of the indenture. These covenants are many and technical, and they must be watched during the entire period that a bond issue is outstanding. We will describe some of these covenants in subsequent pages.

It is very important that corporate trustees be competent and financially responsible. To this end, there is a federal statute known as the Trust Indenture Act that requires that for all corporate bond offerings in the amount of more than $5 million sold in interstate commerce there must be a corporate trustee. The indenture must include adequate requirements for performance of the trustee's duties on behalf of bondholders; there must be no conflict between the trustee's interest as a trustee and any other interest it may have, especially if it is also a creditor of the issuer; and there must be provision for reports by the trustee to bondholders. If a corporate issuer fails to pay interest or principal, the trustee may declare a default and take such action as may be necessary to protect the rights of bondholders. If the corporate issuer has promised in the indenture to always maintain an amount of current assets equal to two times the amount of current liabilities, the trustee must watch the corporation's balance sheet and see that the promise is kept. If the issuer fails to maintain the prescribed amounts, the trustee must take action on behalf of the bondholders. However, it must be emphasized that the trustee is paid by the debt issuer and can only do what the indenture provides. The indenture may contain a clause stating that the trustee undertakes to perform such duties and only such duties as are specifically set forth in the indenture, and no implied covenants or obligations shall be read into the indenture against the trustee. Also, the trustee is usually under no obligation to exercise the rights or powers under the indenture at the request of bondholders unless it has been offered reasonable security or indemnity. The trustee is not bound to make investigations into the facts surrounding documents delivered to it, but it may do so if it sees fit.

The terms of bond issues set forth in bond indentures are always a compromise between the interests of the bond issuer and those of investors who buy bonds. The issuer always wants to pay the lowest possible rate of interest and wants its actions bound as little as possible with legal covenants. Bondholders want the highest possible interest rate, the best security, and a variety of covenants to restrict the issuer in one way or another. As we discuss the provisions of bond indentures, keep this opposition of interests in mind and see how compromises are worked out in practice.

SOME BOND FUNDAMENTALS

Bonds can be classified by a number of characteristics, which we will use for ease of organizing this section.

Bonds Classified by Issuer Type

The five broad categories of corporate bonds sold in the United States based on the type of issuer are public utilities, transportations, industrials, banks and finance companies, and international or Yankee issues. Finer breakdowns are often made by market participants to create homogeneous groupings. For example, public utilities are subdivided into telephone or communications, electric companies, gas distribution and transmission companies, and water companies. The transportation industry can be subdivided into airlines, railroads, and trucking companies. Like public utilities, transportation companies often have various degrees of regulation or control by state and/or federal government agencies. Industrials are a catchall class, but even here, finer degrees of distinction may be needed by analysts. The industrial grouping includes manufacturing and mining concerns, retailers, and service-related companies. Even the Yankee or international borrower sector can be more finely tuned. For example, one might classify the issuers into categories such as supranational borrowers (International Bank for Reconstruction and Development and the European Investment Bank), sovereign issuers (Canada, Australia, and the United Kingdom), and foreign municipalities and agencies.

Corporate Debt Maturity

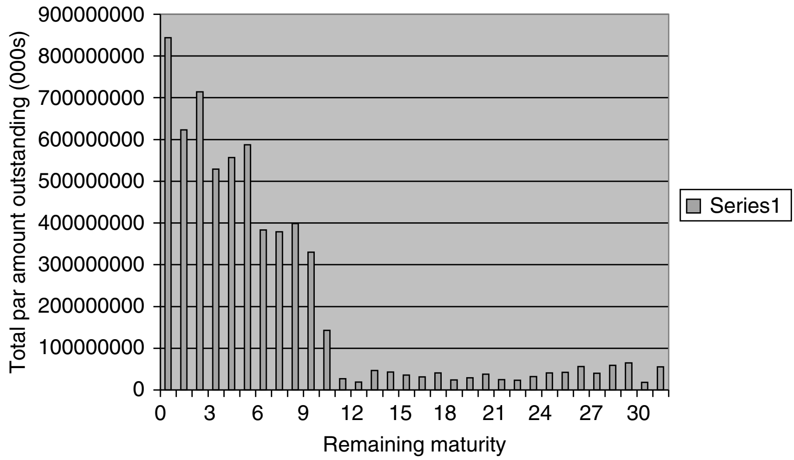
A bond's maturity is the date on which the issuer's obligation to satisfy the terms of the indenture is fulfilled. On that date, the principal is repaid with any premium and accrued interest that may be due. However, as we shall see later when discussing debt redemption, the final maturity date as stated in the issue's title may or may not be the date when the contract terminates. Many issues can be retired prior to maturity.

Exhibit 13–1 presents the distribution of the total par amount outstanding for a sample of corporate bonds (excluding medium-term notes) by remaining maturity as of December 31, 2002. The sample is restricted to bonds in the Fixed Income Security Database with offering amounts greater than $25 million.[1] The last

1. The Fixed Income Securities Database is jointly published by LJS Global Information Services and Arthur Warga at the University of Houston.

EXHIBIT 13–1

Maturity Distribution of Corporate Debt



column in the graph past 30 years represents the total par amount outstanding with a remaining maturity of greater than 30 years and less than or equal to 100 years. Before the Great Depression, there were a number of long-term bond issues with maturities of 100 or more years. During the 1990s, there were a number of 100-year bonds issued. In 1993, Walt Disney Co. offered the first 100-year bonds to the public since 1937.[2]

Interest Payment Characteristics

The three main interest payment classifications of domestically issued corporate bonds are straight-coupon bonds, zero-coupon bonds, and floating-rate, or variable-rate, bonds. Floating-rate issues are discussed in Chapter 16, and the other two types are examined below.

However, before we get into interest-rate characteristics, let us briefly discuss bond types. We refer to the interest rate on a bond as the *coupon*. This is technically wrong because bonds issued today do not have coupons attached. Instead, bonds are represented by a certificate, similar to a stock certificate, with a brief description of the terms printed on both sides. These are called *registered bonds*. The principal amount of the bond is noted on the certificate, and the interest-paying agent or trustee has the responsibility of making payment by check to the registered holder on the due date. Years ago bonds were issued in *bearer* or

2. See Malcolm Foster, "Wall Street Goes Global with Bonds for the Long Haul," *Bloomberg's Markets,* April 1997, Bloomberg Financial Services, pp. 71–76.

coupon form, with coupons attached for each interest payment. However, the registered form is considered safer and entails less paperwork. As a matter of fact, the registered bond certificate is on its way out as more and more issues are sold in *book-entry* form. This means that only one master or global certificate is issued. It is held by a central securities depository that issues receipts denoting interests in this global certificate.

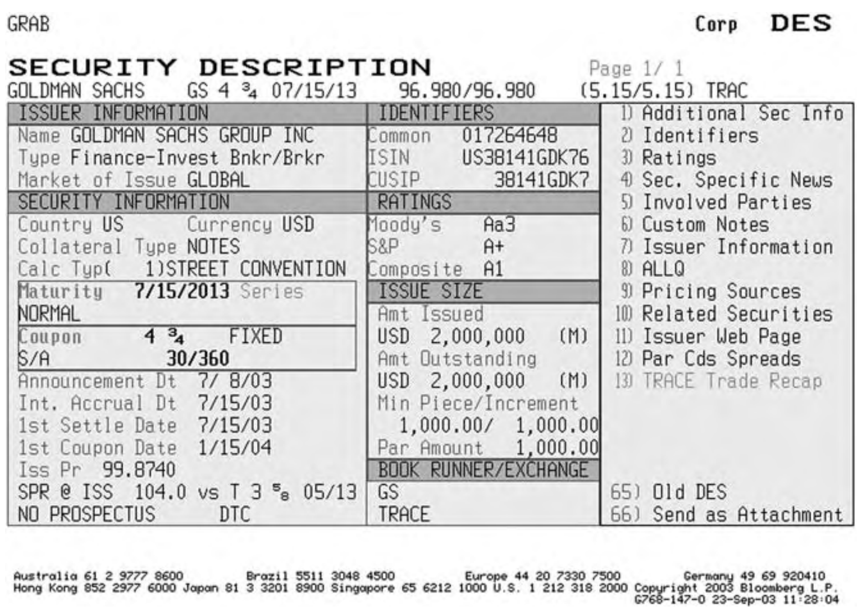
Straight-coupon bonds have an interest rate set for the life of the issue, however long or short that may be; they are also called *fixed-rate bonds*. Most fixed-rate bonds in the United States pay interest semiannually and at maturity. For example, consider a coupon bond issued by Goldman Sachs Group in July 2003. Exhibit 13–2 presents a Bloomberg Security Description screen for this issue. This bond carries a coupon rate of 4.75% and has a par amount of $1,000. Accordingly, this bond will make payments of $23.75 each January 15 and July 15, including the maturity date of July 15, 2013. On the maturity date, the bond's par amount is also paid. Bonds with annual coupon payments are uncommon in the U.S. capital markets but are the norm in continental Europe.

Interest on corporate bonds is based on a year of 360 days made up of twelve 30-day months. The corporate calendar day-count convention is referred to as 30/360.

Most fixed-rate corporate bonds pay interest in a standard fashion. However, there are some variations of which one should be aware. Most domestic

EXHIBIT 13–2

Bloomberg Security Description Screen of a Goldman Sachs Coupon Bond


GRAB Corp DES

SECURITY DESCRIPTION Page 1/ 1

GOLDMAN SACHS GS 4 3/4 07/15/13 96.980/96.980 (5.15/5.15) TRAC

ISSUER INFORMATION	IDENTIFIERS	
Name GOLDMAN SACHS GROUP INC	Common 017264648	1) Additional Sec Info
Type Finance-Invest Bnkr/Brkr	ISIN US38141GDK76	2) Identifiers
Market of Issue GLOBAL	CUSIP 38141GDK7	3) Ratings
SECURITY INFORMATION	**RATINGS**	4) Sec. Specific News
Country US Currency USD	Moody's Aa3	5) Involved Parties
Collateral Type NOTES	S&P A+	6) Custom Notes
Calc Typ(1)STREET CONVENTION	Composite A1	7) Issuer Information
Maturity **7/15/2013** Series	**ISSUE SIZE**	8) ALLQ
NORMAL	Amt Issued	9) Pricing Sources
Coupon **4 3/4** FIXED	USD 2,000,000 (M)	10) Related Securities
S/A **30/360**	Amt Outstanding	11) Issuer Web Page
Announcement Dt 7/ 8/03	USD 2,000,000 (M)	12) Par Cds Spreads
Int. Accrual Dt 7/15/03	Min Piece/Increment	13) TRACE Trade Recap
1st Settle Date 7/15/03	1,000.00/ 1,000.00	
1st Coupon Date 1/15/04	Par Amount 1,000.00	
Iss Pr 99.8740	**BOOK RUNNER/EXCHANGE**	
SPR @ ISS 104.0 vs T 3 5/8 05/13	GS	65) Old DES
NO PROSPECTUS DTC	TRACE	66) Send as Attachment

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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bonds pay interest in U.S. dollars. However, starting in the early 1980s, issues were marketed with principal and interest payable in other currencies, such as the Australian, New Zealand, or Canadian dollar or the British pound. Generally, interest and principal payments are converted from the foreign currency to U.S. dollars by the paying agent unless it is otherwise notified. The bondholders bear any costs associated with the dollar conversion. Foreign currency issues provide investors with another way of diversifying a portfolio, but not without risk. The holder bears the currency, or exchange-rate, risk in addition to all the other risks associated with debt instruments.

There are a few issues of bonds that can participate in the fortunes of the issuer over and above the stated coupon rate. These are called *participating bonds* because they share in the profits of the issuer or the rise in certain assets over and above certain minimum levels. Another type of bond rarely encountered today is the *income bond.* These bonds promise to pay a stipulated interest rate, but the payment is contingent on sufficient earnings and is in accordance with the definition of available income for interest payments contained in the indenture. Repayment of principal is not contingent. Interest may be cumulative or noncumulative. If payments are cumulative, unpaid interest payments must be made up at some future date. If noncumulative, once the interest payment is past, it does not have to be repaid. Failure to pay interest on income bonds is not an act of default and is not a cause for bankruptcy. Income bonds have been issued by some financially troubled corporations emerging from reorganization proceedings.

Zero-coupon bonds are, just as the name implies, bonds without coupons or an interest rate. Essentially, zero-coupon bonds pay only the principal portion at some future date. These bonds are issued at discounts to par; the difference constitutes the return to the bondholder. The difference between the face amount and the offering price when first issued is called the *original-issue discount* (OID). The rate of return depends on the amount of the discount and the period over which it accretes. For example, consider a zero-coupon bond issued by Corning, Inc., that matures November 8, 2015, and is priced in late September 2003 at 75.3333. Exhibit 13–3 presents a Bloomberg Security Description screen for this issue. Note that this zero-coupon bond is convertible into 8.3304 shares of Corning common stock at any time. In addition, this bond is callable on or after November 8, 2005, and is also putable. According to the prospectus, the put price is the initial offering price of 74.1923 plus the accrued original issue discount through the redemption date. These embedded option features will be discussed in more detail shortly. Most zero-coupons issued today are structured similarly in that they are convertible, callable, and putable. Zero-coupon convertibles were pioneered originally by Merrill Lynch with a product called Liquid Yield Option Notes, or LYONs.

Zeros were first publicly issued in the corporate market in the spring of 1981 and were an immediate hit with investors. The rapture lasted only a couple of years because of changes in the income tax laws that made ownership more costly on an after-tax basis. Also, these changes reduced the tax advantages to issuers. However, tax-deferred investors, such as pension funds, could still take

EXHIBIT 13–3

Bloomberg Security Description Screen of a Corning, Inc., Zero-Coupon Bond

GRAB Corp **DES**

SECURITY DESCRIPTION Page 1/ 4

CORNING INC GLW0 11/08/15-05 75.3333/ 76.3333 (4.02/3.38) BGN @ 9/22

CONVERTIBLE INFORMATION	IDENTIFIERS	1) Additional Sec Info
CONV TO 8.3304 SHARES	Common 012058870	2) Call Schedule
PER 1000.00 NOMINAL DP100%	ISIN US219350AJ43	3) Put Schedule
GLW (US) $9.72 ( )	CUSIP 219350AJ4	4) Convertible Info.
CONVERTIBLE UNTIL 11/ 6/15	RATINGS	5) Identifiers
PARITY 8.10 PREMIUM 842.72%	Moody's Ba2	6) Ratings
ISSUER INFORMATION	S&P BB+	7) Fees/Restrictions
Name CORNING INC	Fitch BB	8) Prospectus
Market of Issue US DOMESTIC	ISSUE SIZE	9) Sec. Specific News
SECURITY INFORMATION	Amt Issued	10) Involved Parties
Coupon 0 ZERO COUPON	USD 2,712,546 (M)	11) Custom Notes
N/A 30/360	Amt Outstanding	12) Issuer Information
Maturity 11/ 8/2015 Series	USD 886,044.00 (M)	13) ALLQ
CONV/PUT/CALL 11/ 8/05@ 81.95	Min Piece/Increment	14) Pricing Sources
Country US Currency USD	1,000.00/ 1,000.00	15) Related Securities
1st Coupon Date	Par Amount 1,000.00	16) Issuer Web Page
Price @ Issue 74.1923	BOOK RUNNER/EXCHANGE	17) Par Cds Spreads
Calc Typ (49)CONVERTIBLE	GS	65) Old DES
HAVE PROSPECTUS DTC	TRACE	66) Send as Attachment

INIT PRX/SHR=US$89.0625. INIT CVR PREM=25%. CPN SUBJ TO CHNG TO 2% UPON TAX EVENT. SR. UNSEC'D. CALL FROM 11/05 @ACCR VALU. POISON PUT. O/S 6/03.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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advantage of zero-coupon issues. One important risk is eliminated in a zero-coupon investment—the reinvestment risk. Because there is no coupon to reinvest, there isn't any reinvestment risk. Of course, although this is beneficial in declining-interest-rate markets, the reverse is true when interest rates are rising. The investor will not be able to reinvest an income stream at rising reinvestment rates. Investors tend to find zeros less attractive in lower-interest-rate markets because compounding is not as meaningful as when rates are higher. Also, the lower the rates are, the more likely it is that they will rise again, making a zero-coupon investment worth less in the eyes of potential holders.

In bankruptcy, a zero-coupon bond creditor can claim the original offering price plus accrued and unpaid interest to the date of the bankruptcy filing, but not the principal amount of $1,000. Zero-coupon bonds have been sold at deep discounts, and the liability of the issuer at maturity may be substantial. The accretion of the discount on the corporation's books is not put away in a special fund for debt retirement purposes. There are no sinking funds on most of these issues. One hopes that corporate managers invest the proceeds properly and run the corporation for the benefit of all investors so that there will not be a cash crisis at maturity. The potentially large balloon repayment creates a cause for concern among investors. Thus it is most important to invest in higher-quality issues so as to reduce the risk of a potential problem. If one wants to speculate in lower-rated bonds, then that investment should throw off some cash return.

Finally, a variation of the zero-coupon bond is the *deferred-interest bond* (DIB), also known as a *zero-coupon bond*. These bonds generally have been subordinated issues of speculative-grade issuers, also known as *junk issuers*. Most of the issues are structured so that they do not pay cash interest for the first five years. At the end of the deferred-interest period, cash interest accrues and is paid semiannually until maturity, unless the bonds are redeemed earlier. The deferred-interest feature allows newly restructured, highly leveraged companies and others with less-than-satisfactory cash flows to defer the payment of cash interest over the early life of the bond. Barring anything untoward, when cash interest payments start, the company will be able to service the debt. If it has made excellent progress in restoring its financial health, the company may be able to redeem or refinance the debt rather than have high interest outlays.

An offshoot of the deferred-interest bond is the pay-in-kind (PIK) debenture. With PIKs, cash interest payments are deferred at the issuer's option until some future date. Instead of just accreting the original-issue discount as with DIBs or zeros, the issuer pays out the interest in additional pieces of the same security. The option to pay cash or in-kind interest payments rests with the issuer, but in many cases the issuer has little choice because provisions of other debt instruments often prohibit cash interest payments until certain indenture or loan tests are satisfied. The holder just gets more pieces of paper, but these at least can be sold in the market without giving up one's original investment; PIKs, DIBs, and zeros do not have provisions for the resale of the interest portion of the instrument. An investment in this type of bond, because it is issued by speculative-grade companies, requires careful analysis of the issuer's cash-flow prospects and ability to survive.

SECURITY FOR BONDS

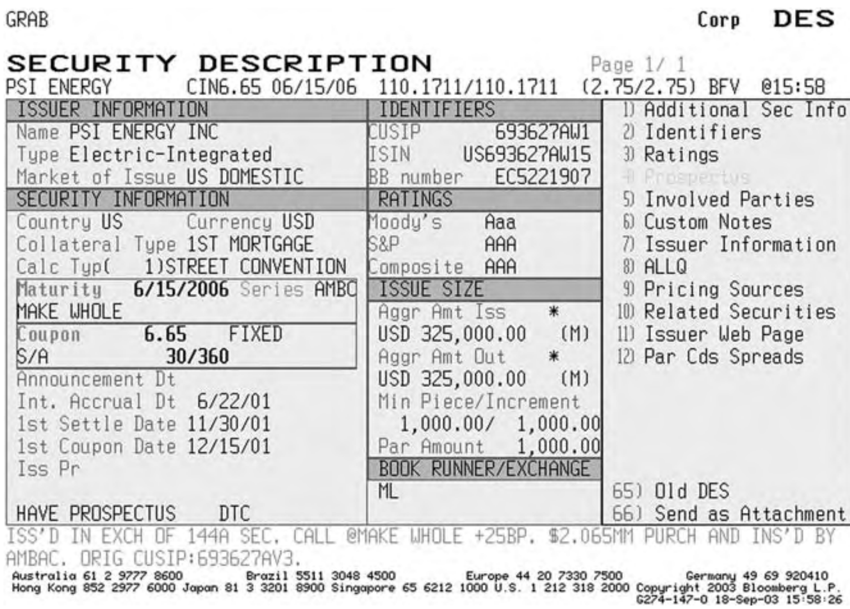
Investors who buy corporate bonds prefer some kind of security underlying the issue. Either real property (using a mortgage) or personal property may be pledged to offer security beyond that of the general credit standing of the issuer. In fact, the kind of security or the absence of a specific pledge of security is usually indicated by the title of a bond issue. However, the best security is a strong general credit that can repay the debt from earnings.

Mortgage Bond

A mortgage bond grants the bondholders a first-mortgage lien on substantially all its properties. This lien provides additional security for the bondholder. As a result, the issuer is able to borrow at a lower rate of interest than if the debt were unsecured. A debenture issue (i.e., unsecured debt) of the same issuer almost surely would carry a higher coupon rate, other things equal. A *lien* is a legal right to sell mortgaged property to satisfy unpaid obligations to bondholders. In practice, foreclosure of a

EXHIBIT 13–4

Bloomberg Security Description Screen of a PSI Energy First-Mortgage Bond



mortgage and sale of mortgaged property are unusual. If a default occurs, there is usually a financial reorganization on the part of the issuer, in which provision is made for settlement of the debt to bondholders. The mortgage lien is important, though, because it gives the mortgage bondholders a very strong bargaining position relative to other creditors in determining the terms of a reorganization.

Often first-mortgage bonds are issued in series with bonds of each series secured equally by the same first mortgage. As an example, Exhibit 13–4 presents a Bloomberg Security Description screen of a first-mortgage bond issued by PSI Energy. This issue has a coupon rate of 6.65% and matures on June 15, 2006. Many companies, particularly public utilities, have a policy of financing part of their capital requirements continuously by long-term debt. They want some part of their total capitalization in the form of bonds because the cost of such capital is ordinarily less than that of capital raised by sale of stock. Thus, as a principal amount of debt is paid off, they issue another series of bonds under the same mortgage. As they expand and need a greater amount of debt capital, they can add new series of bonds. It is a lot easier and more advantageous to issue a series of bonds under one mortgage and one indenture than it is to create entirely new bond issues with different arrangements for security. This arrangement is called a *blanket mortgage*. When property is sold or released from the lien of the mortgage, additional property or cash may be substituted or bonds may be retired in order to provide adequate security for the debtholders.

When a bond indenture authorizes the issue of additional series of bonds with the same mortgage lien as those already issued, the indenture imposes certain conditions that must be met before an additional series may be issued. Bondholders do not want their security impaired; these conditions are for their benefit. It is common for a first-mortgage bond indenture to specify that property acquired by the issuer subsequent to the granting of the first-mortgage lien shall be subject to the first-mortgage lien. This is termed the *after-acquired clause.* Then the indenture usually permits the issue of additional bonds up to some specified percentage of the value of the after-acquired property, such as 60%. The other 40%, or whatever the percentage may be, must be financed in some other way. This is intended to ensure that there will be additional assets with a value significantly greater than the amount of additional bonds secured by the mortgage. Another customary kind of restriction on the issue of additional series is a requirement that earnings in an immediately preceding period must be equal to some number of times the amount of annual interest on all outstanding mortgage bonds including the new or proposed series (1.5, 2, or some other number). For this purpose, *earnings* usually are defined as earnings before income tax. Still another common provision is that additional bonds may be issued to the extent that earlier series of bonds have been paid off.

One seldom sees a bond issue with the term *second mortgage* in its title. The reason is that this term has a connotation of weakness. Sometimes companies get around that difficulty by using such words as *first and consolidated, first and refunding,* or *general and refunding mortgage bonds.* Usually this language means that a bond issue is secured by a first mortgage on some part of the issuer's property but by a second or even third lien on other parts of its assets. A general and refunding mortgage bond is generally secured by a lien on all the company's property *subject* to the prior lien of first-mortgage bonds, if any are still outstanding.

Collateral Trust Bonds

Some companies do not own fixed assets or other real property and so have nothing on which they can give a mortgage lien to secure bondholders. Instead, they own securities of other companies; they are *holding companies,* and the other companies are *subsidiaries*. To satisfy the desire of bondholders for security, they pledge stocks, notes, bonds, or whatever other kinds of obligations they own. These assets are termed *collateral* (or personal property), and bonds secured by such assets are *collateral trust bonds*. Some companies own both real property and securities. They may use real property to secure mortgage bonds and use securities for collateral trust bonds. As an example, Exhibit 13–5 presents a Bloomberg Security Description screen for a collateral trust bond issued by National Rural Utilities in January 1999. The coupon rate on the bond is 5.7%, and it matures on January 15, 2010. According to the bond's prospectus, the

EXHIBIT 13–5

Bloomberg Security Description Screen of a National Rural Utilities Collateral Trust Bond

GRAB Corp DES

SECURITY DESCRIPTION Page 1/ 1

NATL RURAL UTIL NRUC5.7 01/15/10 108.156/108.156 (4.21/4.21) TRAC

ISSUER INFORMATION	IDENTIFIERS	1) Additional Sec Info
Name NATIONAL RURAL UTILITIES	CUSIP 637432CN3	2) Identifiers
Type Finance-Other Services	ISIN US637432CN32	3) Ratings
Market of Issue US DOMESTIC	BB number EC3793022	4) Fees/Restrictions
SECURITY INFORMATION	RATINGS	5) Prospectus
Country US Currency USD	Moody's Aaa	6) Sec. Specific News
Collateral Type COLLATERAL TRUST	S&P AAA	7) Involved Parties
Calc Typ(1)STREET CONVENTION	Fitch AAA	8) Custom Notes
Maturity 1/15/2010 Series MBIA	ISSUE SIZE	9) Issuer Information
NORMAL	Aggr Amt Iss *	10) ALLQ
Coupon 5.7 FIXED	USD 200,000.00 (M)	11) Pricing Sources
S/A 30/360	Aggr Amt Out *	12) Related Securities
Announcement Dt	USD 200,000.00 (M)	13) Issuer Web Page
Int. Accrual Dt 1/11/99	Min Piece/Increment	14) Par Cds Spreads
1st Settle Date 1/11/99	1,000.00/ 1,000.00	15) TRACE Trade Recap
1st Coupon Date 7/15/99	Par Amount 1,000.00	
Iss Pr	BOOK RUNNER/EXCHANGE	
	LEH	65) Old DES
HAVE PROSPECTUS DTC	TRACE	66) Send as Attachment

SEC'D. LONG 1ST CPN. $7.2MM PURCH & INS'D BY MBIA. ORIG CUSIP:637432CJ2.
MBIA INSURED TRADING OTC.

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securities deposited with the trustee include mortgage notes, cash, and other permitted investments. Note also that the bond is insured by MBIA.

The legal arrangement for collateral trust bonds is much the same as that for mortgage bonds. The issuer delivers to a corporate trustee under a bond indenture the securities pledged, and the trustee holds them for the benefit of the bondholders. When voting common stocks are included in the collateral, the indenture permits the issuer to vote the stocks so long as there is no default on its bonds. This is important to issuers of such bonds because usually the stocks are those of subsidiaries, and the issuer depends on the exercise of voting rights to control the subsidiaries.

Indentures usually provide that, in event of default, the rights to vote stocks included in the collateral are transferred to the trustee. Loss of the voting right would be a serious disadvantage to the issuer because it would mean loss of control of subsidiaries. The trustee also may sell the securities pledged for whatever prices they will bring in the market and apply the proceeds to payment of the claims of collateral trust bondholders. These rather drastic actions, however, usually are not taken immediately on an event of default. The corporate trustee's primary responsibility is to act in the best interests of bondholders, and their interests may be served for a time at least by giving the defaulting issuer a proxy to vote stocks held as collateral and thus preserve the holding company structure. It also may defer the sale of collateral when it seems likely that bondholders would fare better in a financial reorganization than they would by sale of collateral.

Collateral trust indentures contain a number of provisions designed to protect bondholders. Generally, the market or appraised value of the collateral must be maintained at some percentage of the amount of bonds outstanding. The percentage is greater than 100 so that there will be a margin of safety. If collateral value declines below the minimum percentage, additional collateral must be provided by the issuer. There is almost always provision for withdrawal of some collateral, provided other acceptable collateral is substituted.

Collateral trust bonds may be issued in series in much the same way that mortgage bonds are issued in series. The rules governing additional series of bonds require that adequate collateral must be pledged, and there may be restrictions on the use to which the proceeds of an additional series may be put. All series of bonds are issued under the same indenture and have the same claim on collateral.

Equipment Trust Certificates

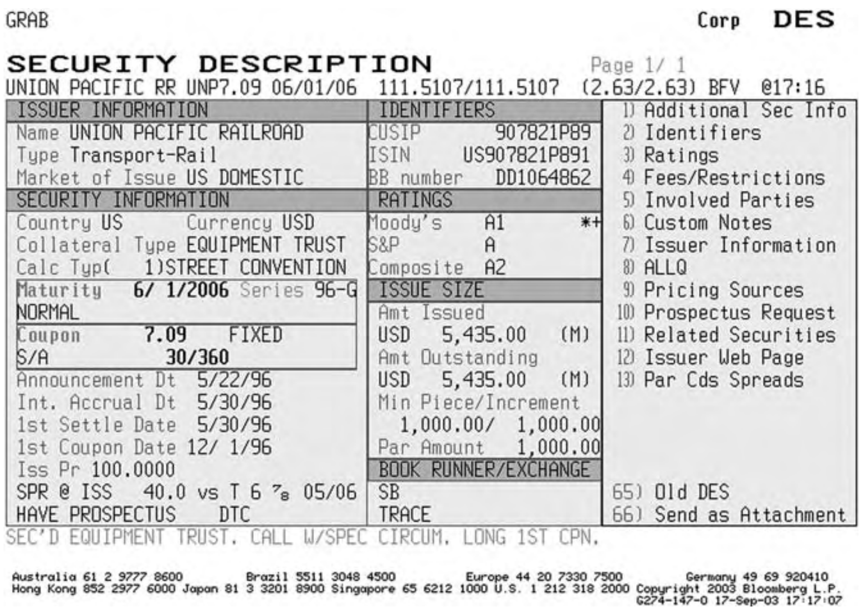
The desire of borrowers to pay the lowest possible rate of interest on their obligations generally leads them to offer their best security and to grant lenders the strongest claim on it. Many years ago, the railway companies developed a way of financing purchase of cars and locomotives, called *rolling stock,* that enabled them to borrow at just about the lowest rates in the corporate bond market.

Railway rolling stock has for a long time been regarded by investors as excellent security for debt. This equipment is sufficiently standardized that it can be used by one railway as well as another. And it can be readily moved from the tracks of one railroad to those of another. There is generally a good market for lease or sale of cars and locomotives. The railroads have capitalized on these characteristics of rolling stock by developing a legal arrangement for giving investors a legal claim on it that is different from, and generally better than, a mortgage lien.

The legal arrangement is one that vests legal title to railway equipment in a trustee, which is better from the standpoint of investors than a first-mortgage lien on property. A railway company orders some cars and locomotives from a manufacturer. When the job is finished, the manufacturer transfers the legal title to the equipment to a trustee. The trustee leases it to the railroad that ordered it and at the same time sells *equipment trust certificates* (ETCs) in an amount equal to a large percentage of the purchase price, normally 80%. Money from sale of certificates is paid to the manufacturer. The railway company makes an initial payment of rent equal to the balance of the purchase price, and the trustee gives that money to the manufacturer. Thus the manufacturer is paid off. The trustee collects lease rental money periodically from the railroad and uses it to pay interest and principal on the certificates. These interest payments are known as dividends. The amounts of lease rental payments are worked out carefully so that they are enough to pay the equipment trust certificates. At the end of some period of time, such as

EXHIBIT 13–6

Bloomberg Security Description Screen of a Union Pacific Railroad Equipment Trust Certificate


GRAB Corp DES

SECURITY DESCRIPTION Page 1/ 1
UNION PACIFIC RR UNP7.09 06/01/06 111.5107/111.5107 (2.63/2.63) BFV @17:16

ISSUER INFORMATION	IDENTIFIERS	
Name UNION PACIFIC RAILROAD	CUSIP 907821P89	1) Additional Sec Info
Type Transport-Rail	ISIN US907821P891	2) Identifiers
Market of Issue US DOMESTIC	BB number DD1064862	3) Ratings
SECURITY INFORMATION	RATINGS	4) Fees/Restrictions
Country US Currency USD	Moody's A1 *+	5) Involved Parties
Collateral Type EQUIPMENT TRUST	S&P A	6) Custom Notes
Calc Typ(1)STREET CONVENTION	Composite A2	7) Issuer Information
Maturity 6/ 1/2006 Series 96-G	ISSUE SIZE	8) ALLQ
NORMAL	Amt Issued	9) Pricing Sources
Coupon 7.09 FIXED	USD 5,435.00 (M)	10) Prospectus Request
S/A 30/360	Amt Outstanding	11) Related Securities
Announcement Dt 5/22/96	USD 5,435.00 (M)	12) Issuer Web Page
Int. Accrual Dt 5/30/96	Min Piece/Increment	13) Par Cds Spreads
1st Settle Date 5/30/96	1,000.00/ 1,000.00	
1st Coupon Date 12/ 1/96	Par Amount 1,000.00	
Iss Pr 100.0000	BOOK RUNNER/EXCHANGE	
SPR @ ISS 40.0 vs T 6 7/8 05/06	SB	65) Old DES
HAVE PROSPECTUS DTC	TRACE	66) Send as Attachment

SEC'D EQUIPMENT TRUST. CALL W/SPEC CIRCUM. LONG 1ST CPN.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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15 years, the certificates are paid off, the trustee sells the equipment to the railroad for some nominal price, and the lease is terminated.

As an example, Exhibit 13–6 presents a Bloomberg Security Description screen for an equipment trust certificate issued by the Union Pacific Railroad in May 1996. This certificate carries a coupon rate of 7.09% and pays interest semiannually. As can be seen in the left-center part of the screen, this certificate was issued as part of a series. The certificate matures on June 1, 2006.

Railroad ETCs usually are structured in serial form; that is, a certain amount becomes payable at specified dates until the final installment. For example, a $60 million ETC might mature $4 million on each June 15 from 2000 through 2014. Each of the 15 maturities may be priced separately to reflect the shape of the yield curve, investor preference for specific maturities, and supply-and-demand considerations. The advantage of a serial issue from the investor's point of view is that the repayment schedule matches the decline in the value of the equipment used as collateral. Hence principal repayment risk is reduced. From the issuer's side, serial maturities allow for the repayment of the debt periodically over the life of the issue, making less likely a crisis at maturity due to a large repayment coming due at one time.

The beauty of this arrangement from the viewpoint of investors is that the railroad does not legally own the rolling stock until all the certificates are paid. In case the railroad does not make the lease rental payments, there is no big legal hassle about foreclosing a lien. The trustee owns the property and can take it back because failure to pay the rent breaks the lease. The trustee can lease the equipment to another railroad and continue to make payments on the certificates from new lease rentals.

This description emphasizes the legal nature of the arrangement for securing the certificates. In practice, these certificates are regarded as obligations of the railway company that leased the equipment and are shown as liabilities on its balance sheet. In fact, the name of the railway appears in the title of the certificates. In the ordinary course of events, the trustee is just an intermediary who performs the function of holding title, acting as lessor, and collecting the money to pay the certificates. It is significant that even in the worst years of a depression, railways have paid their equipment trust certificates, although they did not pay bonds secured by mortgages. Although railroads have issued the largest amount of equipment trust certificates, airlines also have used this form of financing.

Debenture Bonds

While bondholders prefer to have security underlying their bonds, all else equal, most bonds issued are unsecured. These unsecured bonds are called *debentures.* With the exception of the utilities and structured products, nearly all other corporate bonds issued are unsecured.

Debentures are not secured by a specific pledge of designated property, but this does not mean that they have no claim on the property of issuers or on their earnings. Debenture bondholders have the claim of general creditors on all assets of the issuer not pledged specifically to secure other debt. And they even have a claim on pledged assets to the extent that these assets have value greater than necessary to satisfy secured creditors. In fact, if there are no pledged assets and no secured creditors, debenture bondholders have first claim on all assets along with other general creditors.

These unsecured bonds are sometimes issued by companies that are so strong financially and have such a high credit rating that to offer security would be superfluous. Such companies simply can turn a deaf ear to investors who want security and still sell their debentures at relatively low interest rates. But debentures sometimes are issued by companies that have already sold mortgage bonds and given liens on most of their property. These debentures rank below the mortgage bonds or collateral trust bonds in their claim on assets, and investors may regard them as relatively weak. This is the kind that bears the higher rates of interest.

Even though there is no pledge of security, the indentures for debenture bonds may contain a variety of provisions designed to afford some protection to investors. Frequently the amount of a debenture bond issue is limited to the amount of the initial issue. This limit is to keep issuers from weakening the position of debenture holders by running up additional unsecured debt. Sometimes additional debentures may be issued a specified number of times in a recent accounting period, provided that the issuer has earned its bond interest on all existing debt plus the additional issue.

If a company has no secured debt, it is customary to provide that debentures will be secured equally with any secured bonds that may be issued in the future. This is known as the *negative-pledge clause.* Some provisions of debenture bond issues are intended to give the corporate trustee early warning of deterioration in the issuer's financial condition. The issuer may be required to always maintain a specified minimum amount of net working capital—the excess of current assets over current liabilities—equal to not less than the amount of debentures outstanding. The corporate trustee must watch the issuer's balance sheet and, on failure to maintain the required amount of net working capital, take whatever action is appropriate in the interest of debenture holders. Another common restriction is one limiting the payment of cash dividends by the issuer. Another restriction limits the proportion of current earnings that may be used to pay dividends. However, the trend in recent years, at least with investment-grade companies, is away from indenture restrictions.

Subordinated and Convertible Debentures

Many corporations issue *subordinated debenture bonds*. The term *subordinated* means that such an issue ranks after secured debt, after debenture bonds, and often after some general creditors in its claim on assets and earnings. Owners of this kind of bond stand last in line among creditors when an issuer fails financially.

Because subordinated debentures are weaker in their claim on assets, issuers would have to offer a higher rate of interest unless they also offer some special inducement to buy the bonds. The inducement can be an option to convert bonds into stock of the issuer at the discretion of bondholders. If the issuer prospers and the market price of its stock rises substantially in the market, the bondholders can convert bonds to stock worth a great deal more than what they paid for the bonds. This conversion privilege also may be included in the provisions of debentures that are not subordinated. Convertible securities are discussed in Part 8.

The bonds may be convertible into the common stock of a corporation other than that of the issuer. Such issues are called *exchangeable bonds.* There are also issues indexed to a commodity's price or its cash equivalent at the time of maturity or redemption.

Guaranteed Bonds

Sometimes a corporation may guarantee the bonds of another corporation. Such bonds are referred to as *guaranteed bonds.* The guarantee, however, does not mean that these obligations are free of default risk. The safety of a guaranteed bond depends on the financial capability of the guarantor to satisfy the terms of the guarantee, as well as the financial capability of the issuer. The terms of the guarantee may call for the guarantor to guarantee the payment of interest and/or repayment of the principal. A guaranteed bond may have more than one corporate guarantor. Each guarantor may be responsible for not only its pro rata share but also the entire amount guaranteed by the other guarantors.

ALTERNATIVE MECHANISMS TO RETIRE DEBT BEFORE MATURITY

We can partition the alternative mechanisms to retire debt into two broad categories—namely, those mechanisms that must be included in the bond's indenture in order to be used and those mechanisms that can used without being included in the bond's indenture. Among those debt retirement mechanisms included in a bond's indenture are the following: call and refunding provisions, sinking funds, maintenance and replacement funds, and redemption through sale of assets. Alternatively, some debt retirement mechanisms are not required to be included in the bond indenture (e.g., fixed-spread tender offers).

Call and Refunding Provisions

Many corporate bonds contain an embedded option that gives the issuer the right to buy the bonds back at a fixed price either in whole or in part prior to maturity. The feature is known as a *call provision*. The ability to retire debt before its scheduled maturity date is a valuable option for which bondholders will demand compensation ex-ante. All else equal, bondholders will pay a lower price for a callable bond than an otherwise identical option-free (i.e., straight) bond. The difference between the price of an option-free bond and the callable bond is the value of the embedded call option.

Conventional wisdom suggests that the most compelling reason for corporations to retire their debt prior to maturity is to take advantage of declining borrowing rates. If they are able to do so, firms will substitute new, lower-cost debt for older, higher-cost issues. However, firms retire their debt for other reasons as well. For example, firms retire their debt to eliminate restrictive covenants, to alter their capital structure, to increase shareholder value, or to improve financial/managerial flexibility. There are two types of call provisions included in corporate bonds—a fixed-price call and a make-whole call. We will discuss each in turn.

Fixed-Price Call Provision

With a standard fixed-price call provision, the bond issuer has the option to buy back some or all of the bond issue prior to maturity at a fixed price. The fixed price is termed the *call price*. Normally, the bond's indenture contains a call-price schedule that specifies when the bonds can be called and at what prices. The call prices generally start at a substantial premium over par and decline toward par over time such that in the final years of a bond's life, the call price is usually par.

In some corporate issues, bondholders are afforded some protection against a call in the early years of a bond's life. This protection usually takes one of two forms. First, some callable bonds possess a feature that prohibits a bond call for a certain number of years. Second, some callable bonds prohibit the bond from being refunded for a certain number of years. Such a bond is said to be *nonrefundable.* Prohibition of refunding precludes the redemption of a bond issue if the funds used to repurchase the bonds come from new bonds being issued with a lower coupon than the bonds being redeemed. However, a refunding prohibition does not prevent the redemption of bonds from funds obtained from other sources (e.g., asset sales, the issuance of equity, etc.) Call prohibition provides the bondholder with more protection than a bond that has a refunding prohibition that is otherwise callable.[3]

Make-Whole Call Provision

In contrast to a standard fixed-price call, a make-whole call price is calculated as the present value of the bond's remaining cash flows subject to a floor price equal to par value. The discount rate used to determine the present value is the yield on a comparable-maturity Treasury security plus a contractually specified *make-whole call premium.* For example, in March 2001, Coca-Cola announced the issuance of $500 million of 5.75% coupon global notes with a maturity date of March 15, 2011. These notes are redeemable at any time either in whole or in part at the issuer's option. The redemption price is the greater of (1) 100% of the principal amount plus accrued interest or (2) the make-whole redemption price, which is equal to the sum of the present value of the remaining coupon and principal payments discounted at the Treasury rate plus 15 basis points. The spread of 15 basis points is the aforementioned make-whole call premium. Thus the make-whole call price is essentially a floating call price that moves inversely with the level of interest rates.

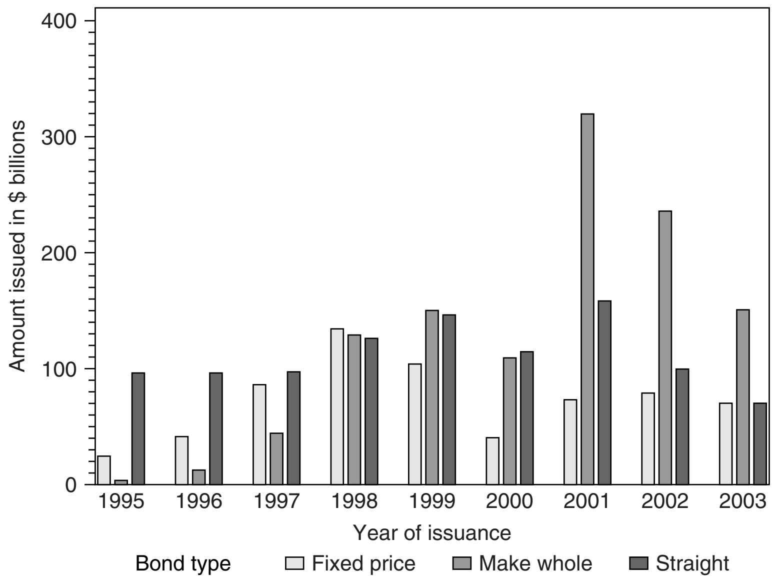
The Treasury rate is calculated in one of two ways. The most common method is to use a constant-maturity Treasury (CMT) yield as the Treasury rate. CMT yields are published weekly by the Federal Reserve in its statistical release H.15. The maturity of the CMT yield will match the bond's remaining maturity (rounded to the nearest month). If there is no CMT yield that exactly corresponds with the bond's remaining maturity, a linear interpolation is employed using the yields of the two closest available CMT maturities. Once the CMT yield is determined, the discount rate for the bond's remaining cash flows is simply the CMT yield plus the make-whole call premium specified in the indenture.

The second and less common method of determining the Treasury rate is to select a U.S. Treasury security having a maturity comparable with the remaining maturity of the make-whole call bond in question. This selection is made by a primary U.S. Treasury dealer designated in the bond's indenture. An average price for the selected Treasury security is calculated using the price quotations of

3. There are, of course, exceptions to a call prohibition, such as sinking funds and redemption of the debt under certain mandatory provisions.

EXHIBIT 13–7

Total Par Amount of Corporate Bonds Outstanding by Type of Call Provision



multiple primary dealers. The average price is then used to calculate a bond-equivalent yield. This yield is then used as the Treasury rate.

Make-whole call provisions were first introduced in publicly traded corporate bonds in 1995. Bonds with make-whole call provisions are now issued routinely. Moreover, the make-whole call provision is growing in popularity while bonds with fixed-price call provisions are declining. Exhibit 13–7 presents a graph that shows the total par amount outstanding of corporate bonds issued in billions of dollars by type of bond (straight, fixed-price call, make-whole call) for years 1995 to 2003 (through June 30).[4] This sample of bonds contains all debentures issued on and after January 1, 1995, that might have certain characteristics.[5] These data suggest that the make-whole call provision is rapidly becoming the call feature of choice for corporate bonds.

The primary advantage from the firm's perspective of a make-whole call provision relative to a fixed-price call is a lower cost. Since the make-whole call price floats inversely with the level of Treasury rates, the issuer will not exercise

4. Our data source is the Fixed Income Securities Database jointly published by LJS Global Information Services and Arthur Warga at the University of Houston.

5. These characteristics include such things as the offering amount had to be at least $25 million and excluded medium-term notes and bonds with other embedded options (e.g., bonds that were putable or convertible).

the call to buy back the debt merely because its borrowing rates have declined. Simply put, the pure refunding motive is virtually eliminated. This feature will reduce the upfront compensation required by bondholders to hold make-whole call bonds versus fixed-price call bonds.

Sinking-Fund Provision

Term bonds may be paid off by operation of a *sinking fund.* These last two words are often misunderstood to mean that the issuer accumulates a fund in cash, or in assets readily sold for cash, that is used to pay bonds at maturity. It had that meaning many years ago, but too often the money supposed to be in a sinking fund was not all there when it was needed. In modern practice, there is no fund, and *sinking* means that money is applied periodically to redemption of bonds before maturity. Corporate bond indentures require the issuer to retire a specified portion of an issue each year. This kind of provision for repayment of corporate debt may be designed to liquidate all of a bond issue by the maturity date, or it may be arranged to pay only a part of the total by the end of the term. As an example, consider $50 million in debentures issued by K. N. Energy in September 1993. The bonds carry a 6.5% coupon rate and mature on September 1, 2013. The bonds' indenture provides for an annual sinking-fund payment of $5 million beginning on September 1, 2004. Exhibit 13–8 presents a Bloomberg screen of the sinking-fund schedule for this issue. On its maturity date, the balloon maturity will be $5 million, or 10% of the original amount issued. If only a part is paid, the remainder is called a *balloon maturity.*

The issuer may satisfy the sinking-fund requirement in one of two ways. A cash payment of the face amount of the bonds to be retired may be made by the corporate debtor to the trustee. The trustee then calls the bonds by lot for redemption. Bonds have serial numbers, and numbers may be selected randomly for redemption. Owners of bonds called in this manner turn them in for redemption; *interest payments stop at the redemption date.* Alternatively, the issuer can deliver to the trustee bonds with a total face value equal to the amount that must be retired. The bonds are purchased by the *issuer* in the open market. This option is elected by the issuer when the bonds are selling below par. A few corporate bond indentures, however, prohibit the open-market purchase of the bonds by the issuer.

Many electric utility bond issues can satisfy the sinking-fund requirement by a third method. Instead of actually retiring bonds, the company may certify to the trustee that it has used unfunded property credits in lieu of the sinking fund. That is, it has made property and plant investments that have not been used for issuing bonded debt. For example, if the sinking-fund requirement is $1 million, it may give the trustee $1 million in cash to call bonds, it may deliver to the trustee $1 million of bonds it purchased in the open market, or it may certify that it made additions to its property and plant in the required amount, normally $1,667 of plant for each $1,000 sinking-fund requirement. In this case it could satisfy the sinking fund with certified property additions of $1,667,000.

EXHIBIT 13–8

Bloomberg Screen of a Sinking-Fund Schedule for a K. N. Energy Bond.

GRAB Corp **DES**

K N ENERGY INC KMI6 ½ 09/01/13 107.1358/107.1358 (5.56/5.56) BFV @17:11

SINKING FUND SCHEDULE

Type LEVEL Sink Page 2/ 2
Frequency ANNUAL Amt Issued 50,000.00 (M)
Voluntary 1.00 X Scheduled Amt Outstanding 50000.00 (M)
Next Mandatory Sink 9/ 1/04
Avg Life 1/09 Shortest 9/06 Longest 3/09

Data relative to issue date

Date	Amount Cash	Amount %	Total Sunk Cash	Total Sunk %	Remaining Balance Cash	Remaining Balance %
9/ 1/04	5000M	10.0000000	5000M	10.0000	45000M	90.00
9/ 1/05	5000M	10.0000000	10000M	20.0000	40000M	80.00
9/ 1/06	5000M	10.0000000	15000M	30.0000	35000M	70.00
9/ 1/07	5000M	10.0000000	20000M	40.0000	30000M	60.00
9/ 1/08	5000M	10.0000000	25000M	50.0000	25000M	50.00
9/ 1/09	5000M	10.0000000	30000M	60.0000	20000M	40.00
9/ 1/10	5000M	10.0000000	35000M	70.0000	15000M	30.00
9/ 1/11	5000M	10.0000000	40000M	80.0000	10000M	20.00
9/ 1/12	5000M	10.0000000	45000M	90.0000	5000M	10.00

MENU to return to main DES page. PG FWD to see more sink schedule

The issuer is granted a special call price to satisfy any sinking-fund requirement. Usually, the sinking-fund call price is the par value if the bonds were originally sold at par. When issued at a price in excess of par, the sinking-fund call price generally starts at the issuance price and scales down to par as the issue approaches maturity.

There are two advantages of a sinking-fund requirement from the bondholder's perspective. First, default risk is reduced because of the orderly retirement of the issue before maturity. Second, if bond prices decline as a result of an increase in interest rates, price support may be provided by the issuer or its fiscal agent because it must enter the market on the buy side in order to satisfy the sinking-fund requirement. However, the disadvantage is that the bonds may be called at the special sinking-fund call price at a time when interest rates are lower than rates prevailing at the time of issuance. In that case, the bonds will be selling above par but may be retired by the issuer at the special call price that may be equal to par value.

Usually, the periodic payments required for sinking-fund purposes will be the same for each period. Gas company issues often have increasing sinking-fund requirements. However, a few indentures might permit variable periodic payments, where the periodic payments vary based on prescribed conditions set forth in the indenture. The most common condition is the level of earnings of the issuer. In such cases, the periodic payments vary directly with earnings. An issuer prefers such flexibility; however, an investor may prefer fixed periodic payments because of the greater default risk protection provided under this arrangement.

Many corporate bond indentures include a provision that grants the issuer the option to retire more than the amount stipulated for sinking-fund retirement. This option, referred to as an *accelerated sinking-fund provision,* effectively reduces the bondholder's call protection because, when interest rates decline, the issuer may find it economically advantageous to exercise this option at the special sinking-fund call price to retire a substantial portion of an outstanding issue.

With the exception of finance companies, industrial issues almost always include sinking-fund provisions. Finance companies, on the other hand, almost always do not. The inclusion or absence of a sinking-fund provision in public utility debt obligations depends on the type of public utility. Pipeline issues almost always include sinking-fund provisions, whereas telephone issues do not. Electric utility companies have varying sinking-fund provisions. There can be a mandatory sinking fund where bonds have to be retired or, as mentioned earlier, a nonmandatory sinking fund in which it may use certain property credits for the sinking-fund requirement. If the sinking fund applies to a particular issue, it is called a *specific sinking fund.* There are also *nonspecific sinking funds* (also known as *funnel, tunnel, blanket,* or *aggregate sinking funds*), where the requirement is based on the total bonded debt outstanding of an issuer. Generally, it might require a sinking-fund payment of 1% of all bonds outstanding as of year-end. The issuer can apply the requirement to one particular issue or to any other issue or issues. Again, the blanket sinking fund may be mandatory (where bonds have to be retired) or nonmandatory (whereby it can use unfunded property additions).

Maintenance and Replacement Funds

Maintenance and replacement fund (M&R) provisions first appeared in bond indentures of electric utilities subject to regulation by the Securities and Exchange Commission (SEC) under the Public Holding Company Act of 1940. It remained in the indentures even when most of the utilities were no longer subject to regulation under the act. The original motivation for their inclusion is straightforward. Property is subject to economic depreciation, and the replacement fund ostensibly helps to maintain the integrity of the property securing the bonds. An M&R differs from a sinking fund in that the M&R only helps to maintain the value of the security backing the debt, whereas a sinking fund is designed to improve the security backing the debt. Although it is more complex, it is similar in spirit to a provision in a home mortgage requiring the homeowner to maintain the home in good repair.

An M&R requires a utility to determine annually the amounts necessary to satisfy the fund and any shortfall. The requirement is based on a formula that is usually some percentage (e.g., 15%) of adjusted gross operating revenues. The difference between what is required and the actual amount expended on maintenance is the shortfall. The shortfall is usually satisfied with unfunded property additions, but it also can be satisfied with cash. The cash can be used for the retirement of debt or withdrawn on the certification of unfunded property credits.

While the retirement of debt through M&R provisions is not as common as it once was, M&Rs are still used, so bond investors should be cognizant of their presence in an indenture. For example, in April 2000, PPL Electric Utilities Corporation redeemed all its outstanding 9.25% coupon series first-mortgage bonds due in 2019 using an M&R provision. The special redemption price was par. The company's stated purpose of the call was to reduce interest expense.

Redemption through the Sale of Assets and Other Means

Because mortgage bonds are secured by property, bondholders want the integrity of the collateral to be maintained. Bondholders would not want a company to sell a plant (which has been pledged as collateral) and then to use the proceeds for a distribution to shareholders. Therefore, release-of-property and substitution-of-property clauses are found in most bond indentures.

As an illustration, Texas–New Mexico Power Co. issued $130 million in first-mortgage bonds in January 1992 that carried a coupon rate of 11.25%. The bonds were callable beginning in January 1997 at a call price of 105. Following the sale of six of its utilities, Texas–New Mexico Power called the bonds at par in October 1995, well before the first call date. As justification for the call, Texas–New Mexico Power stated that it was forced to sell the six utilities by municipalities in northern Texas, and as a result, the bonds were callable under the eminent domain provision in the bond's indenture. The bondholders sued, stating that the bonds were redeemed in violation of the indenture. In April 1997, the court found for the bondholders, and they were awarded damages, as well as lost interest. In the judgment of the court, while the six utilities were under the threat of condemnation, no eminent domain proceedings were initiated.

Tender Offers

In addition to those methods specified in the indenture, firms have other tools for extinguishing debt prior to its stated maturity. At any time a firm may execute a tender offer and announce its desire to buy back specified debt issues. Firms employ tender offers to eliminate restrictive covenants or to refund debt. Usually the tender offer is for "any and all" of the targeted issue, but it also can be for a fixed dollar amount that is less than the outstanding face value. An offering circular is sent to the bondholders of record stating the price the firm is willing to pay and the window of time during which bondholders can sell their bonds back to the firm. If the firm perceives that participation is too low, the firm can increase the tender offer price and extend the tender offer window. When the tender offer expires, all participating bondholders tender their bonds and receive the same cash payment from the firm.

Recently, tender offers have been executed using a fixed spread as opposed to a fixed price.[6] In a fixed-spread tender offer, the tender offer price is equal to the present value of the bond's remaining cash flows either to maturity or the next call date if the bond is callable. The present-value calculation occurs immediately after the tender offer expires. The discount rate used in the calculation is equal to the yield-to-maturity on a comparable-maturity Treasury or the associated CMT yield plus the specified fixed spread. Fixed-spread tender offers eliminate the exposure to interest-rate risk for both bondholders and the firm during the tender offer window.

CREDIT RISK

All corporate bonds are exposed to credit risk, which includes *credit default risk* and *credit spread risk.*

Measuring Credit Default Risk

Any bond investment carries with it the uncertainty as to whether the issuer will make timely payments of interest and principal as prescribed by the bond's indenture. This risk is termed *credit default risk* and is the risk that a bond issuer will be unable to meet its financial obligations. Institutional investors have developed tools for analyzing information about both issuers and bond issues that assist them in accessing credit default risk. These techniques are discussed in later chapters. However, most individual bond investors and some institutional bond investors do not perform any elaborate credit analysis. Instead, they rely largely on bond ratings published by the major rating agencies that perform the credit analysis and publish their conclusions in the form of ratings. The three major nationally recognized statistical rating organizations (NRSROs) in the United States are Fitch Ratings, Moody's, and Standard & Poor's. These ratings are used by market participants as a factor in the valuation of securities on account of their independent and unbiased nature.

The ratings systems use similar symbols, as shown in Exhibit 13–9. In addition to the generic rating category, Moody's employs a numerical modifier of 1, 2, or 3 to indicate the relative standing of a particular issue within a rating category. This modifier is called a *notch*. Both Standard & Poor's and Fitch use a plus (+) and a minus (–) to convey the same information. Bonds rated triple B or higher are referred to as *investment-grade bonds.* Bonds rated below triple B are referred to as *non-investment-grade bonds* or, more popularly, *high-yield bonds* or *junk bonds.*

Credit ratings can and do change over time. A *rating transition table,* also called a *rating migration table,* is a table that shows how ratings change over

6. See Steven V. Mann and Eric A. Powers, "Determinants of Bond Tender Offer Premiums and Tendering Rates," Moore School of Business, 2003 working paper.

EXHIBIT 13–9

Corporate Bond Credit Ratings

Fitch	Moody's	S&P	Summary Description
			Investment Grade
AAA	Aaa	AAA	Gilt edged, prime, maximum safety, lowest risk, and when sovereign borrower considered "default-free"
AA+	Aa1	AA+	
AA	Aa2	AA	High-grade, high credit quality
AA–	Aa3	AA–	
A+	A1	A+	
A	A2	A	Upper-medium grade
A–	A3	A–	
BBB+	Baa1	BBB+	
BBB	Baa2	BBB	Lower-medium grade
BBB–	Baa3	BBB–	
			Speculative Grade
BB+	Ba1	BB+	
BB	Ba2	BB	Low grade; speculative
BB–	Ba3	BB–	
B+	B1		
B	B	B	Highly speculative
B–	B3		
			Predominantly Speculative, Substantial Risk or in Default
CCC+		CCC+	
CCC	Caa	CCC	Substantial risk, in poor standing
CC	Ca	CC	May be in default, very speculative
C	C	C	Extremely speculative
		CI	Income bonds—no interest being paid
DDD			
DD			Default
D	D		

some specified time period. Exhibit 13–10 presents a hypothetical rating transition table for a one-year time horizon. The ratings beside each of the rows are the ratings at the start of the year. The ratings at the head of each column are the ratings at the end of the year. Accordingly, the first cell in the table tells that 93.20% of the issues that were rated AAA at the beginning of the year still had that rating at

EXHIBIT 13.10

Hypothetical One-Year Rating Transition Table

Rating at Start of Year	*Rating at End of Year*								
	AAA	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**	**D**	**Total**
AAA	93.20	6.00	0.60	0.12	0.08	0.00	0.00	0.00	100
AA	1.60	92.75	5.07	0.36	0.11	0.07	0.03	0.01	100
A	0.18	2.65	91.91	4.80	0.37	0.02	0.02	0.05	100
BBB	0.04	0.30	5.20	87.70	5.70	0.70	0.16	0.20	100
BB	0.03	0.11	0.61	6.80	81.65	7.10	2.60	1.10	100
B	0.01	0.09	0.55	0.88	7.90	75.67	8.70	6.20	100
CCC	0.00	0.01	0.31	0.84	2.30	8.10	62.54	25.90	100

the end. These tables are published periodically by the three rating agencies and can be used to access changes in credit default risk.

Measuring Credit-Spread Risk

The *credit spread* is the difference between a corporate bond's yield and the yield on a comparable-maturity benchmark Treasury security.[7] Credit spreads are so named because the presumption is that the difference in yields is due primarily to the corporate bond's exposure to credit risk. This is misleading, however, because the risk profile of corporate bonds differs from Treasuries on other dimensions; namely, corporate bonds are less liquid and often have embedded options.

Credit-spread risk is the risk of financial loss or the underperformance of a portfolio resulting from changes in the level of credit spreads used in the marking to market of a fixed income product. Credit spreads are driven by both macroeconomic forces and issue-specific factors. Macroeconomic forces include such things as the level and slope of the Treasury yield curve, the business cycle, and consumer confidence. Correspondingly, the issue-specific factors include such things as the corporation's financial position and the future prospects of the firm and its industry.

One method used commonly to measure credit-spread risk is spread duration. Spread duration is the approximate percentage change in a bond's price for a 100 basis point change in the credit spread assuming that the Treasury rate is

7. The U.S. Treasury yield curve is a common but by no means the only choice for a benchmark to compute credit spreads. Other reasonable choices include the swap curve or the agency yield curve.

unchanged. For example, if a bond has a spread duration of 3, this indicates that for a 100 basis point change in the credit spread, the bond's price should change be approximately 3%. Spread duration is discussed in Chapter 9.

EVENT RISK

In recent years, one of the more talked-about topics among corporate bond investors is *event risk.* Over the last couple of decades, corporate bond indentures have become less restrictive, and corporate managements have been given a free rein to do as they please without regard to bondholders. Management's main concern or duty is to enhance shareholder wealth. As for the bondholder, all a company is required to do is to meet the terms of the bond indenture, including the payment of principal and interest. With few restrictions and the optimization of shareholder wealth of paramount importance for corporate managers, it is no wonder that bondholders became concerned when merger mania and other events swept the nation's boardrooms. Events such as decapitalizations, restructurings, recapitalizations, mergers, acquisitions, leveraged buyouts, and share repurchases, among other things, often caused substantial changes in a corporation's capital structure, namely, greatly increased leverage and decreased equity. Bondholders' protection was sharply reduced and debt quality ratings lowered, in many cases to speculative-grade categories. Along with greater risk came lower bond valuations. Shareholders were being enriched at the expense of bondholders.

In reaction to the increased activity of corporate raiders and mergers and acquisitions, some companies incorporated "poison puts" in their indentures. These are designed to thwart unfriendly takeovers by making the target company unpalatable to the acquirer. The poison put provides that the bondholder can require the company to repurchase the debt under certain circumstances arising out of specific designated events such as a change in control. Poison puts may not deter a proposed acquisition but could make it more expensive. In some cases, if the board of directors approves the change in control—a "friendly" transaction (and all takeovers are friendly if the price is right)—the poison put provisions will not become effective. The designated event of change in control generally means either that continuing directors no longer constitute a majority of the board of directors or that a person, including affiliates, becomes the beneficial owner, directly or indirectly, of stock with at least 20% of the voting rights. Many times, in addition to a designated event, a rating change to below investment grade must occur within a certain period for the put to be activated. Some issues provide for a higher interest rate instead of a put as a designated event remedy.

Event risk has caused some companies to include other special debt-retirement features in their indentures. An example is the *maintenance of net worth clause* included in the indentures of some lower-rated bond issues. In this case, an issuer covenants to maintain its net worth above a stipulated level, and if it fails to do so, it must begin to retire its debt at par. Usually the redemptions affect only part of the issue and continue periodically until the net worth recovers to an amount above the stated figure or the debt is retired. In other cases, the company is required only to *offer to redeem* a required amount. An offer to redeem is not mandatory on the bondholders' part; only those holders who want their bonds redeemed need do so. In a number of instances in which the issuer is required to call bonds, the bondholders may elect not to have bonds redeemed. This is not much different from an offer to redeem. It may protect bondholders from the redemption of the high-coupon debt at lower interest rates. However, if a company's net worth declines to a level low enough to activate such a call, it probably would be prudent to have one's bonds redeemed.

Protecting the value of debt investments against the added risk caused by corporate management activity is not an easy job. Investors should analyze the issuer's fundamentals carefully to determine if the company may be a candidate for restructuring. Attention to news and equity investment reports can make the task easier. Also, the indenture should be reviewed to see if there are any protective features. However, even these often can be circumvented by sharp legal minds. Toward this end, some of the debt rating services issue commentary on indenture features of corporate bonds, noting the degree of protection against event risk. Of course, large portfolios can reduce risk with broad diversification among industry lines, but price declines do not always affect only the issue at risk; they also can spread across the board and take the innocent down with them. This happened in the fall of 1988 with the leveraged buyout of RJR Nabisco, Inc. The whole industrial bond market suffered as buyers and traders withdrew from the market, new issues were postponed, and secondary market activity came to a standstill. The impact of the initial leveraged buyout bid announcement on yield spreads for RJR Nabisco's debt to a benchmark Treasury increased from about 100 to 350 basis points. The RJR Nabisco transaction showed that size was not an obstacle. Therefore, other large firms that investors previously thought were unlikely candidates for a leveraged buyout were fair game. The spillover effect caused yield spreads to widen for other major corporations.

HIGH-YIELD BONDS

As noted, high-yield bonds are those rated below investment grade by the ratings agencies. These issues are also known as *junk bonds*. Despite the negative connotation of the term *junk,* not all bonds in the high-yield sector are on the verge of default or bankruptcy. Many of these issues are on the fringe of the investment-grade sector.

Types of Issuers

Several types of issuers fall into the less-than-investment-grade high-yield category. These categories are discussed below.

Original Issuers

Original issuers include young, growing concerns lacking the stronger balance sheet and income statement profile of many established corporations but often with lots of promise. Also called *venture-capital situations* or *growth or emerging market companies,* the debt is often sold with a story projecting future financial strength. From this we get the term *story bond.* There are also the established operating firms with financials neither measuring up to the strengths of investment-grade corporations nor possessing the weaknesses of companies on the verge of bankruptcy. Subordinated debt of investment-grade issuers may be included here. A bond rated at the bottom rung of the investment-grade category (Baa and BBB) or at the top end of the speculative-grade category (Ba and BB) is referred to as a "businessman's risk."

Fallen Angels

"Fallen angels" are companies with investment-grade-rated debt that have come on hard times with deteriorating balance sheet and income statement financial parameters. They may be in default or near bankruptcy. In these cases, investors are interested in the workout value of the debt in a reorganization or liquidation, whether within or outside the bankruptcy courts. Some refer to these issues as "special situations." Over the years, they have fallen on hard times; some have recovered, and others have not.

Restructurings and Leveraged Buyouts

These are companies that have deliberately increased their debt burden with a view toward maximizing shareholder value. The shareholders may be the existing public group to which the company pays a special extraordinary dividend, with the funds coming from borrowings and the sale of assets. Cash is paid out, net worth decreased, and leverage increased, and ratings drop on existing debt. Newly issued debt gets junk-bond status because of the company's weakened financial condition. In 1988, The Kroger Co. declared a dividend of about $3.2 billion in cash and junior subordinated discount notes. Funds were obtained through bank borrowings, with repayment to be made from asset sales and retained future cash flow. The proceeds did not go toward, building the company but toward its weakening and dismantling, at least over the intermediate term. Prior to the special dividend, the senior debt was rated A2 by Moody's. The rating then fell to B1 in 1988 after the special dividend but did recover to Ba1. This was still below the rating prior to the special dividend.

In a leveraged buyout (LBO), a new and private shareholder group owns and manages the company. The debt issue's purpose may be to retire other debt from commercial and investment banks and institutional investors incurred to finance the LBO. The debt to be retired is called *bridge financing* because it provides a bridge between the initial LBO activity and the more permanent financing. One example is Ann Taylor, Inc.'s 1989 debt financing for bridge loan repayment. The proceeds of BCI Holding Corporation's 1986 public debt financing and bank borrowings were used to make the required payments to the common shareholders of

EXHIBIT 13–11

Bloomberg Screen of the Total Returns of Two Corporate Bond Indexes

Send | Help
GRAB Equity IND

MERRILL LYNCH GLOBAL BOND INDICES

Selection: 2 Page 3 Of 3
1) HOA0 in USD US High Yield Master II (____) From: 1/ 1/93 To: 12/31/02
vs Freq: Y D:day W:week
2) COA0 in USD U.S. Corporate Master (----) M:month Q:quarter Y:year

Total Return %

H 20.46 12/31/95 L -5.12 12/31/00 AG 6.36 MD 4.48 SD 8.58 ASD 8.58
H 21.55 12/31/95 L -3.34 12/31/94 AG 8.13 MD 10.17 SD 7.23 ASD 7.23
Lin Cor Coef(r) = 0.5631 r squared = 0.3171

Date	Val1	Val2	Spread	Date	Val1	Val2	Spread
12/31/93	16.694	12.429	4.265				
12/31/94	-1.034	-3.342	2.308				
12/31/95	20.462	21.550	-1.088				
12/31/96	11.270	3.391	7.879				
12/31/97	13.266	10.386	2.880				
12/31/98	2.953	8.720	-5.767				
12/31/99	2.511	-1.886	4.397				
12/31/00	-5.117	9.135	-14.252				
12/31/01	4.477	10.702	-6.225				
12/31/02	-1.894	10.170	-12.065				

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000
G768-147-0 24-Sep-03 15:44:55

Beatrice Companies, pay issuance expenses, and retire certain Beatrice debt and for working capital.

Return Experience of High-Yield Bonds

Commensurate with their greater exposure to risk, high-yield bonds should offer higher average returns over time. While this relationship almost surely will hold true over longer periods of time, over shorter lengths of time investors may not be rewarded for bearing this additional risk. To see this, Exhibit 13–11 presents the annual total returns for the Merrill Lynch High Yield Master Index and the Merrill Lynch Corporate Master Index for the years 1993–2002. The high-yield returns are indeed more volatile, with a standard deviation of 8.58% versus 7.23% for investment-grade bonds. However, the average annual total return for the high-yield bonds is lower, 6.36%, versus 8.13% for investment-grade bonds. These results are largely attributable to the massive underperformance of high-yields bonds during the years 2000–2002—a period of sluggish economic growth for the U.S. economy.

Unique Features of Some Issues

Often actions taken by management that result in the assignment of a non-investment-grade bond rating result in a heavy interest-payment burden. This places severe cash-flow constraints on the firm. To reduce this burden, firms involved with heavy debt burdens have issued bonds with *deferred coupon structures* that permit the issuer to avoid using cash to make interest payments for a period of three to seven years. There are three types of deferred-coupon structures: (1) deferred-interest bonds, (2) step-up bonds, and (3) payment-in-kind bonds.

Deferred-interest bonds are the most common type of deferred-coupon structure. These bonds sell at a deep discount and do not pay interest for an initial period, typically from three to seven years. (Because no interest is paid for the initial period, these bonds are sometimes referred to as "zero-coupon bonds.") *Step-up bonds* do pay coupon interest, but the coupon rate is low for an initial period and then increases ("steps up") to a higher coupon rate. Finally, *payment-in-kind (PIK) bonds* give the issuers an option to pay cash at a coupon payment date or give the bondholder a similar bond (i.e., a bond with the same coupon rate and a par value equal to the amount of the coupon payment that would have been paid). The period during which the issuer can make this choice varies from five to ten years.

In late 1987, an issue came to market with a structure allowing the issuer to reset the coupon rate so that the bond will trade at a predetermined price.[8] The coupon rate may reset annually or even more frequently, or reset only one time over the life of the bond. Generally, the coupon rate at the reset date will be the average of rates suggested by two investment banking firms. The new rate will then reflect (1) the level of interest rates at the reset date and (2) the credit spread the market wants on the issue at the reset date. This structure is called an *extendible reset bond.*

Notice the difference between an extendible reset bond and a typical floating-rate issue. In a floating-rate issue, the coupon rate resets according to a fixed spread over the reference rate, with the index spread specified in the indenture. The amount of the index spread reflects market conditions at the time the issue is offered. The coupon rate on an extendible reset bond, in contrast, is reset based on market conditions (as suggested by several investment banking firms) at the time of the reset date. Moreover, the new coupon rate reflects the new level of interest rates and the new spread that investors seek.

The advantage to investors of extendible reset bonds is that the coupon rate will reset to the market rate—both the level of interest rates and the credit spread—in principle keeping the issue at par value. In fact, experience with extendible reset bonds has not been favorable during periods of difficulties in the high-yield bond market. The sudden substantial increase in default risk has meant that the rise in the rate needed to keep the issue at par value was so large that it would have insured bankruptcy of the issuer. As a result, the rise in the coupon rate has been insufficient to keep the issue at the stipulated price.

8. Most of the bonds have a coupon reset formula that requires the issuer to reset the coupon so that the bond will trade at a price of $101.

Some speculative-grade bond issues started to appear in 1992 granting the issuer a limited right to redeem a portion of the bonds during the noncall period if the proceeds are from an initial public stock offering. In a few cases, proceeds from a secondary stock offering are also a permissible source of funds. Called "clawback" provisions, they merit careful attention by inquiring bond investors. According to Merrill Lynch's High Yield Securities Research Department, an increasing number of high-yield issues have clawbacks. In the nearly three-year period ending June 30, 1994, of the almost 700 high-yield issues in its sample, close to 25% came with clawbacks. The percentage of the issue that can be retired with stock proceeds ranges from 20% to 100%, with the clawback period usually limited to the first three years after issuance. The redemption prices are around 110% of par, give or take a couple of points. Investors should be forewarned of clawbacks because they can lose bonds at the point in time just when the issuer's finances have been strengthened through access to the equity market. Also, the redemption may reduce the amount of the outstanding bonds to a level at which their liquidity in the aftermarket may suffer.

DEFAULT RATES AND RECOVERY RATES

We now turn our attention to the various aspects of the historical performance of corporate issuers with respect to fulfilling their obligations to bondholders. Specifically, we will look at two aspects of this performance. First, we will look at the default rate of corporate borrowers. From an investment perspective, default rates by themselves are not of paramount significance; it is perfectly possible for a portfolio of bonds to suffer defaults and to outperform Treasuries at the same time, provided the yield spread of the portfolio is sufficiently high to offset the losses from default. Furthermore, because holders of defaulted bonds typically recover some percentage of the face amount of their investment, the *default loss rate* is substantially lower than the default rate. Therefore, it is important to look at default loss rates or, equivalently, *recovery rates.*

Default Rates

A default rate can be measured in different ways. A simple way to define a default rate is to use the issuer as the unit of study. A default rate is then measured as the number of issuers that default divided by the total number of issuers at the beginning of the year. This measure gives no recognition to the amount defaulted nor the total amount of issuance. Moody's, for example, uses this default-rate statistic in its study of default rates.[9] The rationale for ignoring dollar amounts is that the credit decision of an investor does not increase with the size of the issuer. The second

9. Moody's Investors Service, "Corporate Bond Defaults and Default Rates: 1970–1994," Moody's Special Report, January 1995, p. 13. Different issuers within an affiliated group of companies are counted separately.

measure is to define the default rate as the par value of all bonds that defaulted in a given calendar year divided by the total par value of all bonds outstanding during the year. Edward Altman, who has performed extensive analyses of default rates for speculative-grade bonds, measures default rates in this way. We will distinguish between the default-rate statistic below by referring to the first as the *issuer default rate* and the second as the *dollar default rate.*

With either default-rate statistic, one can measure the default for a given year or an average annual default rate over a certain number of years. Researchers who have defined dollar default rates in terms of an average annual default rate over a certain number of years have measured it as

$$\frac{\text{Cumulative \$ value of all defaulted bonds}}{\text{Cumulative \$ value of all issuance} \times \text{weighted avg. no. of years outstanding}}$$

Alternatively, some researchers report a cumulative annual default rate. This is done by not normalizing by the number of years. For example, a cumulative annual dollar default rate is calculated as

$$\frac{\text{Cumulative \$ value of all defaulted bonds}}{\text{Cumulative \$ value of all issuance}}$$

There have been several excellent studies of corporate bond default rates. We will not review each of these studies because the findings are similar. Here we will look at a study by Moody's that covers the period 1970 to 1994.[10] Over this 25-year period, 640 of the 4,800 issuers in the study defaulted on more than $96 billion of publicly offered long-term debt. A *default* in the Moody's study is defined as "any missed or delayed disbursement of interest and/or principal." Issuer default rates are calculated. The Moody's study found that the lower the credit rating, the greater is the probability of a corporate issuer defaulting.

There have been extensive studies focusing on default rates for speculative-grade issuers. In their 1987 study, Altman and Nammacher[11] found that the annual default rate for speculative-grade corporate debt was 2.15%, a figure that Altman[12] later updated to 2.40%. Drexel Burnham Lambert's (DBL), the now-defunct investment banking firm that at one time was the major underwriter of speculative-grade bonds, estimates also have shown default rates of about 2.40% per year.[13] Asquith, Mullins, and Wolff,[14] however, found that nearly one out of

10. Moody's Investors Service, "Corporate Bond Defaults and Default Rates: 1970–1994."
11. Edward I. Altman and Scott A. Nammacher, *Investing in Junk Bonds* (New York: Wiley, 1987).
12. Edward I. Altman, "Research Update: Mortality Rates and Losses, Bond Rating Drift," unpublished study prepared for a workshop sponsored by Merrill Lynch Merchant Banking Group, High Yield Sales and Trading, 1989.
13. As reported in various annual issues of *High Yield Market Report: Financing America's Future* (New York and Beverly Hills: Drexel Burnham Lambert, Incorporated).
14. Paul Asquith, David W. Mullins, Jr., and Eric D. Wolff, "Original Issue High Yield Bonds: Aging Analysis of Defaults, Exchanges, and Calls," *Journal of Finance* (September 1989), pp. 923–952.

every three speculative-grade bonds defaults. The large discrepancy arises because researchers use three different definitions of default rate; even if applied to the same universe of bonds (which they are not), all three results could be valid simultaneously.[15]

Altman and Nammacher define the default rate as the par value of all speculative-grade bonds that defaulted in a given calendar year divided by the total par value outstanding during the year. That is, the dollar default rate is calculated. Their estimates (2.15% and 2.40%) are simple averages of the annual dollar default rates over a number of years. DBL took the cumulative dollar value of all defaulted speculative-grade bonds, divided by the cumulative dollar value of all speculative-grade bond issuance, and further divided by the weighted average number of years outstanding to obtain an average annual dollar default rate. Asquith, Mullins, and Wolff use a cumulative dollar default rate statistic. For all bonds issued in a given year, the default-rate is the total par value of defaulted issues as of the date of their study divided by the total part amount originally issued to obtain a cumulative default rate. Their result (that about one in three speculative-grade bonds defaults) is not normalized by the number of years outstanding.

While all three measures are useful indicators of bond default propensity, they are not directly comparable. Even when restated on an annualized basis, they do not all measure the same quantity. The default statistics from all studies, however, are surprisingly similar once cumulative rates have been annualized. A majority of studies place the annual dollar default rates for all original issue high-yield bonds between 3% and 4%.

Recovery Rates

There have been several studies that have focused on recovery rates or default loss rates for corporate debt. Measuring the amount recovered is not a simple task. The final distribution to claimants when a default occurs may consist of cash and securities. Often it is difficult to track what was received and then determine the present value of any noncash payments received.

Here we review recovery information as reported in the Moody's study that we cited earlier. Moody's uses the trading price at the time of default as a proxy for the amount recovered. The recovery rate is the trading price at that time divided by the par value. Moody's found that the recovery rate was 38% for all bonds.

While default rates are the same regardless of the level of seniority, recovery rates differ. The study found that the higher the level of seniority, the greater is the recovery rate.

15. As a parallel, we know that the mortality rate in the United States is currently less than 1% per year, but we also know that 100% of all humans (eventually) die.

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CHAPTER
FOURTEEN

MEDIUM-TERM NOTES

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Over the past three decades, medium-term notes (MTNs) have emerged as a major source of funding for U.S. and foreign corporations, federal agencies, supranational institutions, and sovereign countries. U.S. corporations have issued MTNs since the early 1970s. At that time, the market was established as an alternative to short-term financing in the commercial paper market and long-term borrowing in the bond market, hence the name *medium term.* Through the 1970s, however, only a few corporations issued MTNs, and by 1981, outstandings amounted to only about $800 million. In the 1980s, the U.S. MTN market evolved from a relatively obscure niche market dominated by the auto finance companies into a major source of debt financing for several hundred large corporations. In the 1990s, the U.S. market continued to attract a diversity of new borrowers, and outside the United States, the Euro-MTN market has grown at a phenomenal rate.

Most MTNs are noncallable, unsecured, senior debt securities with fixed coupon rates and investment-grade credit ratings. In these features, MTNs are similar to investment-grade corporate bonds. However, they generally have differed from bonds in their primary distribution process. MTNs traditionally have been sold on a best-efforts basis by investment banks and other broker-dealers acting as agents. In contrast to an underwriter in the conventional bond market, an agent in the MTN market has no obligation to underwrite MTNs for the issuer, and the issuer is not guaranteed funds. Also, unlike corporate bonds, which typically are sold in large, discrete offerings, MTNs usually are sold in relatively small amounts either on a continuous or an intermittent basis.

Borrowers with MTN programs have great flexibility in the types of securities they may issue. As the market for MTNs has evolved, issuers have taken advantage of this flexibility by issuing MTNs with less conventional features.

Many MTNs are now issued with floating interest rates or with rates that are computed according to unusual formulas tied to equity or commodity prices.

This chapter is adapted and updated from Leland E. Crabbe, "Anatomy of the Medium-Term Note Market," *Federal Reserve Bulletin* (August 1993), pp.751–768.

Also, many include calls, puts, and other options. Furthermore, maturities are not necessarily "medium term"—they have ranged from nine months to 30 years and longer. Moreover, like corporate bonds, MTNs are now often sold on an underwritten basis, and offering amounts are occasionally as large as those of bonds. Indeed, rather than denoting a narrow security with an intermediate maturity, an MTN is more accurately defined as a highly flexible debt instrument that can be designed easily to respond to market opportunities and investor preferences.

The emergence of the MTN market has transformed the way that corporations raise capital and that institutions invest. In recent years, this transformation has accelerated because of the development of derivatives markets, such as swaps, options, and futures, that allow investors and borrowers to transfer risk to others in the financial system who have different risk preferences. A growing number of transactions in the MTN market now involve simultaneous transactions in a derivatives market.

This chapter discusses the history and economics of the MTN market, structural rates, and Euro-MTNs.

BACKGROUND OF THE MTN MARKET

General Motors Acceptance Corporation (GMAC) created the MTN market in the early 1970s as an extension of the commercial paper market. To improve its asset/liability management, GMAC and the other auto finance companies needed to issue debt with a maturity that matched that of their auto loans to dealers and consumers. However, underwriting costs made bond offerings with short maturities impractical, and maturities on commercial paper cannot exceed 270 days. The auto finance companies therefore began to sell MTNs directly to investors. In the 1970s, the growth of the market was hindered by illiquidity in the secondary market and by securities regulations requiring approval by the Securities and Exchange Commission (SEC) of any amendment to a registered public offering. The latter, in particular, increased the costs of issuance significantly because borrowers had to obtain the approval of the SEC each time they changed the posted coupon rates on their MTN offering schedule. To avoid this regulatory hurdle, some corporations sold MTNs in the private-placement market.

In the early 1980s, two institutional changes set the stage for rapid growth of the MTN market. First, in 1981, major investment banks acting as agents committed resources to assist in primary issuance and to provide secondary market liquidity. By 1984, the captive finance companies of the three large automakers had at least two agents for their MTN programs. The ongoing financing requirements of these companies and the competition among agents established a basis for the market to develop. Because investment banks stood ready to buy back MTNs in the secondary market, investors became more receptive to adding

MTNs to their portfolio holdings. In turn, the improved liquidity and consequent reduction in the cost of issuance attracted new borrowers to the market.

Second, the adoption by the SEC of Rule 415 in March 1982 served as another important institutional change. Rule 415 permits delayed or continuous issuance of so-called shelf-registered corporate securities. Under shelf registrations, issuers register securities that may be sold for two years after the effective date of the registration without the requirement of another registration statement each time new offerings are made. Thus shelf registration enables issuers to take advantage of brief periods of low interest rates by selling previously registered securities on a moment's notice. In contrast, debt offerings that are not made from shelf registrations are subject to a delay of at least 48 hours between the filing with the SEC and the subsequent offering to the public.

The ability of borrowers to sell a variety of debt instruments with a broad range of coupons and maturities under a single prospectus supplement is another advantage of a shelf-registered MTN program. Indeed, a wide array of financing options has been included in MTN filings.[1] For example, MTN programs commonly give the borrower the choice of issuing fixed- or floating-rate debt.[2] Furthermore, several "global" programs allow for placements in the U.S. market or in the Euromarket. Other innovations that reflect the specific funding needs of issuers include MTNs collateralized by mortgages issued by thrift institutions, equipment trust certificates issued by railways, amortizing notes issued by leasing companies, and subordinated notes issued by bank holding companies. Another significant innovation has been the development of asset-backed MTNs, a form of asset securitization used predominantly to finance trade receivables and corporate loans. This flexibility in types of instruments that may be sold as MTNs, coupled with the market timing benefits of shelf registration, enables issuers to respond readily to changing market opportunities.

In the early and mid-1980s, when finance companies dominated the market, most issues of MTNs were fixed rate, noncallable, and unsecured, with maturities of five years or less. In recent years, as new issuers with more diverse financing needs have established programs, the characteristics of new issues have become less generic. For example, maturities have lengthened as industrial and utility companies with longer financing needs have entered the market. Indeed, in July 1993, Walt Disney Company issued a note with a 100-year maturity off its medium-term note shelf registration. A growing volume of placements

1. For example, MTNs have been callable, putable, and extendible; they have had zero coupons, step-down or step-up coupons, or inverse floating rates, and they have been foreign-currency-denominated or indexed and commodity-indexed.
2. The most common indexes for floating-rate MTNs are the following: the London Interbank Offered Rate (LIBOR), commercial paper, Treasury bills, federal funds, and the prime rate. MTN programs typically give the issuer the option of making floating-rate interest payments monthly, quarterly, or semiannually.

of notes with long maturities has made the designation *medium term* something of a misnomer.

MECHANICS OF THE MARKET

The process of raising funds in the public MTN market usually begins when a corporation files a shelf registration with the SEC.[3] Once the SEC declares the registration statement effective, the borrower files a prospectus supplement that describes the MTN program. The amount of debt under the program generally ranges from $100 million to $1 billion. After establishing an MTN program, a borrower may enter the MTN market continuously or intermittently with large or relatively small offerings. Although underwritten corporate bonds also may be issued from shelf registrations, MTNs provide issuers with more flexibility than traditional underwritings in which the entire debt issue is made at one time, typically with a single coupon and a single maturity.

The registration filing usually includes a list of the investment banks with which the corporation has arranged to act as agents to distribute the notes to investors. Most MTN programs have two to four agents. Having multiple agents encourages competition among investment banks and thus lowers financing costs. The large New York–based investment banks dominate the distribution of MTNs.

Through its agents, an issuer of MTNs posts offering rates over a range of maturities: for example, 9 months to 12 months, 12 months to 18 months, 18 months to 2 years, and annually thereafter (see Exhibit 14–1). Many issuers post rates as a yield spread over a Treasury security of comparable maturity. The relatively attractive yield spreads posted at the maturities of three, four, and five years shown in Exhibit 14–1 indicate that the issuer desires to raise funds at these maturities. The investment banks disseminate this offering rate information to their investor clients.

When an investor expresses interest in an MTN offering, the agent contacts the issuer to obtain a confirmation of the terms of the transaction. Within a maturity range, the investor has the option of choosing the final maturity of the note sale, subject to agreement by the issuing company. The issuer will lower its posted rates once it raises the desired amount of funds at a given maturity. In the example in Exhibit 14–1, the issuer might lower its posted rate for MTNs with a five-year maturity to 40 basis points over comparable Treasury securities after it sells the desired amount of debt at this maturity. Of course, issuers also change their offering rate scales in response to changing market conditions. Issuers may withdraw from the market by suspending sales or, alternatively, by posting narrow offering spreads at all maturity ranges. The proceeds from primary trades in

3. SEC-registered MTNs have the broadest market because they have no resale or transfer restrictions and generally fit within an investor's investment guidelines.

EXHIBIT 14–1

An Offering Rate Schedule for a Medium-Term Note Program

Medium-Term Notes		Yield Spread of MTN over Treasury Securities (basis points)	*Treasury Securities*	
Maturity Range	**Yield (percent)**		**Maturity**	**Yield (percent)**
9 months to 12 months	(a)	(a)	9 months	3.35
12 months to 18 months	(a)	(a)	12 months	3.50
18 months to 2 years	(a)	(a)	18 months	3.80
2 years to 3 years	4.35	35	2 years	4.00
3 years to 4 years	5.05	55	3 years	4.50
4 years to 5 years	5.60	60	4 years	5.00
5 years to 6 years	6.05	60	5 years	5.45
6 years to 7 years	6.10	40	6 years	5.70
7 years to 8 years	6.30	40	7 years	5.90
8 years to 9 years	6.45	40	8 years	6.05
9 years to 10 years	6.60	40	9 years	6.20
10 years	6.70	40	10 years	6.30

(a) means no rate posted.

the MTN market typically range from $1 million to $25 million, but the size of transactions varies considerably.[4] After the amount of registered debt is sold, the issuer may "reload" its MTN program by filing a new registration with the SEC.

Although MTNs generally are offered on an agency basis, most programs permit other means of distribution. For example, MTN programs usually allow the agents to acquire notes for their own account and for resale at par or at prevailing market prices. MTNs also may be sold on an underwritten basis. In addition, many

4. Financing strategies vary among the borrowers. Some corporate treasurers prefer to "go in for size" on one day with financings in the $50 million to $100 million range, reasoning that smaller offerings are more time-consuming. Furthermore, a firm may be able to maintain a "scarcity value" for its debt by financing intermittently with large offerings, rather than continuously with small offerings. Other treasurers prefer to raise $50 million to $100 million over the course of several days with $2 million to $10 million drawdowns. These corporate treasurers argue that a daily drawdown of $50 million is an indication that they should have posted a lower offering rate. In regard to the posting of offering rates, some treasurers post an absolute yield, whereas others post a spread over Treasuries, usually with a cap on the absolute yield. A few active borrowers typically post rates daily in several maturity sectors; less active borrowers post only in the maturity sector in which they seek financing and suspend postings when they do not require funds.

MTN programs permit the borrower to bypass financial intermediaries by selling debt directly to investors.

THE ECONOMICS OF MTNs AND CORPORATE BONDS

In deciding whether to finance with MTNs or with bonds, a corporate borrower weighs the interest cost, flexibility, and other advantages of each security.[5] The growth of the MTN market indicates that MTNs offer advantages that bonds do not. However, most companies that raise funds in the MTN market also have continued to issue corporate bonds, suggesting that each form of debt has advantages under particular circumstances.

Offering Size, Liquidity, and Price Discrimination

The amount of the offering is the most important determinant of the cost differential between the MTN and corporate bond markets. For large, standard financings (such as $300 million of straight debt with a 10-year maturity), the all-in interest cost to an issuer of underwritten corporate bonds may be lower than the all-in cost of issuing MTNs. This cost advantage arises from economies of scale in underwriting and, most important, from the greater liquidity of large issues. As a result, corporations that have large financing needs for a specific term usually choose to borrow with bonds. From an empirical point of view, the liquidity premium, if any, on small offerings has yet to be quantified. Nevertheless, the sheer volume of financing in the MTN market suggests that any liquidity premium that may exist for small offerings is not a significant deterrent to financing. According

5. Apart from the distribution process, MTNs have several less significant features that distinguish them from underwritten corporate bonds. First, MTNs typically are sold at par, whereas traditional underwritings frequently are sold at slight discounts or premiums to par. Second, the settlement for MTNs is in same-day funds, whereas corporate bonds generally settle in next-day funds. Although MTNs with long maturities typically settle three business days after the trade date (as is the convention in the corporate bond market), MTNs with short maturities sometimes have a shorter settlement period.

Finally, semiannual interest payments to noteholders typically are made on a fixed cycle without regard to the offering date or the maturity date of the MTN; in contrast, corporate bonds typically pay interest on the first or fifteenth day of the month at six-month and annual intervals from the date of the offering. The interest payment convention in the MTN market usually results in a short or a long first coupon and a short final coupon. Consider, for example, an MTN program that pays interest on March 1 and September 1 and at maturity of the notes. A $100,000 MTN sold on May 1 with a 9% coupon and a 15-month maturity from such a program would distribute a "short" first coupon of $3,000 on September 1, a full coupon of $4,500 on March 1, and a "short" final coupon of $3,750 plus the original principal on August 1 of the following year. Like corporate bonds, interest on fixed-rate MTNs is calculated on the basis of a 360-day year of twelve 30-day months.

to market participants, the interest cost differential between the markets has narrowed in recent years as liquidity in the MTN market has improved. Many borrowers estimate that the premium is now only about 5 to 10 basis points.[6]

Furthermore, many borrowers believe that financing costs are slightly lower in the MTN market because its distribution process allows borrowers to price discriminate. Consider an example of a company that needs to raise $100 million. With a bond offering, the company may have to raise the offering yield significantly, for example, from 6% to 6.25%, to place the final $10 million with the marginal buyer. In contrast, with MTNs, the company could raise $90 million by posting a yield of 6%; to raise the additional $10 million, the company could increase its MTN offering rates or issue at a different maturity. Consequently, because all the debt does not have to be priced to the marginal buyer, financing costs can be lower with MTNs.

The Flexibility of MTNs

Even if conventional bonds enjoy an interest-cost advantage, this advantage may be offset by the flexibility that MTNs afford. Offerings of investment-grade straight bonds are clustered at standard maturities of 2, 3, 5, 7, 10, and 30 years. Also, because the fixed costs of underwritings make small offerings impractical, corporate bond offerings rarely amount to less than $100 million. These institutional conventions tend to keep corporations from implementing a financing policy of matching the maturities of assets with those of liabilities. By contrast, drawdowns from MTN programs over the course of a month typically amount to $30 million, and these drawdowns frequently have different maturities and special features that are tailored to meet the needs of the borrower. This flexibility of the MTN market allows companies to match more closely the maturities of assets and liabilities.

The flexibility of continuous offerings also plays a role in a corporation's decision to finance with MTNs. With MTNs, a corporation can "average out" its cost of funds by issuing continuously rather than coming to market on a single day. Therefore, even if bond offerings have lower average yields, a risk-averse borrower might still elect to raise funds in the MTN market with several offerings in a range of $5 million to $10 million over several weeks, rather than with a single $100 million bond offering.

The flexibility of the MTN market also allows borrowers to take advantage of funding opportunities. By having an MTN program, an issuer can raise a sizable amount of debt in a short time; often the process takes less than half an hour. Bonds also may be sold from a shelf registration, but completion of the transaction may be delayed by the arrangement of a syndicate, the negotiation of an

6. Commissions to MTN agents typically range from 0.125% to 0.75% of the principal amount of the note sale, depending on the stated maturity and the credit rating assigned at the time of issuance. Fees to underwriters of bond offerings are somewhat higher.

underwriting agreement, and the "preselling" of the issue to investors. Furthermore, some corporations require that underwritten offerings receive prior approval by the president of the company or the board of directors. In contrast, a corporate treasurer may finance with MTNs without delay and at her discretion.[7]

Discreet Funding with MTNs

The MTN market also provides corporations with the ability to raise funds discreetly because the issuer, the investor, and the agent are the only market participants that have to know about a primary transaction. In contrast, the investment community obtains information about underwritten bond offerings from a variety of sources.

Corporations often avoid the bond market in periods of heightened uncertainty about interest rates and the course of the economy, such as the period after the 1987 stock market crash. Underwritings at such times could send a signal of financial distress to the market. Similarly, corporations in distressed industries, such as commercial banking in the second half of 1990, can use the MTN market to raise funds quietly rather than risk negative publicity in the high-profile bond market. Thus, during periods of financial turmoil, the discreet nature of the MTN market makes it an attractive alternative to the bond market.

Reverse Inquiry in the MTN Market

Another advantage of MTNs is that investors often play an active role in the issuance process through the phenomenon known as *reverse inquiry.* For example, suppose that an investor desires to purchase $15 million of A-rated finance company debt with a maturity of six years and nine months. Such a security may not be available in the corporate bond market, but the investor may be able to obtain it in the MTN market through reverse inquiry. In this process, the investor relays the inquiry to an issuer of MTNs through the issuer's agent. If the issuer finds the terms of the reverse inquiry sufficiently attractive, it may agree to the transaction even if it was not posting rates at the maturity that the investor desires.

According to market participants, trades that stem from reverse inquiries account for a significant share of MTN transactions. Reverse inquiry not only benefits the issuer by reducing borrowing costs but also allows investors to use the flexibility of MTNs to their advantage. In response to investor preferences, MTNs issued under reverse inquiry often include embedded options and frequently pay interest according to unusual formulas. This responsiveness of the

7. The administrative costs may be lower with MTNs than with bonds. After the borrower and the investor have agreed to the terms of a transaction in the MTN market, the borrower files a one-page pricing supplement with the SEC, stating the sale date, the rate of interest, and the maturity date of the MTN. In contrast, issuers of corporate bonds sold from shelf registrations are required to file a prospectus supplement.

MTN market to the needs of investors is one of the most important factors driving the growth and acceptance of the market.

STRUCTURED MTNs

MTNs have been issued as part of structured transactions. In a structured MTN, a corporation issues an MTN and simultaneously enters into one or several swap agreements to transform the cash flows that it is obligated to make. The simplest type of structured MTN involves a "plain vanilla" interest-rate swap.[8] In such a financing, a corporation might issue a three-year, floating-rate MTN that pays LIBOR plus a premium semiannually. At the same time, the corporation negotiates a swap transaction in which it agrees to pay a fixed rate of interest semiannually for three years in exchange for receiving LIBOR from a swap counterparty. As a result of the swap, the borrower has synthetically created a fixed-rate note because the floating-rate payments are offsetting.

At first glance, structured transactions seem needlessly complicated. A corporation simply could issue a fixed-rate MTN. However, as a result of the swap transaction, the corporation may be able to borrow at a lower rate than it would pay on a fixed-rate note. Indeed, most MTN issuers decline to participate in structured financings unless they reduce borrowing costs at least 10 or 15 basis points. Issuers demand this compensation because, compared with conventional financings, structured financings involve additional expenses, such as legal and accounting costs and the cost of evaluating and monitoring the credit risk of the swap counterparty. For complicated structured transactions, most issuers require greater compensation.

Many structured transactions originate with investors through a reverse inquiry. This process begins when an investor has a demand for a security with specific risk characteristics. The desired security may not be available in the secondary market, and regulatory restrictions or bylaws prohibit some investors from using swaps, options, or futures to create synthetic securities. Through a reverse inquiry, an investor will use MTN agents to communicate its desires to MTN issuers. If an issuer agrees to the inquiry, the investor will obtain a security that is custom-tailored to its needs. The specific features of these transactions vary in response to changes in market conditions and investor preferences. For example, in 1991, many investors desired securities with interest rates that varied inversely with short-term market interest rates. In response to investor inquiries, several corporations issued "inverse floating-rate" MTNs that paid an interest rate of, for example, 12% minus LIBOR. At the time of the transaction, the issuers of inverse floating-rate MTNs usually entered into swap transactions to eliminate their exposure to falling interest rates.

Although structured transactions in the MTN market often originate with investors, investment banks also put together such transactions. Most investment

8. Interest-rate swaps are described in Chapter 55.

banks have specialists in derivative products who design securities to take advantage of temporary market opportunities. When an investment bank identifies an opportunity, it will inform investors and propose that they purchase a specialized security. If an investor tentatively agrees to the transaction, the MTN agents in the investment bank will contact an MTN issuer with the proposed structured transaction.

Most investors require that issuers of structured MTNs have triple-A or double-A credit ratings. By dealing with highly rated issuers, the investor reduces the possibility that the value of the structured MTN will vary with the credit quality of the issuer. In limiting credit risk, the riskiness of the structured MTN mainly reflects the specific risk characteristics that the investor prefers.[9] Consequently, federal agencies and supranational institutions, which have triple-A ratings, issue a large share of structured MTNs. The credit-quality profile of issuers of structured MTNs has changed slightly in recent years, however, as some investors have become more willing to purchase structured MTNs from single-A corporations. In structured transactions with lower-rated borrowers, the investor receives a higher promised yield as compensation for taking on greater credit risk.

Market participants estimate that structured MTNs accounted for 20% to 30% of MTN volume in the 1990s, compared with less than 5% in the late 1980s. The growth of structured MTNs highlights the important role of derivative products in linking various domestic and international capital markets. Frequently, the issuers of structured MTNs are located in a different country from that of the investors.

The increasing volume of structured transactions is testimony to the flexibility of MTNs. When establishing MTN programs, issuers build flexibility into the documentation that will allow for a broad range of structured transactions. Once the documentation is in place, an issuer is able to reduce borrowing costs by responding quickly to temporary opportunities in the derivatives market.

The flexibility of MTNs is also evident in the wide variety of structured MTNs that pay interest or repay principal according to unusual formulas. Some of the common structures include the following: (1) floating-rate MTNs tied to the federal funds rate, LIBOR, commercial paper rates, or the prime rate, many of which have included caps or floors on rate movements, (2) step-up MTNs, the interest rate on which increases after a set period, (3) LIBOR differential notes, which pay interest tied to the spread between, say, LIBOR in two currencies, (4) dual-currency MTNs, which pay interest in one currency and principal in another, (5) equity-linked MTNs, which pay interest according to a formula based on an equity index, such as the Standard & Poor's 500 or the Nikkei, and (6) commodity-linked MTNs, which have interest tied to a price index or to the price of specific

9. An additional reason for the high credit quality of structured MTNs is that some investors, such as money market funds, face regulatory restrictions on the credit ratings of their investments. See Leland Crabbe and Mitchell A. Post, "The Effect of SEC Amendments to Rule 2a-7 on the Commercial Paper Market," *Finance and Economics Discussion Series* 199 (Board of Governors of the Federal Reserve System, May 1992).

commodities such as oil or gold. The terms and features of structured MTNs continue to evolve in response to changes in the preferences of investors and developments in financial markets.

EURO-MTNs

MTNs have become a major source of financing in international financial markets, particularly in the Euromarket. Like Eurobonds, Euro-MTNs are not subject to national regulations, such as registration requirements.[10] Although Euro-MTNs and Eurobonds can be sold throughout the world, the major underwriters and dealers are located in London, where most offerings are distributed.

As in the U.S. market, flexibility is the driving force behind the rapid growth of the Euro-MTN market. Under a single documentation framework, an issuer with a Euro-MTN program has great flexibility in the size, currency denomination, and structure of offerings. Furthermore, reverse inquiry gives issuers of Euro-MTNs the opportunity to reduce funding costs by responding to investor preferences.

The characteristics of Euro-MTNs are similar, but not identical, to MTNs issued in the U.S. market. In both markets, most MTNs are issued with investment-grade credit ratings, but the ratings on Euro-MTNs tend to be higher. In both markets, most offerings have maturities of one to five years. However, offerings with maturities longer than 10 years account for a smaller percentage of the Euromarket than of the U.S. market. In both markets, dealers have committed to provide liquidity in the secondary market, but by most accounts, the Euromarket is less liquid.

In many ways, the Euro-MTN market is more diverse than the U.S. market. For example, the range of currency denominations of Euro-MTNs is broader, as would be expected. The Euromarket also accommodates a broader cross-section of borrowers, both in terms of the country of origin and the type of borrower, which includes sovereign countries, supranational institutions, financial institutions, and industrial companies. Similarly, Euro-MTNs have a more diverse investor base, but the market is not as deep as the U.S. market.

10. Bonds and MTNs may be classified as either domestic or international. By definition, a domestic offering is issued in the home market of the issuer. For example, MTNs sold in the United States by U.S. companies are domestic MTNs in the U.S. market. Similarly, MTNs sold in France by French companies are domestic MTNs in the French market. Bonds and MTNs sold in the international market can be further classified as foreign or Euro. Foreign offerings are sold by foreign entities in a domestic market of another country. For example, bonds sold by foreign companies and sovereigns in the U.S. market are foreign bonds, known as "Yankee bonds." Eurobonds and Euro-MTNs are international securities offerings that are not sold in a domestic market. As a practical matter, statisticians, tax authorities, and market participants often disagree about whether particular securities should be classified as domestic, foreign, or Euro.

In several respects, the evolution of the Euro-MTN market has paralleled that of the U.S. market. Two of the more important developments have been the growth of structured Euro-MTNs and the emergence of large, discrete offerings. Structured transactions represent 50% to 60% of Euro-MTN issues, compared with 20% to 30% in the U.S. market. In the Euro-MTN market, many of the structured transactions involve a currency swap in which the borrower issues an MTN that pays interest and principal in one currency and simultaneously agrees to a swap contract that transforms required cash flow into another currency. Most structured Euro-MTNs arise from investor demands for debt instruments that are otherwise unavailable in the public markets. To be able to respond to investor-driven structured transactions, issuers typically build flexibility into their Euro-MTN programs. Most programs allow for issuance of MTNs with unusual interest payments in a broad spectrum of currencies with a variety of options.

Large, discrete offerings of Euro-MTNs first appeared in 1991, and about 40 of these offerings occurred in 1992. They are similar to Eurobonds in that they are underwritten and often are syndicated using the fixed-price reoffering method. As a result of this development, the distinction between Eurobonds and Euro-MTNs has blurred, just as the distinction between corporate bonds and MTNs has blurred in the U.S. market.

CHAPTER

FIFTEEN

INFLATION-LINKED BONDS

JOHN B. BRYNJOLFSSON, CFA
Managing Director and Portfolio Manager
PIMCO Real Return Bond Fund
Pacific Investment Management Company

Inflation is the key driver of investment performance. It determines how much each dollar of return is worth, and it dictates asset returns themselves. Consider the 17-year period from 1983 to 2000, a period marked by falling inflation. Falling raw materials prices allowed corporate margins to expand. Simultaneously, falling interest rates had a positive impact on the price-to-earnings multipliers being applied to those expanded corporate earnings. The result was doubly explosive equity returns. For different reasons, the inflation-adjusted returns of bonds and cash similarly were favorably affected by falling inflation during this period. The opposite happens during bouts of rising inflation. The 17-year inflationary period from 1966 to 1983 represented one of the worst investment climates in modern history for equities, bonds, and cash.

More recently, investors have found a weapon that effectively offsets this threat to stable and predictable investment returns—and that weapon is the subject matter of this chapter.

TIPS (Treasury Inflation Protection Securities)[1] are bonds that promise to protect and grow investors' purchasing power. The U.S. Treasury delivers on this promise by adjusting the principal of TIPS based on changes in the consumer price index (CPI).[2] It repays the bondholders' principal in an amount that exactly maintains the

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I wish to thank my clients, colleagues at PIMCO, industry contacts, and many friends for their contributions, insight, and support.

1. United States Secretary of the Treasury Robert Rubin coined the term *TIPS* in 1996, before the official launch of "Treasury Inflation-Indexed Securities" (TIIS) in January 1997. Market participants have gravitated to a generic use of the acronym *TIPS* to refer to all forms of inflation-linked bonds, singular and plural. For clarity, this chapter will do the same. Other terms sometimes used to describe this class of bonds include *inflation-linked bonds, IPBS, TIIS, linkers,* and *real-return bonds.*
2. The Bureau of Labor Statistics, an independent economics-oriented agency of the U.S. Department of Labor, is responsible for gathering and reporting price changes at the consumer level. The CPI series used to calculate TIPS is the non-seasonally adjusted Consumer Price Index for all Urban Consumers (CPI-U). See the discussion about the CPI later in this chapter.

EXHIBIT 15–1

Schematic Cash Flow of TIPS

	Purchase	First Annual Coupon	Interim Annual Coupon	Last Annual Coupon	Principal	Return (per Annum)
Date	1/15/00	1/15/01	1/15/05	1/15/10	1/15/10	1/15/10
Real $ Cash Flow	(1,000)	20.00	20.00	20.00	1,000	2.00
CPI (Base = 200)	200.0	206.0	231.8	268.7	268.7	3.00
Indexed Principal	1,000	1,030	1,159	1,343	1,343	(na)
Nominal $ Cash Flow	(1,000)	20.60	23.18	26.87	1343.50	5.06

Source: Pacific Investment Management Company.

purchasing power of their original investment, as defined by the CPI. In addition, the U.S. Treasury pays interest in an amount that also maintains the purchasing power of the stream of semiannual interest payments by calculating coupon payments based on the CPI-indexed principal amounts. (See Exhibit 15–1.)

The U.S. Treasury launched the TIPS program in 1997, and through the middle of 2004 issued over $200 billion of the securities. According to Federal Reserve Bank statistics, on a typical day more than $4 billion of the securities are traded. Since the 1940s, at least 15 governments and numerous corporations have issued similarly structured securities. In the United Kingdom, inflation-indexed securities account for more than 20% of government bonds outstanding. For clarity, we will focus our discussion on the U.S. Treasury TIPS and introduce substantive differences of other TIPS where appropriate.

TIPS are best known as a defensive hedge against the fear of inflation, but they offer tactical and strategic advantages as well. Tactically, investors are attracted to the opportunity TIPS afford to speculate on changes in inflation and real interest rates. Strategically, individual and institutional investors with long-term objectives are attracted to TIPS high real yield, low correlation to traditional financial assets, and muted volatility. They sense TIPS will help them to achieve their long-term investment goals and reduce risk in the process.

The unique characteristics of TIPS qualify them as a fundamental asset class, as are equities, traditional bonds, and cash. TIPS have relatively high correlation with one-another and unusually low correlation with other asset classes. As a whole, they form a large, investable, and easily benchmarked universe.

In addition to TIPS' correlative appeal, their novelty and scope attest to their importance as an investment instrument. This chapter has two goals; the first and most important is to introduce market participants to this important new investment instrument. The second is to provide portfolio managers with a comprehensive examination of the investment qualities that make TIPS unique.

We begin with the mechanics of TIPS cash flows. We explore real yield and real duration, two measures that are analogous to a nominal bond's yield to maturity and effective duration. The marketplace section narrates a brief history of TIPS, including their trading characteristics. The valuation and performance section presents a framework and evaluates the TIPS market of the first quarter of 2004 in the context of that framework. The investors section discusses how professional managers and institutions are using TIPS within portfolios and in asset-liability management. The issuers section introduces the suppliers of TIPS and explains why they use the prevailing structures. We then address common investor concerns, specifically on taxes and deflation.

MECHANICS AND MEASUREMENT

How TIPS Work

The merit of TIPS is that while the principal and interest repaid to investors fluctuates based on the level of the CPI, the purchasing power of each payment is fixed. As a consequence, the *real yield* of TIPS (the growth in purchasing power that a hold-to-maturity investor will earn) is fixed. The assumptions corresponding to Exhibit 15–1 are described below:

- Issuance date of 1/15/00
- Issuance price of $100.00
- 10-year maturity
- 2% real coupon paid annually, and
- 3% annualized inflation rate.

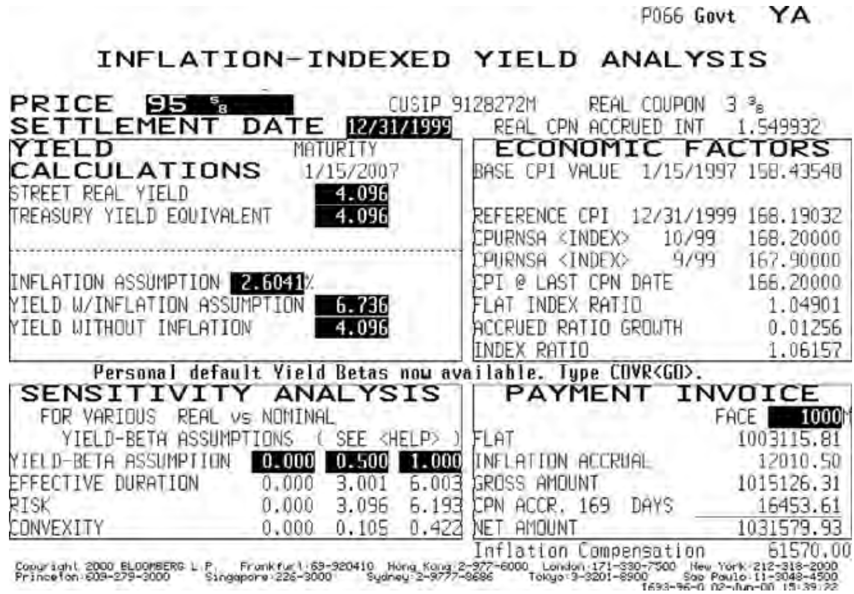
If the CPI for the TIPS issuance date is 200.0 and the CPI for a coupon date one year later is 206.0, year-over-year inflation would be reported as 3.00%. The TIPS' adjusted principal would be 1.03 times its original value, or $1,030 per $1,000 of "original face."

This indexed principal is used to calculate the coupon paid. In other words, the Treasury calculates the amount of each coupon payment, *after the principal has been adjusted for inflation.* This exhibit shows that the compounding effect of a 2% real coupon with a 3% inflation rate results in a *nominal* cash-flow annualized return of 5.06%.

The calculations of actual Treasury TIPS cash flows and returns are only somewhat more complicated. TIPS pay interest semiannually at one-half their stated annual coupon rate. The inflation-indexed principal is accrued daily, based on an interpolation between the two most recent monthly CPI figures reported prior to the settlement month. And lastly, Treasury uses a rather arcane rounding procedure for interim and final calculations (included in Bloomberg analytics). (See Exhibit 15–2.)

EXHIBIT 15–2

Bloomberg Screen Illustrating Actual Settlement Calculations


P066 Govt YA

INFLATION-INDEXED YIELD ANALYSIS

PRICE 95 5/8 CUSIP 9128272M REAL COUPON 3 3/8
SETTLEMENT DATE 12/31/1999 REAL CPN ACCRUED INT 1.549932

YIELD CALCULATIONS MATURITY 1/15/2007
STREET REAL YIELD 4.096
TREASURY YIELD EQUIVALENT 4.096
INFLATION ASSUMPTION 2.6041%
YIELD W/INFLATION ASSUMPTION 6.736
YIELD WITHOUT INFLATION 4.096

ECONOMIC FACTORS
BASE CPI VALUE 1/15/1997 158.43548
REFERENCE CPI 12/31/1999 168.19032
CPURNSA <INDEX> 10/99 168.20000
CPURNSA <INDEX> 9/99 167.90000
CPI @ LAST CPN DATE 166.20000
FLAT INDEX RATIO 1.04901
ACCRUED RATIO GROWTH 0.01256
INDEX RATIO 1.06157

Personal default Yield Betas now available. Type COVR<GO>.

SENSITIVITY ANALYSIS
FOR VARIOUS REAL vs NOMINAL
YIELD-BETA ASSUMPTIONS (SEE <HELP>)

YIELD-BETA ASSUMPTION	0.000	0.500	1.000
EFFECTIVE DURATION	0.000	3.001	6.003
RISK	0.000	3.096	6.193
CONVEXITY	0.000	0.105	0.422

PAYMENT INVOICE
FACE 1000M

FLAT	1003115.81
INFLATION ACCRUAL	12010.50
GROSS AMOUNT	1015126.31
CPN ACCR. 169 DAYS	16453.61
NET AMOUNT	1031579.93
Inflation Compensation	61570.00

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I693-96-0 02-Jun-00 15:39:22

Source: Bloomberg LP.

The Consumer Price Index (CPI)

The specific CPI series used for TIPS indexation is the Non-Seasonally Adjusted, All-Urban Consumer Price Index (NSA CPI-U), and it is reported monthly. Unlike the seasonally adjusted series, the NSA CPI-U is not subject to revision. One consequence of using the NSA CPI-U is that the series includes predictable seasonal fluctuations in inflation. For example, each December when inflation typically is muted by year-end price cutting and inventory liquidations, the NSA CPI-U index tends to fall slightly below its trend growth rate, whereas in certain other months it tends to rise slightly above the underlying trend.

The CPI report that measures the price level in a given month, for example, May, typically is reported on or near the 15th of the following month, in this case June. The two-week hiatus between June 15 and July 1 when the TIPS accruals begin allows for potential delays in the official release of the CPI and eliminates the need to calculate day counts across month-end. The last daily accrual occurs on July 31, about seven weeks after the CPI is reported. Thus the May CPI is fully incorporated into the August 1 TIPS principal.

This relatively quick 15-day turnaround of CPI reports into TIPS indexation is described as a three-month lag because the May (month 5) CPI is fully incorporated into the TIPS by August 1 (month 8). To calculate the TIPS principal for any settlement date other than the first of a month, for example, July 10, calculate as follows:

1. Find the TIPS principal that applies to July 1; this is based on the April NSA CPI-U report (month 7 – 3 = month 4).
2. Find the TIPS principal that applies to August 1; this is based on the May NSA CPI-U report (month 8 – 3 = month 5).
3. Divide 9, the number of days accrual (the 10th day of the month – the 1st day of the month) by 31 (the number of days in that month).
4. Linearly interpolate by adding 9/31 of the difference between the July 1 and August 1 TIPS' principal values to the July 1 value.

Real Frame of Reference, Real Yield, Nominal Yield, and Break-Even Inflation Rate

Real Frame of Reference

A nominal frame of reference looks at investments in terms of dollars, without regard for any change in purchasing power of those dollars. In contrast, a real frame of reference takes into account the loss of purchasing power due to inflation. Put another way, it calculates how many bushels of wheat, baskets of apples, or more generally, the standard of living to which a given dollar amount corresponds. If it costs 100 "real dollars" to purchase a basket of consumer goods in the year 2000, in the year 2020, 100 "real dollars" will still purchase that same basket.

Any investment can be described from either a *real* or *nominal* frame of reference. To directly compare the expected returns of any two investments, one must choose either a real or a nominal frame of reference. For example, in *Stocks for the Long Run, 1998,* Jeremy Siegel describes equities from 1926 through 1997 as having generated *either* a 7.2% real return *or* a 10.6% nominal return.

Ideally, the frame of reference would be dictated by one's goals, but in practice, the choice is heavily influenced by the characteristics of the investment instrument. For instance, conventional bonds are described easily in a *nominal* frame of reference because they have fixed *nominal* coupons and principal. TIPS, on the other hand, are described more easily within a *real* frame of reference because they have fixed *real* coupons and principal. Not surprisingly, TIPS' *real* yield, *real* duration, and other real characteristics are relatively intuitive and as easy to calculate as a nominal bond's yield to maturity, effective duration, and other nominal characteristics.

Real Yield

The real yield of a TIPS bond represents the annualized growth rate of purchasing power earned by holding the security to maturity. Real yield can be calculated easily on a standard bond calculator by entering the TIPS quoted market price, coupon rate, and maturity date. The calculator does not know the bond is a TIPS or that the price and coupon rate are *real.* It is the user's responsibility to interpret the result as the "real yield."[3]

The *real* yield of a *nominal* bond is more difficult to calculate because it can be precisely determined only with the benefit of hindsight. In practice, when analysts speak of a nominal bond's real yield, they may be (1) referring to its "current" real yield (approximated by subtracting the current year-over-year inflation from the bond's nominal yield), (2) "guesstimating" the nominal bond's "expected" real yield based on expectations of future inflation, or (3) speaking of historical realized real yields on bonds that have matured.

Nominal Yield

The opposite situation occurs with nominal yields. While the nominal yield of a conventional bond is determined easily, the nominal yield of TIPS is more difficult to pin down. The nominal yield realized by holding TIPS to maturity depends on the average level and trajectory of inflation over the bond's lifetime. Ignoring the trajectory of the inflation rate, and focusing only on the average level of inflation, the realized nominal yield can be approximated as

$$\text{TIPS realized nominal yield} = (1 + \text{real yield}) \times (1 + \text{inflation}) - 1$$

Break-Even Inflation Rate

The break-even inflation rate is the rate that results in the holder of a TIPS "breaking even" with the holder of a nominal bond. Using the preceding equation, the nominal yield of the TIPS can be set to equal the nominal yield of the conventional bond. Solving the equation for the break-even inflation rate gives

$$\begin{aligned}&\text{Break-even inflation rate}\\&\quad = (1 + \text{conventional nominal yield}) / (1 + \text{TIPS real yield}) - 1\end{aligned}$$

If the conventional bond's nominal yield is 7% and the TIPS real yield is 4% (both expressed in simple annualized terms), the break-even inflation rate is 2.88%. For most purposes, approximating the preceding equation as the simple difference between the two bonds' yields, 3%, is appropriate—and general industry practice.

Exhibit 15–3 plots nominal yields, real yields, and their differences over a period including the fall of 1998. This period was notably marked by a significant deflationary scare. An astute investor might have construed the dramatic decline of the break-even inflation rate to below 1% as an opportunity.

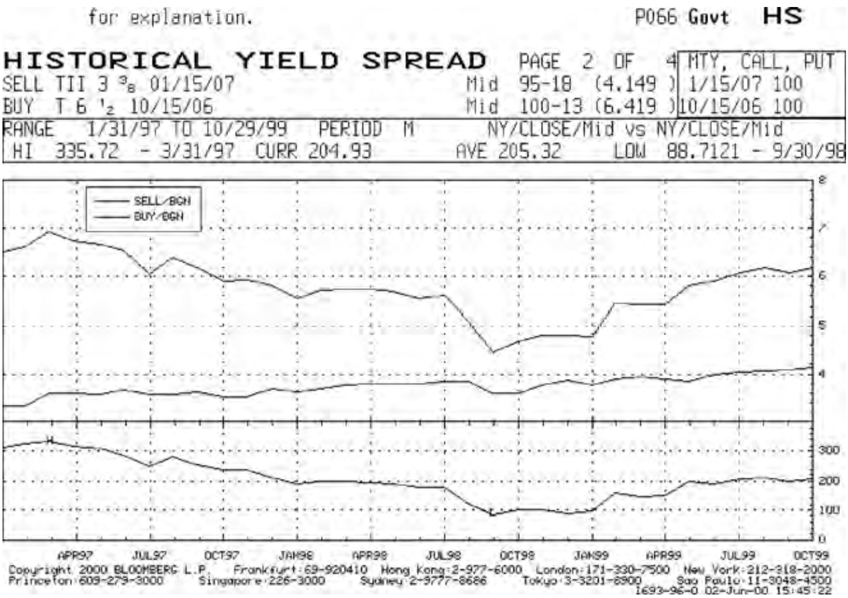
Although the break-even inflation rate may be useful to assess market inflation expectations or to gauge break-even requirements for narrowly constrained fixed income investors, it generally overstates the risk-adjusted breakeven inflation rate applicable to long-term strategies. In particular, the riskier nominal

---

3. Two phenomena that could cause a minor difference in TIPS quoted real yield from the TIPS realized real yield are (1) real reinvestment rate of coupon cash flows and (2) the time lag between the applicable date for the CPI and the applicable date for TIPS indexing.

EXHIBIT 15–3

Bloomberg Screen Showing Break-Even Inflation Rates



Source: Bloomberg LP.

bonds embody inflation risk premiums. Researchers have estimated the embedded inflation risk premium in nominal bonds to be between 0.50% and 1.0%.[4]

Because TIPS pay in real dollars, exhibit low volatility, and have a low correlation with other assets, at least part of such inflation risk premiums should not be embodied in TIPS yields. Therefore, the risk-adjusted break-even inflation rate for TIPS equals the calculated break-even inflation rate minus an inflation risk premium. This means an investor can advantageously use TIPS even when his expected inflation rate equals the calculated break-even inflation rate. Such an investor will gain by lowering overall portfolio risk or from "reallocating" the risk capacity created into other sectors.

4. Citing the tremendous supply of TIPS, the illiquidity of TIPS, and the substantial exposure that TIPS have to changes in real interest rates, Lucas and Quek suggest that a part of (or the entire) "inflation-risk premium" may be offset. See Gerald Lucas and Timothy Quek, "Valuing and Trading TIPS," Chapter 9 in John Brynjolfsson and Frank J. Fabozzi (eds.), *Handbook of Inflation Indexed Bonds* (New Hope, PA: Frank J. Fabozzi Associates, 1999). For a more detailed discussion of implied break-evens and risk-premiums, see the seminal work on expectations and markets by M. Harrison and D. Kreps, "Martingales and Multiperiod Securities Markets," *Journal of Economic Theory* (1979), pp. 381–408.

Real and Effective Duration

Real Duration

Duration is the measure of a bond's market-value sensitivity to changes in yields—real *or* nominal. The preceding section describing real and nominal frames of reference and real and nominal yields is pivotal to any discussion of duration. By definition, the *real* duration of TIPS is the percentage change in its market value associated with a 1.0% change in its *real* yield. For example, if the market value (MV) of TIPS is $1,000 and the market values associated with a 0.50% decrease and a 0.50% increase in the TIPS real yield are $1,051 and $951, respectively, the TIPS real duration is 10. In order to center the calculation at current yield levels, the 1.0% change in the definition is applied equally as a 0.50% decrease and a 0.50% increase in yield.

Algebraically, the formula for TIPS real duration is

$$100 \times [\text{MV}(\text{real yield} + 0.50\%) - \text{MV}(\text{real yield} - 0.50\%)]/\text{MV}(\text{real yield})$$

Not surprisingly, the TIPS duration formula is identical to that of a nominal bond (excepting the frame of reference). It follows that TIPS' duration can be calculated using a standard bond calculator. As with the calculation for real yield, it is the user's responsibility to remember that the result is the TIPS' *real* duration. (Using real duration within a dedicated TIPS portfolio is discussed in a later section.)

As relevant as real duration is to TIPS' portfolio managers, it is critical to understand that TIPS' real duration does not quantify the exposure of TIPS to changes in nominal yields. First, the correlation of real yields with nominal yields historically has tended to be quite low—real duration measures sensitivity to phenomena that may affect nominal bonds in an opposite way or not at all. Second, real yields tended to be significantly less volatile than nominal yields—so any given "real duration" tended to correspond with significantly less portfolio volatility than the same "nominal duration." Recently this has not been the case. Perhaps this is due to extremely high levels of confidence in the Federal Reserve's ability to successfully and perpetually target a stable inflation rate between 2% and 3%. Correlations between real and nominal yields have been high, and TIPS yield have been almost as, or more volatile than, nominal yields. History will judge how rational this turns out to be.

Effective Duration

To compare TIPS' risk with that of nominal bonds so that they may be included within a conventional bond portfolio, a manager needs a measure of TIPS' sensitivity to changes in *nominal* interest rates. The method for determining market-value change of TIPS as a function of nominal-yield change is the "effective duration" calculation. The limitation is that since this calculation must infer a change in real yield from the given change in nominal yield, the measure is statistical rather than deterministic.

Initially, this dilemma caused more than a few managers to conclude that the risk exposure of TIPS could not be managed within the context of a conventional fixed income portfolio. But it was soon realized that in the 1980s, for example, mortgage-backed securities overcame similar concerns. The calculation of effective duration for mortgages calls for an inference that a change in nominal Treasury yield will result in a change in the underlying yield of mortgage cash flows.

Similar to TIPS, yields underlying mortgage pricing are not perfectly correlated with Treasury yields. In fact, during the deflationary scare in the summer of 1998, mortgage prices dramatically underperformed what naive calculations of mortgage effective durations would have predicted. For a brief period, as Treasury yields fell, mortgage yields actually rose. Nonetheless, effective duration is used broadly to determine a mortgage's value change as a function of nominal-yield change. It is incumbent on fixed income managers to manage the remaining mortgage basis risk.

Although crude, the best metric we have found for converting TIPS' real yield into "effective duration" is to apply a 75% multiplicative factor to TIPS' real durations. This approach is often described as a "75% yield beta"—a reference to the second coefficient (beta) of a linear regression of change in real yield against a change in nominal yield. Like mortgages, TIPS' effective duration should be used only as a loose metric for nominal interest-rate exposure because substantial risk (basis risk) remains.

Occasionally, nominal yields fall, and TIPS' real yields rise, meaning that TIPS experience negative effective durations. Conversely, occasionally, nominal yields rise, and real yields rise even more, meaning TIPS experience capital losses greater than what their *ex-ante* effective durations predict. It is incumbent on managers who use TIPS to manage the basis risk that TIPS embody beyond their modest effective duration.

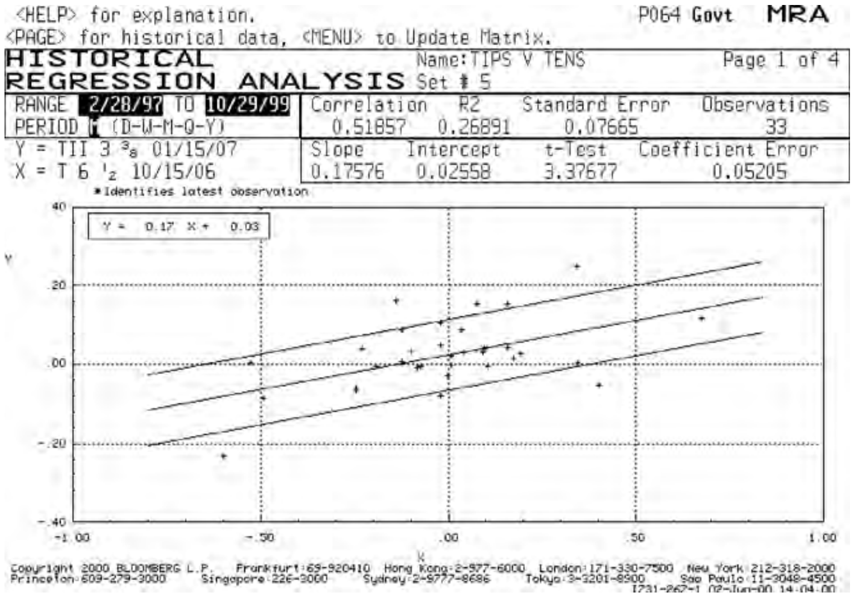
Exhibit 15–4 plots the monthly change in TIPS' 2007 real yield on the vertical axis as a scatter chart, with the corresponding monthly change in nominal yield on the horizontal axis. The slope of the "best fit" regression line shows that historically the "yield beta" over that period, at 17.56%, has been lower than the 75% that we use. The regression result will vary (as a function of the time period chosen to calculate the individual change), the time period included in the study, the securities chosen, and perhaps most important, the economic environment.

TIPS' real duration measures risk as it relates to change in real yield, and TIPS' effective duration measures risk as it relates to changes in nominal yield. Two broader measures of TIPS' risk are volatility and relative volatility. Volatility is simply the standard deviation of TIPS' prices (or returns). It varies over time and across maturities as a function of the calculation period and measurement interval. Exhibit 15–5 graphs the historical price volatility of the first Treasury 10-year TIPS issued.

Relative volatility is a measure of TIPS' volatility as a fraction of the volatility of another instrument such as a nominal bond having a comparable maturity. Exhibit 15–6 plots the price volatility of a comparable maturity Treasury. A comparison of Exhibits 15–5 and 15–6 from the beginning of 1998 through late 1999 illustrates that the TIPS bond exhibited about one-third the price volatility of a comparable-maturity nominal Treasury bond.

EXHIBIT 15–4

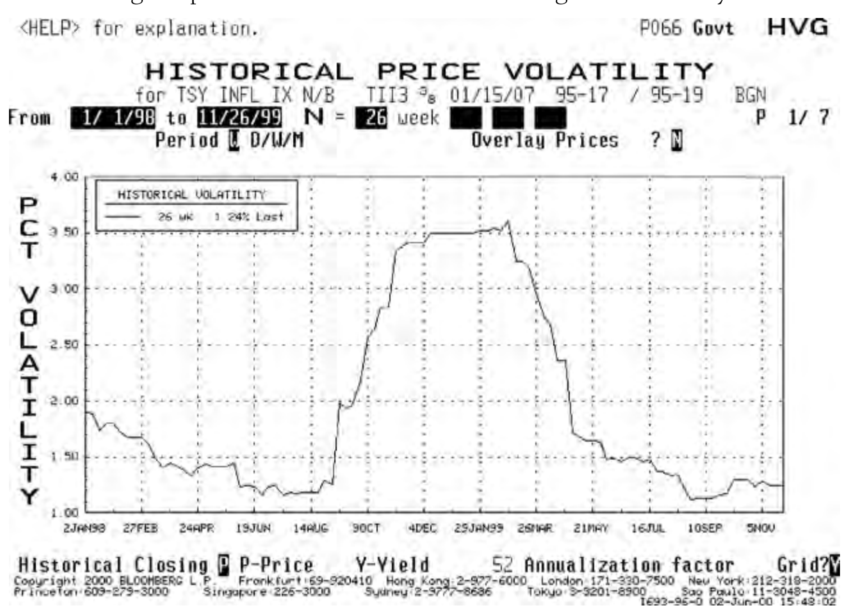
Bloomberg Screen—Historical Regression Analysis—Monthly Yield Changes of 2007 TIPS versus Monthly Yield Changes of 2006 Treasury



Source: Bloomberg LP.

EXHIBIT 15–5

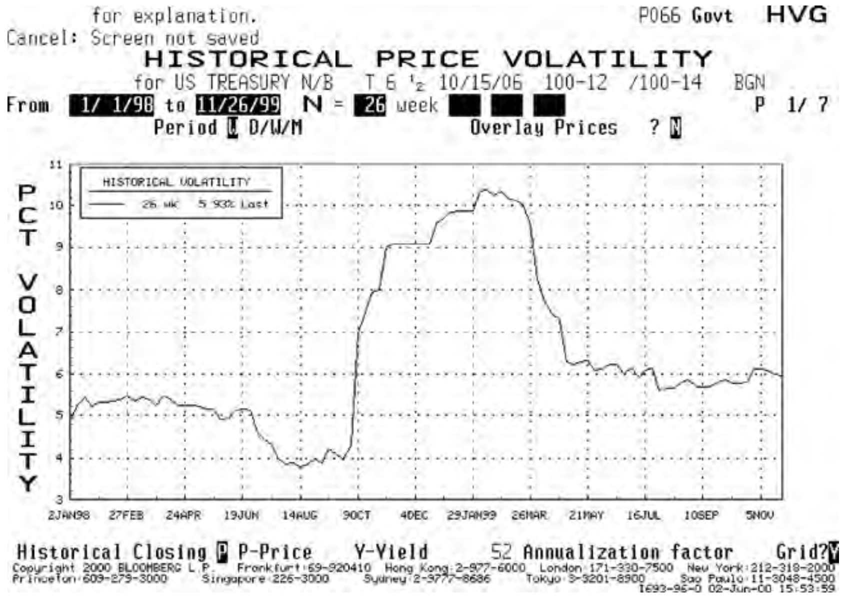
Bloomberg Graph of TIPS Bond's 26-Week Rolling Price Volatility



Source: Bloomberg LP.

EXHIBIT 15–6

Bloomberg Graph of Conventional Treasury's 26-Week Rolling Price Volatility



Source: Bloomberg LP.

MARKETPLACE

A Brief History of TIPS

Conceptually, TIPS are such a fundamental economic instrument that it is possible that they predate nominal bonds and even coins. In essence, the buyer of these bonds is simply "storing" (and earning a return on) a current basket of goods she will consume in the future.

In ancient Mesopotamia, warehouse receipts referencing quantities of grains and other goods were traded in a secondary market and were in some ways preferred to the currency of the day.[5] These receipts "were" TIPS. They could be traded, and on maturity, their value would be redeemed in the form of a "real basket" of consumer goods.

In the United States, TIPS date back to the birth of the nation. In 1780, the state of Massachusetts created debt colorfully inscribed as follows:

> Both Principal and Interest to be paid in the then current Money of said State, in a greater or less Sum, according as Five Bushels of CORN, Sixty-eight Pounds and four–seventh Parts of a Pound of BEEF, Ten Pounds of SHEEP'S WOOL, and

5. Glyn Davies, *A History of Money* (Cardiff: University of Wales Press, 1994).

EXHIBIT 15–7

Postwar Introductions of Indexed Bonds and Inflation Rates

Date	Country	Inflation Index	Inflation Rate
1945	Finland	WPI	6.4
1952	Sweden	CPI	2.0
1955	Iceland	CPI	15.7
1966	Chile	CPI	22.2
1972	Argentina	WPI	19.7
1981	United Kingdom	CPI	14.0
1989	Mexico	CPI	114.8
1994	Sweden	CPI	4.4
1997	United States	CPI	3.0
1999	France-Domestic	CPI ex tobacco	1.3
1999	France-Eurozone	Eurozone HICP ex tobacco	1.5
2003	Greece	Eurozone HICP ex tobacco	4.0
2003	Italy-Eurozone	Eurozone HICP ex tobacco	2.8
2004	Japan	CPI ex fresh food	(0.1)

WPI: wholesale price index; Inflation: in year prior to introduction except Iceland, for which the prior 5-year average inflation is reported.

Source: John Y. Campbell and Robert J. Shiller, "A Scorecard for Indexed Government Debt," NBER Working Paper No.5587, May 1996. (c) 1996 John Y. Campbell and Robert J. Shiller and PIMCO.

> Sixteen Pounds of SOLE LEATHER shall then cost, more or less than One Hundred Thirty Pounds current money, at the then current Prices of Said Articles.[6]

Since World War II, more than 15 countries have issued TIPS, or, more generally, inflation-linked bonds (ILBs). A partial list is provided in Exhibit 15–7. As the exhibit suggests, ILBs are not just issued by countries experiencing runaway inflation. Countries often issue ILBs as they are embarking on successful disinflationary initiatives. For example, in Iceland from 1949 to 1954, inflation averaged over 15% per year. In 1955, the year following the introduction of their ILBs, Iceland's recorded inflation rate fell to zero.[7]

Quotation and Settlement

In the United States, TIPS are quoted on a "real clean" basis—as distinguished from a "nominal dirty" basis. Fractions of a dollar are quoted as units of 1/32.

In this instance, "real" implies that U.S. TIPS' prices are quoted on the basis of 100 *inflation-adjusted* units of principal. In our first example in Exhibit 15–2,

6. Willard Fisher, "The Tabular Standard in Massachusetts History," *Quarterly Journal of Economics* (May 1913), p. 454.
7. *Statistical Abstract of Iceland,* Table 12.5, p. 150.

the quoted price 95-20 can be interpreted as 95 and 20/32 real dollars, meaning that the investor is paying 95.625% of the *indexed* principal amount. While this may seem intuitive, it is not the only way to quote TIPS' prices. If prices were quoted on a *nominal* basis, as they are in the U.K. linker market, this same purchase would be quoted as 101.512 (95.625 × 1.06157 = the real price times the index ratio). Similarly, to calculate the clean settlement price, which necessarily is paid in "nominal dollars," multiply the real price by the index ratio.

Clean means that the quoted TIPS' price does not include the accrued-interest amount that the buyer of a TIPS bond owes the seller. Just as with nominal bonds, the TIPS' buyer must compensate the seller for coupon income that has been earned since the last coupon payment. Parties therefore can calculate the settlement proceeds by multiplying real accrued interest by the index ratio and adding the result to the clean settlement price. In practice, a computer algorithm as shown in Exhibit 15–2 can be used to incorporate prescribed rounding procedures.

Canadian and French TIPS are quoted similarly to U.S. TIPS, except, of course, local inflation indexes are referenced.

The U.K. linker market is quoted on a "nominal clean price" basis, and therefore, some U.K. linkers trade at prices above $200 per $100 original face. This is so because the country's retail price index (RPI) has more than doubled since the Bank of England began issuing these bonds in the early 1980s.

In Australia and New Zealand, ILBs typically are quoted and traded on a "real yield" basis.

Size, Growth, and Liquidity

By December 2004, the U.S. TIPS market had over $270 billion in market value outstanding and was expected to grow $76 billion annually. The U.S. Treasury does not, however, explicitly announce the quantity or structure of its future debt issuance. But the U.S. Treasury does have a policy of avoiding surprises, and it generally maintains a structure for its calendar of issuance.

Since the first TIPS auction in January 1997, the U.S. Department of the Treasury has expanded the issuance of TIPS to include eight auctions per year (four initial auctions and four reopenings). Currently, the Treasury Department auctions schedule calls for a 10-year TIPS each January and July, a 5-year TIPS each April, and a 20-year TIPS each January. The 10-year issues reopen three months following the initial auction with the 5-year and 20-year issues reopening six months after their initial auctions.

Liquidity

The common metrics of liquidity are turnover, bid-ask spread, and transactional size. TIPS are less liquid than conventional coupon Treasuries, but as measured by the bid-ask spread associated with transacting $50 million, they are more liquid than most corporate bonds, nonagency mortgage pass-through bonds, and even some agency debentures. TIPS are significantly more liquid than other inflation hedges such as real estate, commodity futures, precious metal contracts, natural gas partnerships, timberland deeds, and collectable possessions.

VALUATION AND PERFORMANCE DYNAMICS

As with any bond, the holding-period return of a TIPS bond is the sum of its yield and capital gains. For TIPS, changes in real yield determine capital gains. Thus perhaps the most important question for investors evaluating TIPS is: "What direction are real yields heading?"

Over the long term we believe that real yields in the United States should remain at levels below 2.0%. Historically and comparatively, even a 2.0% real return for a riskless instrument is high. Over the past 70 years, long-term Treasury bonds have realized real yields of just above 2% and short-term Treasury bills just below 1%, with both averages concealing significant volatility in real return. During 1999, real yields on long-term nominal Treasuries averaged about 3.5% and Treasury bills 2.5%.

Determinants of Inflation and the Taylor Rule for Real Yields

Professor John Taylor of Stanford University presents a compelling thesis that there is an immutable link between the sustainable real economic growth rate and the sustainable real fed funds rate. "The Taylor rule" argues that over the long term, the real fed funds rate should average the long-term real economic growth rate of the economy, which he estimated to be about 2%. If the monetary authority maintains the real fed funds rate above this for an extended period of time, the inflation rate will diverge toward deflation. If the authority maintains the real fed funds rate below this, the result ultimately will be hyperinflation. The implication is that TIPS' real yields above 2.0% are overly generous.[8]

But in 1998 a different risk faced policymakers—the possibility of deflation. Paraphrasing Fed Chairman Alan Greenspan, we have to be mindful that the risks and costs of deflation may be as great as the risk and costs of inflation.

The implication is clear. Monetary policy should be relatively easy during the next decade. The Fed likely will manage a funds rate that averages at most 2.0% above inflation and substantially less than the 4% above inflation experienced during the 1980s and 1990s.

INVESTORS

Tactical Use (within Fixed Income Portfolios)

There are times when economic fundamentals, financial market dynamics, or simply structure will result in TIPS performing exceptionally well or, as in 1999,

8. Taylor's equations suggest that in periods of high inflation, high real rates may be temporarily called for.

less badly relative to other investments. All investors can benefit from understanding how to evaluate and purchase TIPS for tactical gain.

In electing to own TIPS for tactical purposes within a fixed income portfolio, an investor may make a relative valuation assessment by comparing them with debt instruments with similar credit, effective duration, and liquidity. After the investment decision is made, the investor must diligently manage the tracking risk, that is, non-fixed income risk, associated with introducing tactical allocation to TIPS.

International Relative Value Opportunities

The international market for ILBs is currently larger than the U.S. TIPS market. We believe that all global ILBs belong to the same asset class. Tactical opportunities exist in all these markets because no region is immune from ebbs and flows in the global supply and demand for capital. To some extent, ILBs from different countries are interchangeable.

However, there are nuances that differentiate ILBs from one another. International ILBs provide investors with avenues to exploit a variety of currencies, monetary policies, and other local phenomena. These tactical opportunities can be reduced to perspectives regarding absolute global real yield levels, inflation rates, and intercountry differences from these global averages. Exhibit 15–8

EXHIBIT 15–8

Global ILBs Tactical Relative Value Summary (April 30, 2004)

Country	Hedged Carry	Real Yield	Inflation Outlook	Implied Yield	Two-Year Gov't	Outstanding (All Maturities, Billion US$)
Australia (index-linked)	0.13	3.40	2.20	5.60	5.47	6.67
Canada (real return bonds)	0.97	2.50	1.20	3.70	2.73	19.50
France (OATi)	1.02	2.10	1.50	3.60	2.58	72.12
Italy (inflation-linked)	1.43	1.80	2.10	3.90	2.47	18.46
Japan (inflation-linked)	0.45	1.10	(0.50)	0.60	0.15	0.91
Sweden (index-linked bonds)	(0.20)	2.50	0.20	2.70	2.90	25.00
U.K. (index-inked gilts)	(1.27)	1.90	1.40	3.30	4.57	151.67
U.S. (inflation-indexed securities)	1.89	2.20	2.00	4.20	2.31	211.59

Source: PIMCO & Barclays Capital.

illustrates relative value relationships along with ancillary data for seven of the larger government issuers of ILBs.

The second and third columns entitled “Hedged Carry” and “Real Yield” should be of particular interest because they report, respectively, a short-term measure and a long-term measure of relative value. Hedged carry is obtained by subtracting two-year government conventional yields from the ILBs’ nominal yield. Real yield incorporates the return of real principal and the interim real income that a ILBs’ holder will earn. The other columns provide the raw data needed to calculate hedge carry and more.

There are potential international risks not included in Exhibit 15–8 that can affect real yields. The first is the credit profile of the particular issuing country. To the extent that government issuers rarely default on debt instruments denominated in their own currencies, credit risk is low. A second factor is issuance. If a country issues more inflation-indexed supply than domestic and global strategic ILBs investors need, yields are likely to rise until sufficient tactical investors are attracted.

ILBs can be used tactically within equity and cash portfolios as well. Conceptually, the motivation is similar. In the United Kingdom investors often allocate out of equities into ILBs as a defensive tactic—much as U.S. equity managers reallocate defensively into utility stocks to protect against violent market declines.

Strategic Use

Strategic allocations are more deliberate than tactical ones and ultimately speak to the inherent investment qualities of ILBs. ILBs can play a significant role within such top-down strategic allocations. Enduring investor goals, such as matching liabilities, diversifying risks, controlling downside exposures, and achieving real return objectives, typically drive these strategic allocations. In contrast, bottom-up valuation, market timing, and other opportunistic considerations rarely are important aspects of the strategic decision-making process.

Investors typically make strategic asset allocations among the fundamental asset classes: equities, bonds, cash, and inflation hedges. Unadvisedly, some investors opt for finer gradations using more unwieldy sets of narrowly defined asset classes such as large-capitalization, midcap, small-cap equities, and government bonds at the top-level of their asset allocation framework.

Typically, the thread that holds the elements of an asset class together is that each element’s returns are driven primarily by common fundamental phenomena. Simply, correlations between members of the same asset class will be high, whereas correlations between assets that are members of different asset classes will be low.

For ILBs, inflation and real global interest rate are the identifying fundamental phenomena that drive returns. Thus it is reasonable that all ILBs (Treasury, international, agency, and corporate) comprise a distinct asset class, separate from equities, (nominal) bonds, and cash. Real estate, commodities, and certain other "inflation hedges" also fall into this inflation-hedging asset class.

There are three general situations that warrant a strategic reallocation into ILBs. First, portfolio managers looking for higher returns without increased risk may investigate moving out of low-risk assets such as cash. Second, those motivated toward preserving past gains might consider a defensive allocation out of higher-risk assets such as equities or real estate. Importantly, a defensive allocation will tend to decrease or eliminate shortfall probability dramatically. (Shortfall probability is the likelihood that a portfolio will fall below a minimum acceptable threshold.) And third, ILBs can be used strategically in an asset-liability management context.

Asset-Liability Management (ALM)

Asset-liability management is closely related to asset allocation. Traditionally, asset allocation studies do not explicitly incorporate liabilities. They tend to focus on increasing absolute levels of return through allocations to higher-returning assets or through diversification of assets, thereby reducing risk calculated without regard to liabilities.

ALM studies focus on reducing the mismatch between assets and liabilities. Traditionally, researchers have studied ALM in a conventional nominal frame of reference where the exposure of assets and liabilities to conventional yield changes is compared and to some extent matched. Liabilities are assumed to be nominal liabilities even when they are in fact inflation-sensitive.

The large-scale introduction of TIPS by the U.S. Treasury has given asset-liability managers the ability to measure and manage both assets and liabilities that are predominantly real. This is a reprieve for the many investors discussed later.

Investors are no longer limited to choosing between asset allocation or asset-liability management. The two can be combined into a framework generally termed *surplus management*—optimizing the return and risk of surplus (assets net of liabilities).

Risk/Return Optimization

The novelty of ILBs as an asset class in the United States poses challenges for strategic users of the securities. In particular, to include ILBs in a standard nominal Markowitz mean-variance optimization, the analyst must input appropriate expected return, variance, and correlation data for ILBs as well as other assets (or liabilities) included in the optimization.

Although conceptually inputs for such optimizations are forward-looking, practitioners usually rely heavily on historical data. Since U.S. TIPS have existed since 1997, correlation matrices are built using asset class returns from 1997 forward or from pro-forma estimates of TIPS returns prior to 1997. Although most optimization models function in a nominal frame of reference, some practitioners appropriately implement them in a real frame of reference.

Managing Dedicated ILB Portfolios Using Real Duration

After a ILBs allocation has been determined, an implementation strategy must be executed. For this, an investor chooses between active or passive management. In either case, real duration is a useful metric of exposure because it measures the allocation's relative sensitivity to changes (parallel shifts) in the real yield curve.

To construct an ILB portfolio, the practitioner needs first to choose a target "real duration" for the portfolio and then to devise a variety of candidate portfolio structures. The candidate portfolios might include a bulleted portfolio having all its ILBs close to the target duration and a barbell portfolio with a combination of longer and shorter ILBs weighted to achieve the target duration.

To select the most advantageous portfolio structure from those with the same real duration, the practitioner need only concern herself with the exposure to changes in the general real yield curve slope of the various candidate portfolios. This is so because the candidate portfolios have the same real yield duration, so their response to parallel shifts will be very similar.

Investor Types: Pension Plans, Endowments, Foundations, and Individuals

Defined-benefit pension plans have both retired-lives and active-lives liabilities. Although ILBs as assets may match the active-life portion of these plans extremely well, plan sponsors typically do not rely exclusively on ILBs to back their active-lives liabilities. Instead, they reach for higher expected returns by using other asset classes with higher risk and return qualities. Given that ILBs and the active-lives liabilities are both linked to inflation,[9] sponsors realize that to reach for higher returns, they take on some risk of underperformance in inflationary environments. In addition to generic asset allocations, pension plans may use ILBs to protect a surplus, to offset substantial equity risk exposure, or to reduce the variability of annual funding requirements. Defined-contribution pension plans and their participants also may benefit from the inclusion of ILBs as described separately below.

Endowments, foundations, and other eleemosynary organizations also may have return objectives that are formulated in *real* terms. Typically their goal is to generate a 5% or higher real return on their investment portfolio. (The IRS generally requires that 5% of a charitable foundation's assets be spent on the delivery of charitable services each year—so a 5% real return, net of expenses and contributions, is required to maintain the foundation's inflation-adjusted size.)

9. More specifically, active-lives liabilities are tied to increases in wages of employees. The pension plans may prescribe that an employee's retirement benefit is a fixed annuity, with each monthly payment being a fraction of employees' highest annual income. This income level is in turn not explicitly but generally highly correlated with the CPI.

Establishing a real-return target for investment performance makes sense for these organizations. Educational or charitable programs, whether they involve physical infrastructure or services, often are budgeted for using inflation-adjusted dollars. Implicitly, such goals, objectives, and plans represent real liabilities.

This suggests that eleemosynaries employ ILBs as a core pillar in their investment strategy. ILBs will not generally achieve 5% returns in isolation, but they go a long way toward engineering out much of the downside risk of return distributions. With the downside risk truncated, more aggressive use of a higher-returning (riskier) asset can be used. As of this writing, eleemosynaries generally have used ILBs only at the margin.

Individuals save primarily to provide for retirement needs and secondarily for children's education, bequeathment, and other goals. Younger individuals may be relatively immune to the damage that inflation can cause in the context of such liabilities. They hold a large proportion of their "wealth" in the intangible real asset known as *human capital* (future earning power). As individuals age, the proportion of their real assets typically decrease as their financial assets increase—leaving those in their late 40s and older relatively vulnerable to the inflationary erosion of retirement living standards.

ISSUERS

Although corporations and agencies can and do issue ILBs, governments are by far the largest issuers. By issuing ILBs, government officials make clearer their commitment to maintaining a low level of inflation. A government's willingness to assume the financial risk of inflation is a powerful signal to the marketplace regarding future policy. Donald T. Brash, governor of the Reserve Bank of New Zealand, characterized this attitude in a speech following New Zealand's introduction of these securities:

> The only "cost" to Government is that, by issuing inflation-adjusted bonds, it foregoes the opportunity of reducing, through inflation, the real cost of borrowing . . . Since [the New Zealand] Government has no intention of stealing the money invested by bondholders, foregoing the right to steal through inflation hardly seems a significant penalty.[10]

How can an investment instrument that makes so much sense for investors, as described in preceding sections, also be advantageous to the issuer? Brash's quote provides one example of how investors gain while the issuer forfeits something it considered worthless to begin with. Next we discuss the U.S. Treasury rationale for issuing TIPS.

10. Donald T. Brash, "Monetary Policy and Inflation-Adjusted Bonds," an address to the New Zealand Society of Actuaries, April 12, 1995.

U.S. Treasury's Rationale

A goal of the Clinton administration was to reduce the future interest burden of the Treasury's debt. Balancing the budget was the main target of this policy, but a secondary objective took aim at "bond market vigilantes." The administration recognized that because of the "maturity premium" inherent in longer-term debt, rolling over a 3-year bond ten times likely would incur less interest cost than issuing a single 30-year bond. One of the most important programs Treasury embarked on during this administration was a deliberate effort to reduce the average maturity of outstanding debt.

TIPS Program

The TIPS program was instituted in this spirit. Like floating-rate debt, TIPS have long *stated* but short *effective* maturities, reducing the "rollover risk" inherent in short-term debt. Additionally, TIPS explicitly provide market-based inflation forecasts for use by the Fed. TIPS reduce the expected cost of financing a government's debt because they are conceptually free of the inflation risk premium built into nominal long-term bond yields. Normally one might conclude that by relieving bond investors of this risk, the Treasury implicitly absorbs a burden or risk equal in magnitude. This is not the case here, however.

By reducing nominal debt and increasing inflation-indexed (real) debt, the Treasury has in effect changed the structure of its liabilities to better match its only asset—its authority to tax. Put another way, the Treasury is the ideal issuer of inflation-indexed debt.

The issuance of TIPS improves taxpayer welfare by eliminating the 0.5% to 1.0% inflation risk premium that researchers believe is embedded in nominal bond yields. At the margin, investors are indifferent to accepting lower yields versus living with the higher risk of nominal debt—so conceptually they are no better or worse off. The elimination of this inflation risk premium is therefore a true welfare gain. In practice, the welfare gains of issuing TIPS have been split between issuers and the investors.

Moral Hazard

The government is both the issuer of TIPS (Department of Treasury) and publisher of the CPI (BLS, Department of Labor). The inherent ambiguity in measuring the CPI creates a moral hazard because the government can directly control the economic value of its liability. Fortunately, several factors mitigate the risk of the government publishing statistics that are not scientifically based.

First, professional integrity, a strong institutional infrastructure, and influential political constituencies combine to preclude the government from manipulating the CPI. Second, any confiscation of value through index distortions would be perceived by the financial community as an erosion of credibility or, if blatant, tantamount to default. Since the issuance process is a repeated game of substantial proportion, such an erosion of credibility would have long-term repercussions on future debt issuance and other government promises that would greatly outweigh any apparent short-term economic or political benefits.

International Issuers

The ILB market in the United Kingdom is large and well developed, comprising about 20% of outstanding debt. Additionally, Canada, Australia, France, Italy, and Sweden have issued ILBs in large enough quantities to ensure reasonable market liquidity as well.

While each of these countries shares the basic inflation-protection concept with their U.S. cousins, differences include market size, trading liquidity, time lag associated with the inflation indexation, taxation, day-count conventions, and quotation conventions. These differences substantially influence both observed quoted real yields and "true" real yields available to investors.

All the ILBs issued by these six governments, together with those issued by the U.S. Treasury, make up a performance benchmark of liquid global inflation bonds known as the *Barclays Capital Global Inflation-Linked Bond Index.*

Corporate Issuers and CPI Floaters

In addition to the U.S. Treasury and foreign government issuers, U.S. corporations, agencies, and municipalities have issued inflation-indexed bonds. Two of the earliest corporate issuers were the Tennessee Valley Authority and Salomon Brothers. Their inflation-indexed bonds were virtually identical in structure to U.S. Treasury TIPS. Other issuers, including Nationsbank, Toyota Motor Credit, the Student Loan Marketing Association (SLMA), and the Federal Home Loan Bank (FHLB), have chosen to structure their bonds as CPI floaters.

A CPI floater is a hybrid between TIPS and a conventional floating-rate note (FRN). Like a TIPS, its return is closely linked to CPI inflation. Like a conventional floating-rate note, its principal is fixed in size. The coupon rate of a CPI floater fluctuates and is typically defined as the CPI inflation rate plus a fixed-percentage margin.

OTHER ISSUES

Taxation

U.S. TIPS are taxed similarly to zero-coupon bonds. They incur a tax liability on phantom income (income earned but not paid.) This does not mean that investors in TIPS pay more taxes or that they pay taxes sooner than holders of nominal bonds. In fact, if inflation, nominal yields, and tax rates are constant, the cash-flow profile of taxes paid and payments received on TIPS is comparable with those of nominal bonds (assuming reinvestment of the excess coupon). In practice, many taxpayers hold TIPS in tax-exempt accounts (40(k)s, etc.) or within mutual funds (which are generally required to distribute taxable income.)

Deflation Protection

Questions naturally arise regarding how TIPS would behave in a deflationary environment (one where prices are literally falling). Applying CPI indexation, the current adjusted principal value would be less than the prior adjusted principal value. This would affect semiannual interest payments accordingly.

Extending this premise, it is certainly possible for the adjusted principal value to fall below the original principal value—and therefore for coupon payments to be calculated on a shrinking base. Note that they would still be positive and almost equal to their original size. For example, even after 10 years of 1% deflation and a resulting price level that was 10% lower than when it started, the semiannual coupon payments on a $1,000 TIPS would still be about $18 (rather than $20 originally). The final principal repayment would be treated even more favorably.

In particular, *the Treasury has guaranteed that for the maturity payment of principal (and only the maturity payment), the investor will not receive less than the original principal amount.*

In such deflationary circumstances, in order to maintain acceptable nominal returns, the Treasury would in effect be paying a higher real return than initially promised. The Treasury decided that the regulatory, institutional, and psychological benefits of providing this guarantee would facilitate distribution of the bonds to an extent that more than justifies the theoretical contingent cost to the government.

This government guarantee of 100% principal return distinguishes TIPS from all other inflation hedges.

CONCLUSION

During the last two decades of the twentieth century, the financial markets enjoyed an unprecedented period of falling inflation and high real returns. But investors inevitably will relearn the history lesson taught thousands of years ago in Mesopotamia: the risk of secular inflation can never be completely eliminated.

Fortunately for investors, the decision by the U.S. Treasury to issue TIPS provides an attractive vehicle to hedge against the risk of inflation. The creation of this new asset class is sure to have broad-reaching implications for both institutional and retail investors. In time it is likely that TIPS allocations will become an integral part of almost all portfolios. Negatively correlated with inflation-sensitive financial asset classes, TIPS increase the efficiency of investment portfolios. The result is a dramatically superior risk/return trade-off, independent of inflation forecasts.

CHAPTER

SIXTEEN

FLOATING-RATE SECURITIES

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Under the rubric of floating-rate securities or simply *floaters,* there are several different types of securities with an essential feature in common: coupon interest will vary over the instrument's life. Floaters, which were first introduced into the European debt market and issued in the United States in the early 1970s, are now issued in every sector of the bond market—government, agency, corporate, municipal, mortgage, and asset-backed—in the United States and in markets throughout the world. Although a floater's coupon formula may depend on a wide variety of economic variables (e.g., foreign exchange rates or commodity prices), a floater's coupon payments usually depend on the level of a money market interest rate (e.g., the London Interbank Offer Rate, or LIBOR, Treasury bills). A floater's coupon rate can be reset semiannually, quarterly, monthly, or weekly. The term *adjustable rate* or *variable rate* typically refers to securities with coupon rates reset not more than annually or based on a longer-term interest rate. However, this is a distinction without a difference, and we will refer to both floating-rate securities and adjustable-rate securities as "floaters."

In this chapter we will discuss the general features of floaters and present some illustrations of the major product types. Most market participants use "spread" or margin measures (e.g., adjusted simple margin or discount margin) to assess the relative value of a floater. We will briefly describe these measures and note their limitations. Finally, we discuss several popular portfolio strategies that employ floaters.

Parts of this chapter are adapted from Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope, PA: Frank J. Fabozzi Associates, 2000).

GENERAL FEATURES OF FLOATERS AND MAJOR PRODUCT TYPES

A floater is a debt security whose coupon rate is reset at designated dates based on the value of some designated reference rate. The coupon formula for a pure floater (i.e., a floater with no embedded options) can be expressed as follows:

$$\text{Coupon rate} = \text{reference rate} \pm \text{quoted margin}$$

The quoted margin is the adjustment (in basis points) that the issuer agrees to make to the reference rate. For example, consider a floating-rate note issued in September 2003 by Columbus Bank & Trust that matures on March 15, 2005. This floater delivers cash flows quarterly and has a coupon formula equal to three-month LIBOR plus 12 basis points.

As noted, the reference rate is the interest rate or index that appears in a floater's coupon formula, and it is used to determine the coupon payment on each reset date within the boundaries designated by embedded caps and/or floors. The four most common reference rates are LIBOR, Treasury bill yields, prime rates, and domestic CD rates, and they appear in the coupon formulas of a wide variety of floating-rate products. Other reference rates are used in more specialized markets such as the markets for mortgage-backed securities and the municipal market. For example, the most common reference rates for adjustable-rate mortgages (ARMs) or collateralized mortgage obligation (CMO) floaters include (1) the one-year Constant Maturity Treasury Rate (i.e., one-year CMT), (2) the 11th District Cost of Funds (COFI), (3) the six-month LIBOR, and (4) the National Monthly Median Cost of Funds Index. In the municipal market, the reference rate for floaters is often a Treasury rate or the prime rate. Alternatively, the reference rate could be a municipal index. Three popular municipal indexes are the J. J. Kenney Index, the Bond Buyer 40 Bond Index, and the Merrill Lynch Municipal Securities Index.[1]

A floater often imposes limits on how much the coupon rate can float. Specifically, a floater may have a restriction on the maximum coupon rate that will be paid on any reset date. This is called a *cap.* Consider a floater issued by Federal Home Bank that matures on October 20, 2006. The coupon formula is the three-month LIBOR plus 75 basis points with a cap of 3.75%. If the three-month LIBOR at a coupon date reset is 3.25%, then the coupon formula would suggest the new coupon rate is 4%. However, the cap restricts the maximum coupon rate to 3.75%. Needless to say, a cap is an unattractive feature from the investor's perspective.

In contrast, a floater also may specify a minimum coupon rate called a *floor.* For example, First Chicago (now First Chicago NBD Corp.) issued a floored floating-rate note in July 1993 that matured in July 2003. This issue delivers quarterly coupon payments with a coupon formula of the three-month LIBOR plus 12.5 basis points with a floor of 4.25%. Thus, if the three-month LIBOR ever fell

1. For a detailed description of each of these reference rates, see Frank J. Fabozzi and Steven V. Mann, *Floating Rate Securities* (New Hope, PA: Frank J. Fabozzi Associates, 2000).

below 4.125%, the coupon rate would remain at 4.25%. A floor is an attractive feature from the investor's perspective.

When a floater possesses both a cap and a floor, this feature is referred to as a *collar.* Thus a collared floater's coupon rate has a maximum and a minimum value. For example, Fannie Mae issued a collared floater in October 1997 that makes quarterly coupon payments and matures in October 2012. The coupon formula is the three-month LIBOR flat (i.e., a spread of zero) with a floor of 6.43% and a cap of 9.5%.

While a floater's coupon rate typically moves in the same direction as the reference rate, there are floaters whose coupon rates move in the opposite direction from the reference rate called *inverse floaters* or *reverse floaters.* A general formula for an inverse floater is

$$K - L \times (\text{reference rate})$$

From the formula, it is easy to see that as the reference rate goes up (down), the coupon rate goes down (up). As an example, consider an inverse floater issued by the Federal Home Loan Bank in April 1999 and matured in April 2002. This issue delivered quarterly coupon payments according to the formula

$$18\% - 2.5 \times (\text{three-month LIBOR})$$

In addition, this inverse floater has a floor of 3% and a cap of 15.5%. Note that for this inverse floater, the value for L (called the *coupon leverage*) in the coupon reset formula is 2.5. Assuming that neither the cap rate nor the floor rate are binding, this means that for every one basis point change in the three-month LIBOR, the coupon rate changes by 2.5 basis points in the opposite direction.[2]

There is a wide variety of floaters that have special features that may appeal to certain types of investors. For example, some issues provide for a change in the quoted margin (i.e., the spread added to or subtracted from the reference in the coupon reset formula) at certain intervals over a floater's life. These issues are called *stepped-spread floaters* because the quoted margin can either step to a higher or lower level over time. Consider Standard Chartered Bank's floater due in December 2006. From its issuance in December 1996 until December 2001, the coupon formula was the three-month LIBOR plus 40 basis points. However, from December 2001 until maturity, the quoted margin "steps up" to 90 basis points.

A *range note* is a floater where the coupon payment depends on the number of days that the specified reference rate stays within a preestablished collar. For instance, Sallie Mae issued a range note in August 1996 (due in August 2003) that made coupon payments quarterly. For every day during the quarter that the three-month LIBOR was between 3% and 9%, the investor earned the three-month LIBOR plus 155 basis points. Interest would accrue at 0% for each day that the three-month LIBOR was outside this collar.

2. When L is greater than 1, the security is referred to as a *leveraged inverse floater.*

There are also floaters whose coupon formula contains more than one reference rate. A *dual-indexed floater* is one such example. The coupon rate formula is typically a fixed percentage plus the difference between two reference rates. For example, the Federal Home Loan Bank issued a floater in November 2001 that was called in November 2002 whose coupon formula was the following:

$$\text{10-year Constant Maturity Treasury rate} + \text{400 basis points} - \text{6-month LIBOR}$$

In addition, this issue had a cap of 24% and a floor of 0%.

Although the reference rate for most floaters is an interest rate or an interest-rate index, numerous kinds of reference rates appear in coupon formulas. This is especially true for structured notes. Potential reference rates include movements in foreign exchange rates, the price of a commodity (e.g., gold), movements in an equity index (e.g., the Standard & Poor's 500 Index), or an inflation index (e.g., CPI). Financial engineers are capable of structuring floaters with almost any reference rate. For example, in March 1996, the Federal Home Loan Bank issued a structured note with the seven-year swap rate as the reference rate in the coupon formula. Specifically, this inverse floater makes semiannual coupon payments using the following formula:

$$2.5 \times (9.219\% - \text{7-year swap rate})$$

This issue has a floor of 0%.

CALL AND PUT PROVISIONS

Just like fixed-rate issues, a floater may be *callable.* The call option gives the issuer the right to buy back the issue prior to the stated maturity date. The call option may have value to the issuer some time in the future for two basic reasons. First, market interest rates may fall so that the issuer can exercise the option to retire the floater and replace it with a fixed-rate issue. Second, the required margin decreases so that the issuer can call the issue and replace it with a floater with a lower quoted margin.[3] The issuer's call option is a disadvantage to the investor because the proceeds received must be reinvested either at a lower interest rate or a lower margin. Consequently, an issuer who wants to include a call feature when issuing a floater must compensate investors by offering a higher quoted margin.

For amortizing securities (e.g., mortgage-backed and some asset-backed securities) that are backed by loans that have a schedule of principal repayments, individual borrowers typically have the option to pay off all or part of their loan prior to the scheduled date. Any additional principal repayment above the scheduled amount is called a *prepayment.* The right of borrowers to prepay is called the

3. The required margin is the spread (either positive or negative) the market requires as compensation for the risks embedded in the issue. If the required margin equals the quoted margin, a floater's price will be at par on coupon reset dates.

prepayment option. Basically, the prepayment option is analogous to a call option. However, unlike a call option, there is not a call price that depends on when the borrower pays off the issue. Typically, the price at which a loan is prepaid is its par value.

Floaters also may include a *put provision* that gives the security holder the option to sell the security back to the issuer at a specified price on designated dates. The specified price is called the *put price.* The put's structure can vary across issues. Some issues permit the holder to require the issuer to redeem the issue on any coupon payment date. Others allow the put to be exercised only when the coupon is adjusted. The time required for prior notification to the issuer or its agent varies from as little as four days to as long as a couple of months. The advantage of the put provision to the holder of the floater is that if after the issue date the margin required by the market for a floater to trade at par rises above the issue's quoted margin, the investor can force the issuer to redeem the floater at the put price and then reinvest the proceeds in a floater with the higher quoted margin.

SPREAD MEASURES

There are several yield spread measures or margins that are used routinely to evaluate floaters. The four margins commonly used are spread for life, adjusted simple margin, adjusted total margin, and discount margin. All these spread measures are available on Bloomberg's Yield Analysis (YA) screen.

Spread for Life

When a floater is selling at a premium/discount to par, a potential buyer of a floater will consider the premium or discount as an additional source of dollar return. *Spread for life* (also called *simple margin*) is a measure of potential return that accounts for the accretion (amortization) of the discount (premium) as well as the constant index spread over the security's remaining life.

Adjusted Simple Margin

The *adjusted simple margin* (also called *effective margin*) is an adjustment to spread for life. This adjustment accounts for a one-time cost-of-carry effect when a floater is purchased with borrowed funds. Suppose that a security dealer has purchased $10 million of a particular floater. Naturally, the dealer has a number of alternative ways to finance the position—borrowing from a bank, repurchase agreement, etc. Regardless of the method selected, the dealer must make a one-time adjustment to the floater's price to account for the cost of carry from the settlement date to next coupon reset date.

Adjusted Total Margin

The *adjusted total margin* (also called *total adjusted margin*) adds one additional refinement to the adjusted simple margin. Specifically, the adjusted total margin is the adjusted simple margin plus the interest earned by investing the difference between the floater's par value and the carry-adjusted price.[4]

Discount Margin

One common method of measuring potential return that employs discounted cash flows is *discount margin.* This measure indicates the average spread or margin over the reference rate the investor can expect to earn over the security's life given a particular assumed path that the reference rate will take to maturity. The assumption that the future levels of the reference rate are equal to today's level is the current market convention. The procedure for calculating the discount margin is as follows:

1. Determine the cash flows assuming that the reference rate does not change over the security's life.
2. Select a margin (i.e., a spread above the reference rate).
3. Discount the cash flows found in (1) by the current value of the reference rate plus the margin selected in (2).
4. Compare the present value of the cash flows as calculated in (3) with the price. If the present value is equal to the security's price, the discount margin is the margin assumed in (2). If the present value is not equal to the security's price, go back to (2) and select a different margin.

For a floater selling at par, the discount margin is simply the quoted margin. Similarly, if the floater is selling at a premium (discount), then the discount margin will be below (above) the quoted margin. An illustration of the calculation of discount margin is provided in Chapter 5.

Practitioners use the spread measures presented above to gauge the potential return from holding a floater. Much like conventional yield measures for fixed income securities, the yield or margin measures discussed here are, for the most part, relatively easy to calculate and interpret. However, these measures reflect relative value only under several simplifying assumptions (e.g., reference rates do not change).

One of the key difficulties in using the measures described in this chapter is that they do not recognize the presence of embedded options. As discussed, there are callable/putable floaters and floaters with caps and/or floors. However, the recognition of embedded options is critical to valuing floaters properly. If an issuer

4. When the floater's adjusted price is greater than 100, the additional increment is negative and represents the interest foregone.

can call an issue when presented with the opportunity and refund at a lower spread, the investor must then reinvest at the lower spread. With this background, it should not be surprising that sophisticated practitioners value floaters using arbitrage-free binomial interest rate trees and Monte Carlo simulations. These models are designed to value securities whose cash flows are interest-rate-dependent.

PRICE VOLATILITY CHARACTERISTICS OF FLOATERS

The change in the price of a fixed-rate security when market rates change occurs because the security's coupon rate differs from the prevailing rate for new comparable bonds issued at par. Thus an investor in a 10-year, 7% coupon bond purchased at par, for example, will find that the bond's price will decline below par if the market requires a yield greater than 7% for bonds with the same risk and maturity. By contrast, a floater's coupon resets periodically, thereby reducing its sensitivity to changes in rates. For this reason, floaters are said to be more "defensive" securities. This does not mean, of course, that a floater's price will not change.

Factors That Affect a Floater's Price

A floater's price will change depending on the following factors:

1. Time remaining to the next coupon reset date
2. Changes in the market's required margin
3. Whether or not the cap or floor is reached

We will discuss the impact of each of these factors in the following sections.

Time Remaining to the Next Coupon Reset Date

The longer the time to the next coupon reset date, the more a floater behaves like a fixed-rate security, and the greater is a floater's potential price fluctuation. Conversely, the shorter the time between coupon reset dates, the smaller is the floater's potential price fluctuation.

To understand why this is so, consider a floater with five years remaining to maturity whose coupon formula is the one-year Treasury rate plus 50 basis points, and the coupon is reset today when the one-year Treasury rate is 5.5%. The coupon rate will remain at 6% for the year. One month hence, an investor in this floater effectively would own an 11-month instrument with a 6% coupon. Suppose that at that time the market requires a 6.2% yield on comparable issues with 11 months to maturity. Then our floater would be offering a below-market rate (6% versus 6.2%). The floater's price must decline below par to compensate the investor for the submarket yield. Similarly, if the yield that the market requires on a comparable instrument with a maturity of 11 months is less than 6%, the floater will trade at a premium. For a floater in which the cap is not binding and for which the market does not demand a margin different from the quoted margin, a floater that resets daily will trade at par.

Changes in the Market's Required Margin

At the initial offering of a floater, the issuer will set the quoted margin based on market conditions so that the security will trade near par. Subsequently, if the market requires a higher/ lower margin, the floater's price will decrease/increase to reflect the current margin required. We shall refer to the margin that is demanded by the market as the "required margin." For example, consider a floater whose coupon formula is the one-month LIBOR plus 40 basis points. If market conditions change such that the required margin increases to 50 basis points, this floater would be offering a below-market margin. As a result, the floater's price will decline below par value. By the same token, the floater will trade above its par value if the required margin is less than the quoted margin—less than 40 basis points in our example.

The required margin for a particular issue depends on (1) the margin available in competitive funding markets, (2) the credit quality of the issue, (3) the presence of any embedded call or put options, and (4) the liquidity of the issue. An alternative source of funding to floaters is a syndicated loan. Consequently, the required margin will be driven, in part, by margins available in the syndicated loan market.

The portion of the required margin attributable to credit quality is referred to as the "credit spread." The risk that there will be an increase in the credit spread required by the market is called *credit-spread risk*. The concern for credit-spread risk applies not only to an individual issue but also to a sector or the economy as a whole. For example, credit spreads may increase due to a financial crises (e.g., a stock market crash) while the individual issuer's condition and prospects remain essentially unchanged.

A portion of the required margin reflects the call risk if the floater is callable. Because the call feature imposes hazards on the investor, the greater the call risk, the higher is the quoted margin at issuance, other things equal. After issuance, depending on how interest rates and required margins change, the perceived call risk and the margin required as compensation for this risk will change accordingly. In contrast to call risk owing to an embedded call option, a put provision provides benefits to the investor. If a floater is putable at par, all else the same, its price should trade at par near the put date.

Finally, a portion of the quoted margin at issuance will reflect the issue's perceived liquidity. *Liquidity risk* is the threat of an increase in the required margin due to a perceived deterioration in an issue's liquidity. Investors in nontraditional floater products are particularly concerned with liquidity risk.

Whether or Not the Cap or Floor Is Reached

For a floater with a cap, once the coupon rate as specified by the coupon formula rises above the cap rate, the floater then offers a below-market coupon rate, and the floater will trade at a discount. The floater will trade more and more like a fixed-rate security the further the capped rate is below the prevailing market rate. Simply put, if a floater's coupon rate does not float, it is effectively a fixed-rate security. *Cap risk* is the risk that the floater's value will decline because the cap is reached.

The situation is reversed if the floater has a floor. Once the floor is reached, all else equal, the floater will trade either at par value or at a premium to par if the coupon rate is above the prevailing rate offered for comparable issues.

Duration of Floaters

We have just described how a floater's price will respond to a change in the required margin, holding all other factors constant. As explained in Chapter 9, the measure used by market participants to quantify the sensitivity of a security's price to changes in interest rates is called *duration*. A security's duration tells us the approximate percentage change in its price for a 100 basis point change in rates. The procedure of computing a security's duration was explained in Chapter 9.

Two measures are employed to estimate a floater's sensitivity to each component of the coupon formula. *Index duration* is a measure of the floater's price sensitivity to changes in the reference rates holding the quoted margin constant. Correspondingly, *spread duration* measures a floater's price sensitivity to a change in the "quoted margin" or "spread" assuming the reference rate remains unchanged.

Price Volatility of an Inverse Floater

An inverse floater can be created by acquiring a fixed-rate security and splitting it into a floater and an inverse floater. The fixed-rate security from which the floater and inverse floater are created is called the *collateral*. The interest paid to the floater investor and inverse floater investor must be such that it is equal to the interest rate paid on the collateral.

Because valuations are additive (i.e., the value of the collateral is the sum of the floater and inverse floater values), durations (properly weighted) are additive as well. Accordingly, the duration of the inverse floater is related in a particular fashion to the duration of the collateral and the duration of the floater. Specifically, the duration of an inverse floater will be a multiple of the duration of the collateral from which it is created.

To understand this, suppose that a 30-year fixed-rate bond with a market value of $100 million is split into a floater and an inverse floater with market values of $80 million and $20 million, respectively. Assume also that the duration of the collateral (i.e., the 30-year fixed-rate bond) is 8. Given this information, we know that for a 100 basis point change in required yield the collateral's value will change by approximately 8%, or $8 million (8% times $100 million). Since the floater and inverse floater are created from the collateral, the combined change in value of the floater and the inverse floater must be $8 million for a 100 basis point change in required yield. The question becomes how do we partition the change in value between the floater and inverse floater. If the duration of the floater is small, as explained earlier, then the inverse floater must experience the full force of the $8 million change in value. For this to occur, the duration of the inverse floater must be approximately 40. A duration of 40 will mean a 40% change in the inverse floater's value for a 100 basis point change in required yield and a change in value of approximately $8 million (40% times $20 million).

Effectively, the inverse floater is a leveraged position in the collateral. That is, ownership of an inverse floater is equivalent to buying the collateral and funding it on a floating-rate basis, where the reference rate for the borrowing is equal to the reference rate for the inverse floater. Accordingly, the duration of the inverse floater is a multiple of the duration of the collateral.

PORTFOLIO STRATEGIES

Several portfolio strategies have been employed using floaters. These include (1) basic asset/liability management strategies, (2) risk arbitrage strategies, (3) betting on changes in the required margin, and (4) arbitrage between fixed- and floating-rate markets using asset swaps. We will briefly describe each of these strategies in turn.

Asset/liability management strategies can be explained most easily using depository institutions. These institutions typically borrow short term, and their objective is to lock in a spread over their short-term funding costs. Not surprisingly, one obvious way to accomplish this objective is to invest in floating-rate products. Naturally, this strategy is not without risks. The floater's coupon rate likely will be capped, whereas the short-term funding may not be. This is known as *cap risk*. Further, the floater's reference rate may not be the same as the reference rate for funding. If this is the case, the institution is exposed to *basis risk*.

Risk arbitrage strategies using floaters are not arbitrage in the true sense of the term. One example of this type of strategy involves money managers using leverage (via repurchase agreements) to invest in agency adjustable-rate passthrough securities that earn a higher spread over their borrowing rate. Of course, this is not a "risk free" transaction. Like before, the manager likely will be exposed to cap risk if the floater's coupon is capped while the funding rate is not. The manager also may be exposed to basis risk if the two reference rates are mismatched. Finally, there is *price risk* if the floater's risk changes for the worse, and the floater must be sold prior to maturity. In this case, the quoted margin will no longer compensate the investor for the security's risks, and the floater will sell at a discount to par. No serious investor believes that a risk arbitrage strategy is a reliable source of spread income.

Investors also can speculate on whether a floater's required margin will change. When a floater is issued, the quoted margin contained in the coupon formula will be set so that the floater will be priced at or near par. After the floater enters the secondary market, the quoted margin for a standard floater does not change. Thus, if the floater's risk does not change and the compensation demanded by the market does not change either, the floater's price will be par on every coupon reset date. In this case, the quoted margin offered by the security and quoted margin required by the market (called the *required margin*) are the same.

If conditions change such that the required spread is greater than (less than) the quoted margin, the floater will trade at discount (premium) to par. Given this background, one obvious strategy money managers pursue is betting on a change in the required margin for a single issue or a sector.

Lastly, some money managers arbitrage between floaters and fixed-rate securities using a so-called asset swap. An asset-based swap transaction involves the creation of synthetic security via the purchase of an existing security and the simultaneous execution of a swap.

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CHAPTER
SEVENTEEN

NONCONVERTIBLE PREFERRED STOCK

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Preferred stock is a hybrid security that combines features of both common stocks and corporate bonds. While preferred stock possesses some debtlike features, it is considered to be an equity security. Preferred stockholders have a claim on the cash dividends paid by the issuing corporation, and their claim is senior to that of common shareholders. Furthermore, cash dividends paid to preferred stockholders are almost always fixed by contract (e.g., a specified dollar amount or percentage of their face value). Accordingly, "plain vanilla" preferred stock is, in essence, a perpetuity. The specified percentage is called the *dividend rate,* which may be fixed or floating. Almost all preferred stock issued today limits the payments to be received by the security holder to a specified amount with the proviso that the cash flows received will never exceed those specified in the contract and may be less.

Failure to make preferred stock dividend payments cannot force the issuer into bankruptcy. If the issuer fails to make the preferred dividend payments as specified in the contract, then depending on the terms of the issue, one of two things can occur. If the issue is *cumulative,* the dividend payment accrues until it is fully paid. Conversely, if the issue is *noncumulative,* missed dividend payments simply are forgone. Failure to make dividend payments also may trigger certain restrictions on the issuer's management. As an example, if dividend payments are in arrears, preferred shareholders may be granted voting rights to elect some members to the issuer's board of directors. This feature is called *contingent voting* because the voting rights are contingent on a missed dividend payment.[1]

1. By contrast, *blank check* preferred stock contains a provision that gives voting rights to approved preferred shareholders as protection against a hostile takeover attempt.

Cumulative preferred stock has some debtlike features, namely, (1) the cash flows promised to preferred stockholders are fixed by contract, and (2) preferred stockholders have priority over common stockholders with respect to dividend payments and distribution of the assets in case of bankruptcy.[2] However, on a balance sheet, preferred stock is classified as equity. When there is more than one class of preferred stockholders, the claims of preferred stockholders to the issuer's assets differ in the event of bankruptcy. For example, *first* preferred stock's claim to dividends and assets has priority over other preferred stock. Correspondingly, *second* preferred stock ranks below at least one other issue of preferred stock.

Almost all preferred stock has a sinking-fund provision, and such provisions usually are structured similarly to those used with corporate bonds. A sinking fund is a provision allowing for a preferred stock's periodic retirement over its life span. Most sinking funds require a specific number of shares or a certain percentage of the original issue to be retired periodically, usually on an annual basis. Sinking-fund payments can be satisfied by either paying cash and calling the required number of shares or delivering shares purchased in the open market. Most sinking funds give the issuer a noncumulative option to retire an additional amount of preferred stock equal to the mandatory requirement. This is called a *double-up option*. Preferred shares acquired to satisfy a sinking-fund requirement usually are called using a random selection process.

PREFERRED STOCK ISSUANCE

Corporations use three types of securities—debt, common stock, and preferred stock—to finance their operations. In terms of total dollars issued, preferred stock ranks third by a large margin. For example, in 2002, U.S. corporations issued around $667 billion in debt and $88 billion in common stock, but only $24 billion in preferred stock.

There have been two fundamental shifts in the issuance pattern of preferred stock since the early 1980s. Since the mid-1980s, the major issuers of preferred stock are financial institutions and insurance companies, whereas before this time, public utilities issued a majority of preferred stock. Second, most of the preferred stock issued today carries an adjustable-rate dividend. Traditionally, almost all preferred stock paid a fixed dividend.

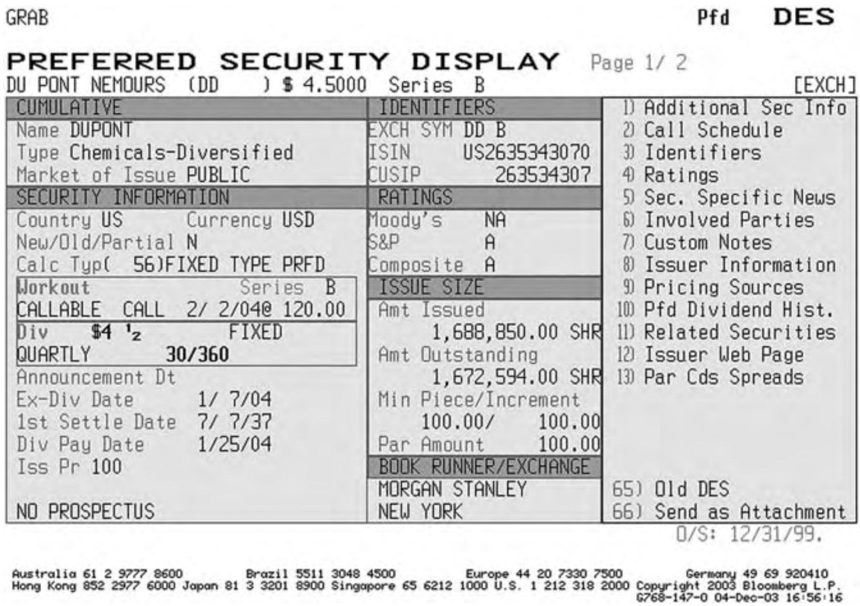
Types of Preferred Stock

There are three types of preferred stock: (1) fixed-rate preferred stock, (2) adjustable-rate preferred stock, and (3) auction-rate and remarketed preferred stock.

2. The position of noncumulative preferred stock is considerably weaker.

EXHIBIT 17–1

Bloomberg's Preferred Security Display for DuPont Preferred Stock


GRAB Pfd DES

PREFERRED SECURITY DISPLAY Page 1/ 2

DU PONT NEMOURS (DD) $ 4.5000 Series B [EXCH]

CUMULATIVE
Name DUPONT
Type Chemicals-Diversified
Market of Issue PUBLIC
SECURITY INFORMATION
Country US Currency USD
New/Old/Partial N
Calc Typ(56)FIXED TYPE PRFD
Workout Series B
CALLABLE CALL 2/ 2/04@ 120.00
Div $4 ½ FIXED
QUARTLY 30/360
Announcement Dt
Ex-Div Date 1/ 7/04
1st Settle Date 7/ 7/37
Div Pay Date 1/25/04
Iss Pr 100
NO PROSPECTUS

IDENTIFIERS
EXCH SYM DD B
ISIN US2635343070
CUSIP 263534307
RATINGS
Moody's NA
S&P A
Composite A
ISSUE SIZE
Amt Issued
1,688,850.00 SHR
Amt Outstanding
1,672,594.00 SHR
Min Piece/Increment
100.00/ 100.00
Par Amount 100.00
BOOK RUNNER/EXCHANGE
MORGAN STANLEY
NEW YORK

1) Additional Sec Info
2) Call Schedule
3) Identifiers
4) Ratings
5) Sec. Specific News
6) Involved Parties
7) Custom Notes
8) Issuer Information
9) Pricing Sources
10) Pfd Dividend Hist.
11) Related Securities
12) Issuer Web Page
13) Par Cds Spreads
65) Old DES
66) Send as Attachment
O/S: 12/31/99.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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Fixed-Rate Preferred Stock

Prior to 1982, all publicly issued preferred stock paid a fixed dividend rate. As an illustration, Exhibit 17–1 presents a Bloomberg Preferred Security Display screen of a DuPont Corp. fixed-rate preferred stock. These shares carry a $4.50 annual dividend that is paid quarterly. Exhibit 17–2 presents the Bloomberg Call Schedule screen for this issue that indicates that it became callable on January 25, 1987, in whole or in part at a price of $120 per share. DuPont must give notice at least 60 days prior to a call.

Adjustable-Rate Preferred Stock

For *adjustable-rate preferred stock* (ARPS), the dividend rate is reset quarterly based on a predetermined spread from the highest of three points on the Treasury yield curve. The predetermined spread is called the *dividend reset spread*. The dividend reset spread is added to or subtracted from the *benchmark rate* determined from the yield curve. The three points on the yield curve are the highest of (1) the 3-month Treasury bill rate, (2) the 10-year Treasury rate, or (3) the 30-year Treasury rate. It is often the case that the dividend reset spread is expressed as a certain percentage of the benchmark rate. As an example, MBNA Corp. issued preferred stock in September 1996 for which the dividend rate was 99% of the highest of the

EXHIBIT 17–2

Bloomberg's Call Schedule for DuPont Preferred Stock

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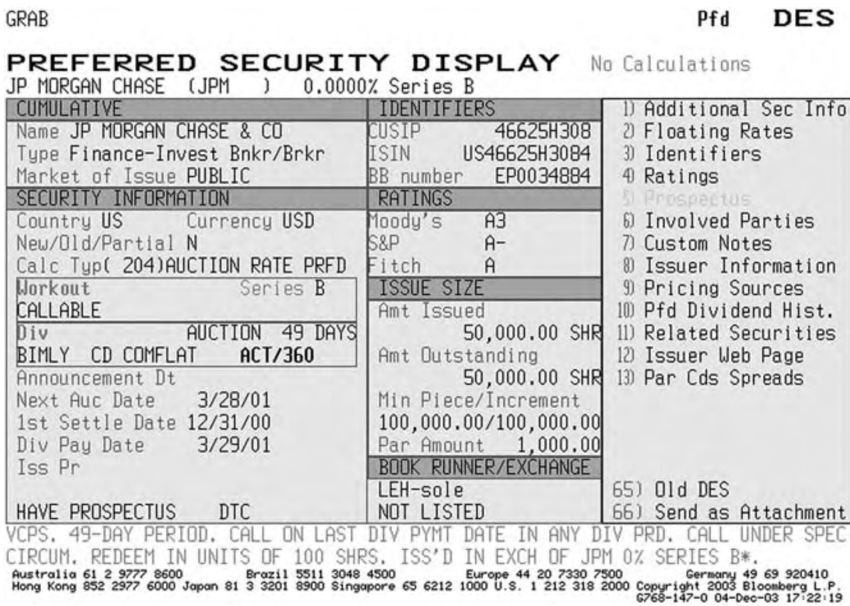
3-month U.S. Treasury rate, the 10-year Constant Maturity Treasury rate, and the 30-year Constant Maturity Treasury rate. In addition, the dividend rate had a cap of 11.5% and a floor of 5.5%. This issue was callable on January 5, 2004, at the issue price of $25 per share. The motivation for linking the dividend rate to the highest of the three points on the Treasury yield curve is to provide the preferred shareholder with some protection against unfavorable shifts in the yield curve.

Auction-Rate and Remarketed Preferred Stock

Most ARPS is perpetual, with a cap and floor on the dividend rate. Because most ARPS is not putable, however, ARPS can trade below par value after issuance if the spread demanded by the market as compensation for the risk of the security is greater than the dividend reset spread. The popularity of ARPS declined when these instruments began trading below their par value. This occurs because when an issuer's credit risk deteriorates, the dividend-rate formula remains unchanged and the preferred stock's value will decline. In 1984, a new type of preferred stock was issued to overcome this problem—*auction-rate preferred stock*. This innovation was particularly well received by corporate investors who sought tax-advantaged short-term instruments to invest excess funds. The dividend rate on auction-rate preferred stock is reset periodically, but the dividend rate is established through a Dutch auction process.

EXHIBIT 17–3

Bloomberg's Preferred Security Display for JP Morgan Chase Auction-Rate Preferred Stock


GRAB Pfd DES

PREFERRED SECURITY DISPLAY No Calculations
JP MORGAN CHASE (JPM) 0.0000% Series B

CUMULATIVE	IDENTIFIERS	1) Additional Sec Info
Name JP MORGAN CHASE & CO	CUSIP 46625H308	2) Floating Rates
Type Finance-Invest Bnkr/Brkr	ISIN US46625H3084	3) Identifiers
Market of Issue PUBLIC	BB number EP0034884	4) Ratings
SECURITY INFORMATION	RATINGS	5) Prospectus
Country US Currency USD	Moody's A3	6) Involved Parties
New/Old/Partial N	S&P A-	7) Custom Notes
Calc Typ(204)AUCTION RATE PRFD	Fitch A	8) Issuer Information
Workout Series B	ISSUE SIZE	9) Pricing Sources
CALLABLE	Amt Issued	10) Pfd Dividend Hist.
Div AUCTION 49 DAYS	50,000.00 SHR	11) Related Securities
BIMLY CD COMFLAT ACT/360	Amt Outstanding	12) Issuer Web Page
Announcement Dt	50,000.00 SHR	13) Par Cds Spreads
Next Auc Date 3/28/01	Min Piece/Increment	
1st Settle Date 12/31/00	100,000.00/100,000.00	
Div Pay Date 3/29/01	Par Amount 1,000.00	
Iss Pr	BOOK RUNNER/EXCHANGE	
	LEH-sole	65) Old DES
HAVE PROSPECTUS DTC	NOT LISTED	66) Send as Attachment

VCPS. 49-DAY PERIOD. CALL ON LAST DIV PYMT DATE IN ANY DIV PRD. CALL UNDER SPEC CIRCUM. REDEEM IN UNITS OF 100 SHRS. ISS'D IN EXCH OF JPM 0% SERIES B*.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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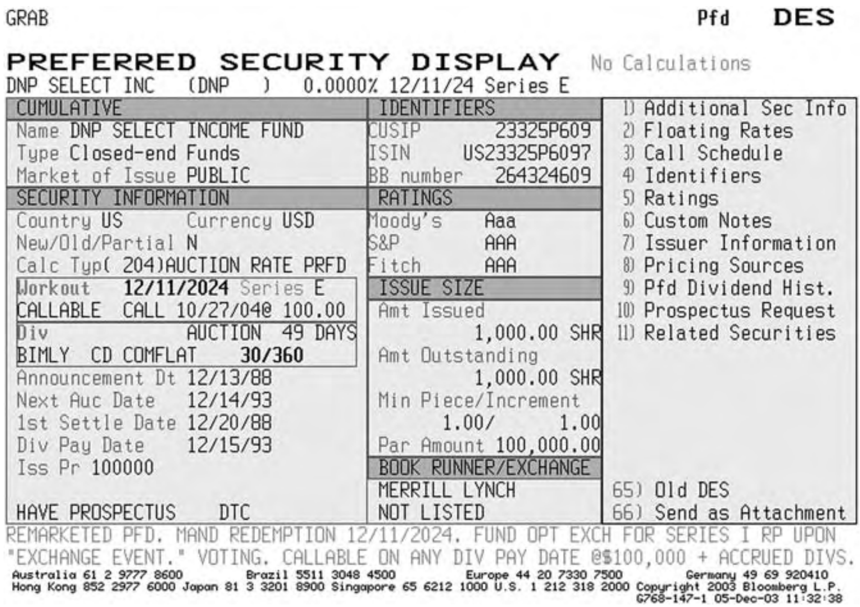
Participants in the auction consist of current preferred shareholders as well as potential buyers. The dividend rate that participants are willing to accept reflects current market conditions. Commercial paper rates typically serve as benchmarks. Auction-rate preferred stock's dividend rate is reset every 28 or 49 days.

As an illustration, JP Morgan Chase issued some Series B auction-rate preferred stock in December 2000 with a par amount of $1,000. Exhibit 17–3 presents the Bloomberg Preferred Security Display screen for this issue. The benchmark rate is the 60-day commercial paper rate, and the reset frequency is 49 days.

In the case of *remarketed* preferred stock, the dividend rate is determined periodically by a remarketing agent, who resets the dividend rate so that any preferred stock can be tendered at par and be resold (remarketed) at the original offering price. An investor has the choice of dividend resets every 7 days or every 49 days. As an example, Exhibit 17–4 presents a Bloomberg Preferred Security Display screen for some remarketed preferred stock issued by DNP Select Income Fund, a closed-end fund, in December 1988. Note three things about the issue. First, the dividend is reset every 49 days. Second, there is a mandatory redemption date of December 11, 2024. Third, the issue is callable on any payment date at par (i.e., $100,000) plus accrued dividends.

EXHIBIT 17–4

Bloomberg's Preferred Security Display for DNP Select Income Fund Preferred Stock


GRAB Pfd DES

PREFERRED SECURITY DISPLAY No Calculations

DNP SELECT INC (DNP) 0.0000% 12/11/24 Series E

CUMULATIVE	IDENTIFIERS	1) Additional Sec Info
Name DNP SELECT INCOME FUND	CUSIP 23325P609	2) Floating Rates
Type Closed-end Funds	ISIN US23325P6097	3) Call Schedule
Market of Issue PUBLIC	BB number 264324609	4) Identifiers
SECURITY INFORMATION	RATINGS	5) Ratings
Country US Currency USD	Moody's Aaa	6) Custom Notes
New/Old/Partial N	S&P AAA	7) Issuer Information
Calc Typ(204)AUCTION RATE PRFD	Fitch AAA	8) Pricing Sources
Workout 12/11/2024 Series E	ISSUE SIZE	9) Pfd Dividend Hist.
CALLABLE CALL 10/27/04@ 100.00	Amt Issued	10) Prospectus Request
Div AUCTION 49 DAYS	1,000.00 SHR	11) Related Securities
BIMLY CD COMFLAT 30/360	Amt Outstanding	
Announcement Dt 12/13/88	1,000.00 SHR	
Next Auc Date 12/14/93	Min Piece/Increment	
1st Settle Date 12/20/88	1.00/ 1.00	
Div Pay Date 12/15/93	Par Amount 100,000.00	
Iss Pr 100000	BOOK RUNNER/EXCHANGE	
	MERRILL LYNCH	65) Old DES
HAVE PROSPECTUS DTC	NOT LISTED	66) Send as Attachment

REMARKETED PFD. MAND REDEMPTION 12/11/2024. FUND OPT EXCH FOR SERIES I RP UPON "EXCHANGE EVENT." VOTING. CALLABLE ON ANY DIV PAY DATE @$100,000 + ACCRUED DIVS.

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
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PREFERRED STOCK RATINGS

Preferred stock is rated just like corporate bonds. A preferred stock rating is an assessment of the issuer's ability to make timely dividend payments and fulfill any other contractually specified obligations (e.g., sinking-fund payments). The three nationally recognized statistical rating organizations (NRSROs) that rate corporate bonds also rate preferred stock. The NRSROs are Fitch Ratings, Moody's Investors Service, Inc., and Standard & Poor's Ratings Group. Symbols used by the NRSROs for rating preferred stock as the same as those used for rating corporate long-term debt. It is important to note that the rating applies to the security issue in question and not to the issuer per se. Two different securities issued by the same firm could have different ratings. Exhibit 17–5 presents a Bloomberg screen with the Standard & Poor's preferred stock rating definitions. Exhibit 17–6 indicates the Standard and Poor's attaches +*s* and –*s*, which are called *notches,* to denote an issue's relative standing within the major ratings categories.[3]

3. Moody's attaches 1s, 2s, and 3s to indicate the same information.

EXHIBIT 17–5

Standard & Poor's Investment-Grade Preferred Stock Ratings Definitions

GRAB Pfd **RATD**

Standard & Poor's
Preferred Stock Ratings
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AAA This is the highest rating that may be assigned by Standard & Poor's to a preferred stock issue and indicates an extremely strong capacity to pay the preferred stock obligations.

AA A preferred stock issue rated 'AA' also qualifies as a high-quality, fixed-income security. The capacity to pay preferred stock obligations is very strong, although not as overwhelming as for issues rated 'AAA'.

A An issue rated 'A' is backed by a sound capacity to pay the preferred stock obligations, although it is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions.

BBB An issue rated 'BBB' is regarded as backed by an adequate capacity to pay the preferred stock obligations. Whereas it normally exhibits adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to make payments for a preferred stock in this category than for issues in the 'A' category.

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EXHIBIT 17–6

Standard & Poor's Non-Investment-Grade Preferred Stock Ratings Definitions

GRAB Pfd **RATD**

Standard & Poor's
Preferred Stock Ratings
Page 3/3

BB, B, CCC
Preferred stock rated 'BB,' 'B,' and 'CCC' are regarded, on balance, as predominantly speculative with respect to the issuer's capacity to pay preferred stock obligations. 'BB' indicates the lowest degree of speculation and 'CCC' the highest. While such issues will likely have some quality and protective characteristics, these are outweighed by larege uncertainties or major risk exposures to adverse conditions.

CC The rating 'CC' is reserved for a preferred stock issue in arrears on dividends or sinking fund payments but that is currently paying.

C A preferred stock rated 'C' is a nonpaying issue.

D A preferred stock rated 'D' is a nonpaying issue with the issuer in default on debt instruments.

Plus (+) or minus (-): To provide more detailed indications of preferred stock quality, ratings from 'AA' to 'CCC' may be modified by the addition of a plus or minus sign to show relative standing within the major rating categories.

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TAX TREATMENT OF DIVIDENDS

Dividend payments made to preferred stockholders are treated as a distribution of earnings. This means that they are not tax deductible to the corporation under the current tax code.[4] Interest payments are tax deductible, not dividend payments. While this raises the after-tax cost of funds if a corporation issues preferred stock rather than borrowing, there is a factor that reduces the cost differential: a provision in the tax code exempts 70% of qualified dividends from federal income taxation if the recipient is a qualified corporation. For example, if corporation A owns the preferred stock of corporation B, for each $100 of dividends received by A, only $30 will be taxed at A's marginal tax rate. The purpose of this provision is to mitigate the effect of double taxation of corporate earnings.

The tax treatment of preferred stock also differs depending on whether it is classified as *old money, new money,* or *partial money*. Old money refers to preferred stock issued before October 1, 1942. For old money preferred stock, the dividend-received deduction is only 42%. Partial money refers to a very small new set of issues that were classified as both old and new money. Old and partial money comprise only a tiny fraction of the preferred stock outstanding today. In other words, virtually all preferred stock outstanding today is new money.

There are two implications of this tax treatment of preferred stock dividends. First, the major buyers of preferred stock are corporations seeking tax-advantaged investments. Indeed, very few individual investors hold preferred stock in their portfolios. Second, the cost of preferred stock issuance is lower than it would be in the absence of the tax provision because the tax benefits are passed through to the issuer by the willingness of corporate investors to accept a lower dividend rate.

4. An exception to this statement is trust-originated preferred securities.

CHAPTER
EIGHTEEN

INTERNATIONAL BOND MARKETS AND INSTRUMENTS

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The creation of global bonds and the distribution of bond issues over the Internet have increased the globalization of the bond market in recent years; however, international bond investing is hardly a new activity. Cross-border investments in government bonds were common before the First World War. By 1920, Moody's was providing credit ratings on some 50 sovereign borrowers. However, most of these foreign investments ended badly for U.S. investors. Hyperinflation under the German Weimar Republic of the 1920s rendered the Reichsmark worthless. Similarly, during the 1920s, U.S. investors saw their foreign investments decline in U.S. dollar terms by 86% in France, 70% in Italy, and 50% in Spain. Interestingly, some of the countries that avoided sharp devaluations during this period (including the United Kingdom, Sweden, and surprisingly, Argentina) have lost much of their value since the collapse of the Bretton Woods system of fixed exchange rates in the 1970s. Between 1930 and 1970, capital controls and domestic regulations sharply curtailed cross-border bond investment. The offshore markets and banks led the way toward greater cross-border investment flows in the early 1980s, prompting governments to introduce domestic market reforms liberalizing capital flows in money, bond, and equity markets. However, some foreign bond markets, such as Italy's, were closed to foreign investors until 1990.[1]

An explosion in international bond trading has occurred over the past 20 years, driven by reductions in capital controls and spectacular technological advances in the dissemination of information and in computing power to track portfolios and forecast capital market trends.

According to data from the Bank for International Settlements, the nominal value of developed global outstanding debt has increased threefold in the past 14 years, from \$15.5 trillion in 1989 to \$50.1 trillion in 2003. Bonds denominated in

1. See Michael Mussa and Morris Goldstein, "The Integration of World Capital Markets," in *Changing Capital Markets: Implications for Monetary Policy* (Federal Reserve Bank of Kansas, 1993) for a more complete discussion.

U.S. dollars are consistently the largest single component of the world bond market, comprising 42% of the total in 2002. The countries that now participate in the European Monetary Union together comprise 32% of the world bond market. International euro-denominated notes and bonds outstanding surpassed U.S. dollar–denominated debt for the first time in 2003, with 44% of euro outstanding debt compared with U.S. dollar debt of 40%. The variety of borrowers in the international bond markets has increased dramatically, and financing techniques in these markets now rival the U.S. domestic market in their sophistication. Although the sheer size of the U.S. economy ensures a central role for U.S. bonds in world capital markets, the growth in volume and turnover in international bonds suggests that a general understanding of their characteristics is in order.[2]

Domestic bonds often are included in diversified portfolios because their price movements are generally less volatile than equities, they pay a known amount of interest at regular intervals, and they mature; that is, with high-credit bonds, you are nearly certain to receive your principal on maturity. U.S. dollar–denominated international bonds behave much like domestic U.S. bonds. But foreign-pay bonds, because of the currency component, are much more volatile.

This chapter will attempt to provide a broad overview of the instruments, markets, and players in international bond investing. First, the instruments and markets for the U.S.-pay sector of the international bond market are described, including emerging market debt. Then the foreign-pay sectors of the international bond market are described, with emphasis placed on the contribution of currency to returns for U.S. dollar–based investors.

THE INSTRUMENTS: EURO, FOREIGN, AND GLOBAL

International bonds are divided into three general categories, domestic, Euro, and foreign, depending on the domicile of the issuer, the nature of the underwriting syndicate, the domicile of the primary buyers, and the currency denomination. Domestic bonds are issued, underwritten, and traded under the currency and regulations of a country's domestic bond market by a borrower located within the country. Eurobonds are underwritten by an international syndicate and traded outside any one domestic market. Foreign bonds are issued under the regulations of a domestic market and are intended primarily for that country's domestic investors by a foreign-domiciled borrower. Global bonds are a hybrid designed to trade and settle in both the Euro and U.S. foreign (or Yankee) markets.

The most decisive influence on the price or yield of a bond is its currency denomination. Thus, for U.S. investors, the pertinent division is between those international bonds that are denominated in U.S. dollars and those denominated in other currencies. Regardless of the domicile of the issuer, the buyer, or the trading

2. For a detailed discussion of national bond markets, see *OECD Public Debt Markets: Trends and Recent Structural Changes* (OCED, 2002).

market, prices of issues denominated in U.S. dollars (U.S.-pay) are affected principally by the direction of U.S. interest rates, whereas prices of issues denominated in other currencies (foreign-pay) are determined primarily by movement of interest rates in the country of the currency denomination. Thus, for U.S. dollar-based investors, the analysis of international bond investing must be separated into two parts: U.S.-pay and foreign-pay.

Most U.S.-pay international bonds can be included in a domestic bond portfolio with little change to the management style and overall risk profile of the portfolio. In most cases, a marginal extra effort is all that is required to analyze the credits of a few new unfamiliar issuers and to learn the settlement procedures for Eurodollar bonds. The notable exception in the U.S.-pay area is in emerging market debt, which, as detailed below, can be far more volatile than most other U.S.-pay bonds. The currency component of foreign-pay bonds, however, introduces a fair degree of volatility of return, and has a far different risk profile than domestic U.S. and U.S.-pay international bonds. The question of currency hedging (either passive, active, or not at all), plus considerations of trading hours, settlement procedures, withholding taxes, and other nuances of trading foreign-pay international bonds, requires much greater training and effort to manage them effectively.

U.S.-PAY INTERNATIONAL BONDS

The U.S.-pay international bond market consists of Eurodollar bonds, which are issued and traded outside any one domestic market, and Yankee bonds, which are issued and traded primarily in the United States. Global bonds are issued in both the Yankee and Eurodollar markets simultaneously, but domestic investors are generally indifferent between global and straight Yankee issues except where liquidity differs. Before examining the instruments in depth, some of the more basic questions regarding U.S.-pay international bonds need to be addressed.

Why do foreign-domiciled issuers borrow in the U.S. dollar markets? First, the U.S. bond market is still one of the largest, most liquid, and most sophisticated of the world's bond markets. By issuing in the U.S. market, foreign entities diversify their sources of funding. Also, as companies have become more global in production and distribution, they have assets and liabilities in many different currencies and hence are less tied to their domestic bond markets. Financial innovations, particularly the advent of the interest-rate and currency swap markets, have greatly expanded the diversity of borrowers, notably in the corporate sector. Companies in need of floating-rate finance often have been able to combine a fixed-coupon bond with an interest-rate swap to create a cheaper means of finance than a traditional floating-rate note. Similarly, when currency swap terms are favorable, a company in need of, say, sterling funds could issue a Eurodollar bond and combine it with a currency swap to create a cheaper source of sterling funds than a traditional U.K. bond issue.

Why should U.S. dollar–based investors be interested in U.S.-pay international bonds? Yankee bonds are registered with the Securities and Exchange

Commission (SEC) and trade like any other U.S. domestic bond. The credit quality of issuers in the Yankee market is very high, although the credit quality of new issuers has been declining in recent years. Eurobonds generally are less liquid than Yankee bonds but sometimes can offer more attractive yields and a broader list of available credits. Since most international bond issues are rated by the major rating agencies, for a little additional credit work, investors may be able to find a higher yield on a U.S.-pay international bond than on other comparably rated issues, especially where the credit may be less familiar to United States investors.

What is the difference between a Yankee and a Eurodollar bond? The primary difference is SEC registration. Yankee bonds are registered with the SEC and are issued and traded in the United States; Eurodollar bonds are issued outside the United States and are traded primarily by foreigners. Eurodollar bonds are issued mostly by corporate issuers; Yankees are issued mostly by high-credit-quality sovereign and sovereign-guaranteed issuers. The size of the Eurodollar market historically has been from four to five times the size of the Yankee market. In addition, Yankees are registered securities; Eurodollar bonds are issued in unregistered, or bearer, form. Yankees pay interest semiannually; Eurodollar bonds carry annual coupons.

Eurodollar Bonds

The Eurobond market existed long before the launch of the pan-European currency, also called the *euro*. In the international bond market, the prefix *Euro*- has come to mean offshore. The Eurodollar banking market began during the cold war as the Soviet Union, wary that the United States might freeze their dollar deposits, preferred to hold their dollar-denominated bank deposits outside the reach of the U.S. authorities. The Eurodollar market grew as banks sought to avoid domestic banking restrictions such as Regulation Q, which set a ceiling on interest levels paid on deposits, and the Glass-Steagall Act, which prohibited banks from engaging in underwriting and brokerage. Restrictions placed on direct investment overseas by U.S. companies in 1968 encouraged companies to raise capital offshore, thus increasing the size of the Eurobond market. However, the most significant growth in the Eurodollar market occurred in the late 1970s as the recycling of large dollar surpluses by OPEC countries (since oil is denominated in dollars) injected huge amounts of liquidity into the market. Balance-of-payments deficits, due in part to higher oil prices, also increased sovereign and sovereign-guaranteed Eurodollar issuance.

Eurodollar bonds are the largest single component of the Eurobond market, which encompasses securities of all different currency denominations. Eurodollar bonds are

1. Denominated in U.S. dollars
2. Issued and traded outside the jurisdiction of any single country

3. Underwritten by an international syndicate
4. Issued in bearer (unregistered) form

Since Eurodollar bonds are not registered with the SEC, as U.S. domestic new issues are required to be, underwriters are legally prohibited from selling new issues to the U.S. public until the issue has "come to rest" and a seasoning period has expired. An issue is usually considered seasoned 40 days after it has been fully distributed.[3] This seasoning requirement effectively locks U.S. investors out of the primary market. Even though a portion of Eurodollar outstandings end up in U.S.-based portfolios after the seasoning period expires, the lack of participation of U.S. investors in new offerings ensures that the Eurodollar market will remain dominated by foreign-based investors. Although no single location has been designated for Eurodollar market making, London is the de facto primary trading center for all Eurobonds.

The Eurodollar bond market has grown dramatically from its humble beginnings in the early 1960s, although the vast majority of growth has occurred in only the past 10 years. In 1980, the total Eurodollar market was a modest $58 billion. By 1990, the market had grown nearly eight times larger to $525 billion,[4] and then it more than doubled again from 1990 to 2000 to $3.4 trillion. Marketability of Eurodollar bonds had improved as the market has grown. In the past, many straight fixed-coupon Eurobonds traded infrequently, particularly among the older issues, which were often only $50 million or less in individual issue size. Normal issue size today is $100–500 million or higher. Despite the increase in market size, liquidity will remain somewhat constrained by the popularity of Eurodollar bonds among European retail investors, who are likely to buy bonds and tuck them away until maturity. Since Eurobonds are held in bearer (unregistered) form, details about major holders of Eurodollar bonds are often unreliable, but market participants estimate that retail investors are significant players in the eurobond market.

Borrowers in the Eurodollar bond market may be divided into four major groups: sovereign, supranational agency, corporate, and financial. Supranational agencies, such as the World Bank and the European Investment Bank, are consistently among the top borrowers, reflecting their constant need for development financing and their lack of "home" issuance market. Sovereign and sovereign-backed borrowers are also prominent, although the growth in sovereign Eurodollar issuance slowed in the late 1980s as governments either cut back on their external borrowing in favor of their domestic bond markets or chose to borrow in the nondollar markets to diversify their currency exposure. Fiscal

3. The SEC's revised Regulation S reduced the seasoning period from 90 to 40 days. Other changes in SEC regulations, notably Regulation 144A, make the Euromarkets and the U.S. domestic bond markets more fungible.
4. See "Size and Structure of the World Bond Market," produced by Merrill Lynch.

retrenchment in most developed countries and the growth of domestic bond markets have served to reduce the role that sovereign issuers play in the primary Eurobond market. Bank and finance companies continue to dominate the new issuance market; however, corporate issuance has been rising while sovereign issuance has been declining.

The future of the Eurodollar bond market is largely a function of the domestic regulatory environment in the major issuer countries. In the late 1980s, Japanese companies were among the most active Eurodollar borrowers. However, the opening up of the Japanese domestic bond market (thus diminishing the relative attractiveness of issuing in the offshore market) and intense fiscal retrenchment by Japanese companies as the economy fell into a long-running recession led to a sharp drop in Japanese Eurobond issuance.

In the short term, the course of the U.S. dollar and U.S. interest rates have the greatest impact on the Eurodollar bond market. The strength in the dollar from 1987 to 1990 and again in the late 1990s, particularly against the yen, increased investor appetite for dollar-denominated securities and encouraged dollar bond issuance. Similarly, the dollar's weakness in 1994 and 1995 led to less issuance of Eurodollar bonds by Japanese borrowers. The relative and absolute level of U.S. interest rates also has a substantial impact on Eurodollar bond issuance.

The direction of U.S. interest rates and the value of the dollar will continue to have an impact on the size and liquidity of the Eurodollar bond market. Over the long term, however, the size and vitality of the market will be decided by the global trend toward financial deregulation. To the extent that national governments continue to dismantle the laws that hobble the development of domestic bond markets, the attraction of Eurodollar bonds, and all Eurobonds, to issuers and investors will diminish. Running counter to this trend, the growth of global bonds (discussed below), which allows for access to a broad array of investors across national and offshore markets, has served to increase the attractiveness of the Eurobond market.

Yankee Bonds

The other portion of the U.S.-pay international bond market, referred to as the "Yankee bond market," encompasses those foreign-domiciled issuers who register with the SEC and borrow dollars via issues underwritten by a U.S. syndicate for delivery in the United States.[5] The principal trading market is in the United States, although foreign buyers can and do participate. Unlike Eurodollar bonds, Yankee bonds pay interest semiannually.

The Yankee market is much older than the Eurodollar market. Overseas borrowers first issued Yankee bonds in the early 1900s, when the U.S. became the

5. A small portion of outstanding Yankee bonds are foreign-currency-denominated. These are not included in this analysis.

world's preeminent creditor nation. The repayment record of these early issues was not good; as much as one-third of the outstanding "foreign" bonds in the United States were in default on interest payments by the mid-1930s. After years of slow growth, the market expanded rapidly after the abolition of the interest-equalization tax in 1974.[6] Between 1985 and 2000, total bonds outstanding in the Yankee market rose from $60 billion to $495 billion, a figure rivaling other sectors of the U.S. corporate market in size.

Supranational agencies and Canadian provinces (including provincial utilities) historically have been the most prominent Yankee issuers, comprising well over half the total market. The corporate sector, which is a major borrower in the Eurodollar bond market, is of only minor importance in the Yankee bond market. The increased use of global bonds, however, has blurred the distinction between the Yankee and Eurodollar bond markets. The rankings of top issuers in the Yankee market change depending on whether global bonds are included or excluded.

The Market for Eurodollar and Yankee Bonds

Foreign investors play a major role in the Yankee market, although the market's location in the United States prevents foreigners from having as dominating a presence as they have in the Euromarkets. Prior to 1984, foreign investors had a preference for U.S.-pay international bonds, which include both Yankees and Eurodollar issues, because they were not subject to the 30% withholding tax imposed by the U.S. government on all interest paid to foreigners. When the withholding tax exception was abolished in July 1984, a major advantage of U.S.-pay international bonds over U.S. Treasuries and domestic corporate bonds was removed. This made Yankees and Eurobonds more attractive relative to the U.S. domestic market, but foreign investor support remained strong. U.S.-pay international bonds offer a yield advantage over U.S. government bonds, usually due to the lesser liquidity and credit quality of international issues, and foreign buyers are often more familiar with Yankee and Eurodollar credits than they are with U.S. domestic credits. Finally, Yankee and Eurodollar issuers sometimes compensate for their "foreign" status in the U.S.-pay market by offering bonds with shorter maturities and greater call protection structures that traditionally appeal to overseas investors.

For these reasons, when foreign buyers seek exposure to U.S.-pay bonds, they often buy U.S.-pay international bonds—Eurodollar or Yankee—instead of

6. The interest equalization tax was imposed on purchases of foreign securities by U.S. residents during the years 1963–1974. The intent and effect of the tax was to discourage foreign borrowing in the United States by increasing the cost of capital. To make returns after the IET competitive with rates on domestic issues, gross rates on foreign borrowings had to be higher than otherwise would have been the case.

domestic issues. The degree of interest of foreign buyers in U.S.-pay securities, or lack thereof, is reflected in narrowing or widening of the yield spread to U.S. Treasury bonds. This is particularly true of Eurodollar bonds because foreign interest governs this market to a greater extent than the Yankee market, which is more attuned to U.S. investor preferences. The fact that the Eurodollar market and the Yankee market have different investor bases occasionally leads to trading disparities between the two markets. For example, similarly structured Canadian Yankee bonds often trade at lower yields than Canadian Eurodollar bonds because U.S. investors tend to be more comfortable with Canadian credits due to the close proximity of the two countries.

The globalization of the investment world has brought the Yankee and Eurodollar bond markets closer together, and it is not uncommon for investors to arbitrage the two markets when yield disparities appear. The dividing line between the two markets has become increasingly blurred with the advent of the "global bond." The World Bank issued the first global bond in 1989, with a $1.5 billion issue that was placed simultaneously in both the Yankee and the Eurodollar markets. The idea was to create an instrument that had attributes of both a Yankee bond and a Eurodollar bond and thereby do away with the market segmentation that inhibited liquidity and created yield disparities. The success of global bond issues is further evidence of the melding of the Euro and domestic markets that has accelerated as barriers to cross-border capital movements have been lowered.

The global bond market has been used primarily by central governments and supranational organizations. However, as many governments have endeavored to increase the depth and liquidity of their domestic bond markets and lower their borrowing requirements through deficit-reduction policies, U.S. borrowers have become a larger presence in the global bond market. U.S. agencies, especially the Federal Mortgage Credit Agencies, have become frequent global bond issuers, as have the international development institutions. Issues of global bonds rose to a peak of $542 billion in 2000, a compound growth rate of nearly 45% since 1990, when $9.3 billion was issued.[7]

Also worthy of mention are the use of Euro medium-term note (MTN) programs and the success of Regulation 144A. Euro-MTNs allow for issuance in different currencies and maturities under one umbrella agreement. Thus borrowers can use Euro-MTNs to tap the markets more quickly and efficiently than with traditional Eurodollar bonds, which require separate documentation for each bond issue. In fact, although Euro-MTNs were used originally only for nonunderwritten private placements, since 1992, Euro-MTNs have been used for underwritten deals as well, further blurring the distinction between Euro-MTNs and traditional Eurobonds. Since the majority of all Eurobond issues are swapped into floating-rate debt and market opportunities to obtain favorable swap terms can be

7. See Khaled Amira, and William C. Handorf, "Global Debt Market Growth, Security Structure, and Bond Pricing," *Journal of Investing* (Spring 2004).

fleeting, borrowers appreciate the flexibility of Euro-MTN programs. Euro-MTNs have been used extensively for small, illiquid, highly structured private issuance competing with private placements. The Euro-MTN market has become more transparent, with the publishing of Euro-MTN issues leading a resurgence of more "plain vanilla" Euro-MTN issues.

Regulation 144A was enacted in 1990 to allow professional investors greater liquidity in trading private placement issues[8] while continuing to restrict access by the general public. Regulation 144A issues have been used extensively by both U.S. and foreign borrowers, with most rated by the major credit-rating agencies. Initially, Regulation 144A securities, due to the somewhat smaller issuance size, had been geared more toward buy-and-hold accounts; however, liquidity is now comparable with that of registered securities. Many 144As are issued with registration rights that allow the issuer quick access to capital and the ability to broaden the issue's liquidity by registering with the SEC.

Bradys, Aztecs, and FLIRBs: The Emerging Markets

Emerging market bonds are often found in global bond portfolios. Most of these bonds are U.S. dollar–denominated; however, local currency instruments, such as Mexican Cetes, are often available to international investors as well. Brady bonds were named after Treasury Secretary Nicholas Brady, who fostered a market-oriented approach to the Latin American debt crisis by repackaging nonperforming bank loans into marketable securities in the late 1980s.

The first Brady agreement was reached with Mexico, and the bonds were issued in March 1990; however, Aztec bonds, a similar privately arranged restructuring of Mexican debt by J. P. Morgan, were issued two years earlier. The Mexican Brady plan offered the commercial banks two options in return for their Mexican loans: a *discount* bond issued at 65% of face value paying a floating market coupon of LIBOR + 13/16 and a *par* bond issued at full face value but paying a below-market fixed coupon of 6.25%. Both discount and par bonds have their principal repayment backed by zero-coupon U.S. Treasuries plus a rolling interest guarantee covering 18 months of interest payments. The banks also were given a third alternative, allowing them to carry existing loans on their books at face value if they agreed to provide new lending to Mexico of at least 25% of their existing exposure over the next three years. Today, many countries have retired their Brady bond debt, instead turning to cheaper financing through Eurobond issues or their domestic credit markets. The Brady bond market, which constituted nearly 100% of the market for emerging country debt, now represents less than one-third as Eurobond issuance has risen.

8. Regulation 144A also provided foreign borrowers with greater access to institutional investors by allowing issuers to provide only the documentation required by their home-market regulators rather than undergo the more cumbersome SEC registration process.

Regardless of currency denomination, the market risk of holding emerging market securities is higher than the risk of holding developed country credits. The turmoil in the emerging markets triggered by the Russian default in August of 1998 and the Asian financial crisis of the previous year serve as vivid reminders of the risks associated with holding emerging market debt. The devaluation of the Thai baht in July 1997 triggered a selloff in emerging market debt that spread through other Southeast Asian markets and, to a lesser extent, Latin American markets as well. Currencies in the region depreciated by 50% to 100% from August to the end of the year, with equity prices dropping by 50% in many markets.

The developed country financial markets in the industrial countries largely escaped the turmoil of the 1997 Asian crisis; however, they were severely affected by the Russian default in August 1998. The resulting flight to safety not only damaged emerging market bond prices but also pushed down yields in the U.S. Treasury market, resulting in a sharp widening of U.S. corporate and agency spreads. These movements led to large losses at the well-known hedge fund Long Term Capital Management. The hedge fund had risk positions of approximately $125 billion supported by a capital base of only $4 billion, many of which were in relatively small and illiquid markets. Ultimately, concerns over Long Term Capital Management's solvency threatened to destabilize the global financial markets, leading the Federal Reserve Board to cut interest rates by 75 basis points and the Federal Reserve Bank of New York to intercede between the hedge fund and its creditors.

Today, the delineation between an emerging and a developed market has become increasingly blurred. Less than seven years since the Asian and Russian crises, 40% of emerging market debt issuers, including Russia, now have investment-grade ratings by the major rating agencies. The shift from pegged to floating exchange rates also has lessened the contagion risk within the emerging markets that led to serial currency devaluations during the Asian crisis.

FOREIGN-PAY INTERNATIONAL BONDS

From the standpoint of the U.S. investor, foreign-pay international bonds encompass all issues denominated in currencies other than the dollar. A number of issues are available to the U.S. investor, but in practically all cases the primary trading market is outside the United States. The currency component introduces a significant source of volatility; hence the most important question facing U.S. investors in foreign-pay international bonds is whether or not to hedge the currency. The theoretical underpinnings of the currency hedge question, however, are beyond the scope of this chapter. The three types of fixed income instruments, just as in the United States bond market, are determined by the domicile of the issuer and the location of the primary trading market: the domestic market; the foreign market (like the Yankee market), where the issuer is domiciled outside of the country of issuance; and the Euro market, which trades outside of any national jurisdiction.

The Non-U.S. Domestic Markets

Securities issued by a borrower within its home market and in that country's currency typically are termed *domestic issues*. These may include bonds issued directly by the government; government agencies, sometimes called *semigovernments;* and corporations. In most countries, the domestic bond market is dominated by government-backed issues, central government issues, government agency issues, and state (provincial) or local government issues. The United States has the most well-developed, actively traded corporate bond market. The introduction of the euro in January 1999 prompted an explosion in corporate bond issuance in Europe. Before European Monetary Union, corporate bonds represented only 6.5% of the European bond market. In the five years following the European Monetary Union, corporate bond oustandings increased nearly threefold.

Bulldogs, Samurais, and Other Foreign Bonds

The *foreign bond market* includes issues sold primarily in one country and currency by a borrower of a different nationality. The Yankee market is the U.S. dollar version of this market. Other examples are the Samurai market, which consists of yen-denominated bonds issued in Japan by non-Japanese borrowers, and the Bulldog market, which is composed of United Kingdom sterling-dominated bonds issued in the United Kingdom by non-British entities. Relative to the size of the domestic bond markets, these foreign bond markets are quite small, and liquidity can be limited. For borrowers, the major advantage of the foreign bond markets is the access they provide to investors in the country in which the bonds are issued. The Samurai market, for example, allows borrowers directly to tap the huge pools of investment capital in Japan. For investors, foreign bonds offer the convenience of domestic trading and settlement and often additional yield.

The Offshore Foreign-Pay Market

Securities issued directly into the international ("offshore") markets are called *Eurobonds*. Eurodollar bonds are the U.S.-pay version; however, Eurobonds can be issued in a variety of currencies, including euros, Japanese yen, even South African rand, and Czech koruna. These securities typically are underwritten by international syndicates and are sold in a number of national markets simultaneously. They may or may not be obligations of, or guaranteed by, an issuer domiciled in the country of currency denomination, and the issuer may be a sovereign government, a corporation, or a supranational agency. The Eurobond market encompasses any bond not issued in a domestic market, regardless of issuer nationality or currency denomination. Eurodollar bonds traditionally have been the largest sector of this market, although issuance of Eurobonds denominated in euros surpassed Eurodollar bonds issuance for the first time in 2003. The decline of the share of the U.S. dollar in Eurobond issuance can be traced to three general trends: A trend depreciation of the dollar from its peak in 1984, a desire to diversify currency exposure and funding sources as the euro and yen have become more important as reserve currencies, and the liquidity of the swaps and other derivatives markets. Eurosterling and Euroyen bonds are the next largest sectors. As with the foreign bond markets, liquidity of Eurobonds is typically less than the liquidity of domestic government issues.

Components of Return

To the dollar-based investor, there are two components of return in actively managed U.S.-pay bond portfolios: coupon income and capital change. Capital change can result from either interest-rate movements or a change in the perceived creditworthiness of the issuer. In foreign-pay investing, a third component of return must be considered: foreign currency movements. The U.S. investor must couple the domestic or internal price movement with income and then translate the total domestic return into dollars to assess the total return in U.S. dollars.

For the U.S. investor in foreign-currency bonds, the prospects for return not only should be viewed in an absolute sense but also should be analyzed relative to returns expected in the U.S. market. The analysis can be separated into three questions.

What Is the Starting Yield Level Relative to Yield Levels on U.S. Bonds?

Where this spread is positive, the income advantage will, over time, provide a cushion against adverse movements of the foreign bond price relative to U.S. bonds or against deterioration in the value of the foreign currency. The longer the time horizon, the greater is the cushion provided by this accumulating income advantage. If, on the other hand, the starting income level of the foreign currency issue is below that provided by U.S. bonds, this income deficiency must be offset by an appreciating currency or positive internal price movement relative to U.S. bonds to provide comparable returns. This may appear to be a difficult challenge, but the decade of the 1970s as a whole saw the best U.S. dollar total returns accruing to the bond investments with the lowest income levels. This same result was achieved in the 1980s, when Japanese yen bonds had the world's best total returns in U.S. dollar terms despite the fact that yen bonds offered the lowest interest rates of the world's major bond markets. The underlying rationale for this result is that bonds with low yields are denominated in currencies of countries with low inflation rates, which theoretically translates into currency appreciation relative to the U.S. dollar.

What Are the Prospects for Internal Price Movements Relative to Expectations for U.S. Bond Prices?

This factor can be broadly discussed in terms of changing yield spreads of foreign-pay bonds versus U.S. issues in the same way that changing yield spreads within the domestic U.S. market are discussed in describing changes in relative prices. However, several points should be considered with regard to this analogy. First, in the U.S. market, all bond prices generally move in the same direction, although not always to the same extent, whereas domestic price movements of foreign-pay bonds may move in the direction opposite to that of the U.S. market. Second, although yield-spread relationships within the U.S. market may fluctuate broadly, in many cases there is a normal spread that has some repetitive meaning. However, changing economic, social, and political trends between the United States and other countries suggest that there are few normal relationships to serve as useful guidelines over the long term.

Third, investors must be aware that similar interest-rate shifts may result in significantly different capital price changes. Both U.S. and international investors are very familiar with the concept of duration; that is, that equal yield movements will result in differing price movements depending on the individual security's current yield, maturity, coupon, and call structure. However, since international bond investors are focused on the spread relationship to the benchmark market (explained in detail below), they often pay less attention to the consequences of duration on similar-maturity bonds across markets. For example, the low yield on Japanese long bonds, currently around 1.50%, makes Japanese 10-year bond prices about one-third more sensitive to changes in yield than New Zealand bonds, where yields are above 7.50%. Thus a 20 basis point (0.2%) decline in the yield of a 10-year New Zealand fixed-coupon government issue starting at a 6.1% yield results in a 1.5% price change, whereas the same 20 basis point move equates to a 1.95% price change for a 10-year Japanese issue with a starting yield of 1.53%. When the more commonly analyzed effects of varying maturities and differing yield changes are added to the impact of different starting yield levels, the resulting changes in relative price movements are not intuitively obvious. For example, the various combinations of starting yield, maturity, and yield change shown in Exhibit 18–1 all result in the same 10% capital price increases.

Finally, changes in credit quality can have dramatic influences on bond prices. Recent examples include Enron and the corporate accounting scandals of 2002, and the sharp drop in emerging market asset prices in the fall of 1998. However, credit concerns also have influenced developed country debt premiums.

What Are the Prospects for Currency Gain versus the U.S. Dollar?

Winston Churchill reportedly said, "There is no sphere of human thought in which it is easier to show superficial cleverness and the appearance of superior wisdom than in discussing currency and exchange." This demonstrates that the debate as to

EXHIBIT 18–1

Impact of Maturity and Starting Yield on Yield and Price Change Relationships

Starting Yield	Maturity (Years)	Yield Change	Price Change
7%	10	–1.41%	+10%
7	5	–2.40	+10
2	10	–1.11	+10
2	5	–2.11	+10

EXHIBIT 18–2

Average Annual Returns of International Bond Index by Components

	Contribution to Return			
	Income	Domestic Capital Gain	Foreign Currency	Total Dollar-Converted Average Annual Return
1985–88	+7.6	+1.5	+14.6	+25.1
1989–92	+8.0	+0.4	–0.5	+7.9
1993–96	+8.6	+2.8	–0.8	+10.8
1997–00	+5.1	+0.4	–3.9	+1.4
2000–03	+2.8	–0.2	+8.6	+11.5
1985–2003	+6.6	+1.1	+3.1	+11.1

Source: Citibank Non-U.S. Dollar World Government Bond Index.

whether or not foreign currency changes can be predicted and, if so, what factors determine such changes is an old one. In many ways, this debate is little different from that regarding the predictability of stock market movements or interest rates. Like the stock and bond markets, a number of factors exert a direct influence on foreign exchange rates. The common problems faced by forecasters are whether these factors already have been fully discounted in prices—be they stock, bond, or currency—and which factor will predominate at any given time. Those factors generally regarded as affecting foreign currency movements include

1. The balance of payments and prospective changes in that balance
2. Inflation and interest-rate differentials between countries
3. The social and political environment, particularly with regard to the impact on foreign investment
4. Relative changes in monetary policy
5. Central bank intervention in the currency markets

Exchange rates historically have been difficult to forecast in part because transactions are increasingly dominated by financial institutions. The latest estimate of average daily turnover in the foreign exchange markets, based on a 2004 survey conducted by the Bank for International Settlements, is $1.9 trillion.

A common question is whether international bond returns are almost entirely a function of currency movements. Exhibit 18–2[9] shows that for the 19-year

9. Monthly total returns in Exhibits 18–2 and 18–3 were taken from Salomon Brothers' International Market Indexes, published monthly, particularly the Salomon Brothers' Non-U.S. Dollar World Government Bond Index. The income component of total return was computed from principal local market returns provided by Salomon Brothers.

EXHIBIT 18–3

Average Annual Returns of International Bond Index by Components

	Contribution to Return			
	Income	Domestic Capital Gain	Foreign Currency	Total Dollar-Converted Average Annual Return
1985	8.1%	2.7%	21.6%	35.0%
1986	7.4%	3.6%	18.1%	31.4%
1987	7.2%	0.4%	25.5%	35.1%
1988	7.6%	–0.5%	–4.4%	2.3%
1989	7.7%	–4.9%	–5.7%	–3.4%
1990	8.3%	–3.5%	10.2%	15.3%
1991	8.1%	5.8%	1.7%	16.2%
1992	7.9%	4.8%	–7.3%	4.8%
1993	7.6%	9.3%	–2.1%	15.1%
1994	7.4%	–10.0%	9.6%	6.0%
1995	7.1%	8.5%	2.9%	19.6%
1996	6.7%	3.0%	–5.3%	4.1%
1997	6.2%	2.3%	–11.9%	–4.3%
1998	5.7%	3.3%	7.9%	17.8%
1999	5.1%	–5.0%	–4.9%	–5.1%
2000	4.8%	0.9%	–7.8%	–2.6%
2001	4.4%	0.4%	–8.0%	–3.5%
2002	4.1%	2.8%	14.0%	22.0%
2003	3.7%	–1.5%	16.0%	18.5%

Source: Citibank Non-U.S. Dollar World Government Bond Index.

period from 1985 to 2003, and for four of the five interim periods, the income component of return proved to be the largest of the three return components, as measured by the Salomon Brothers Non-U.S. World Government Bond Index.

Over a shorter time horizon, however, foreign currency or domestic capital changes can be significantly more important. Exhibit 18–3 breaks down the 1985–2003 period into annual returns to demonstrate the influence domestic capital changes and movements in exchange rates can have on total returns over the short term. Domestic capital changes ranged from –10.0% in 1994 to 9.3% in 1993, and currency returns varied from –11.9% in 1997 to 25.5% in 1987. (Recall that negative foreign currency returns for dollar-based investors correspond to a strengthening in the dollar versus other currencies, and vice versa.) The income component of return varied in a much narrower range throughout the period, from a low of 3.7% in 2003 to a high of 8.3% in 1990.

For individual countries, of course, the variation in components of return can be much greater. Currency movements can be the most volatile component of return, with historical annual gains or losses as high as 20% to 30% against the U.S. dollar. Capital gains have proved much less volatile but still can generate double-digit gains or losses during periods of interest-rate volatility. Lastly, although the income component is by definition always positive, it too can vary substantially from country to country, as noted earlier in the comparison of bond yields in Japan and New Zealand in the discussion on the impact of yield on duration. These data show clearly that all three factors of return—income, capital change, and currency movement—are important and must be considered both absolutely and relative to U.S. alternatives.

CONCLUSION

International bonds, both U.S.-pay and foreign-pay, represent a significant portion of the world's fixed income markets, and an understanding of their characteristics is important for all bond investors. U.S.-pay international bonds generally have very similar characteristics to domestically issued bonds and can offer opportunities to enhance returns in domestic bond portfolios with a little additional credit analysis and education. The risks—and potential returns—however, are much greater in foreign-pay international bonds, which require far more expertise and support to effectively handle the currency, settlement, and custodial risks unique to global bond investing.

U.S.-pay international bonds make up roughly 15% of the U.S. dollar bond market. Issuance and liquidity in these instruments have increased dramatically in the past decade, although continued growth in the Eurodollar and Yankee bond markets is subject to regulatory policies in the domestic markets as well as the vagaries of the dollar and U.S. interest rates. Foreign investors will continue to have a large presence in the U.S.-pay international bond market. Successful use of the Eurodollar and Yankee bond markets requires an ongoing familiarity with foreign investor preferences and issuer motivations.

Investors in foreign-pay bonds must consider income levels and prospective price movements both in absolute terms and relative to U.S.-pay alternatives. The outlook for foreign currency changes also must be evaluated. The evidence indicates that over the 1978–2003 period, converted U.S. dollar returns for foreign-pay bonds were somewhat better than returns for U.S. government bonds, although during shorter time periods within that 26-year interval, foreign-pay bonds sometimes provided inferior returns. Although these facts by themselves may have little repetitive significance, many of the factors leading to the low correlation in returns between the U.S.- and foreign-pay markets can be expected to continue, making foreign-pay international bonds an effective diversifier for U.S. dollar–based portfolios.

CHAPTER

NINETEEN

THE EUROBOND MARKET

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Most inventions are born of necessity, and the Eurobond market is no exception. It grew out of the need to find a home for dollars that were accumulating overseas in the late 1950s. One source of these funds was Russian trade officials who were parking dollars in European banks. This was the time of the Cold War, and the Russians were reluctant to deposit their money in U.S. institutions, where they would be subject to the vicissitudes of international politics. The offshore market was further boosted in the early 1960s by a series of regulations in the United States that encouraged dollar bank deposit growth and borrowing outside the country. The first generally recognized Eurobond was sold in 1963, and the market has grown more or less steadily ever since.

Since its beginnings, the Eurobond market has changed beyond all recognition. Even the way the term *Eurobond* is used has evolved. Forty years seems like a very long time, especially in the financial markets. Yet other sources of finance, such as banking and insurance, have been around for centuries, and the U.S. corporate bond market traces its roots to the 1840s. In many ways the evolution of the Eurobond market can be divided into two distinct periods, one before and one after the introduction of the euro in January 1999. The market remains in a phase of evolution and growth. The limitations we describe later are significant. However, the economic rationale for its continued expansion remains intact. It might take longer than some of the original optimistic pundits predicted, but over time, the Eurobond market will develop the depth and liquidity to match the needs of both investors and issuers.

We have divided this chapter into five sections that chart the evolution of the Eurobond market: (1) the market's roots and growth through the end of 1998, (2) the first five years of the euro-denominated market (from 1999 to 2003), including a discussion of the motivations of investors and issuers for participating in the market, (3) trading and other practices of today's Eurobond market, (4) Eurobond

Ankur Chadda, Sally Cartwright, Tom Howard, and Morven Jones, all of Lehman Brothers, and Maurice Walraven of ABP Investments in the Netherlands provided valuable insights and assistance in the writing of this chapter.

market sectors other than fixed-rate, high-grade corporates, and (5) the outlook for the Eurobond market in the twenty-first century. The bulk of the chapter concerns itself with the high grade euro-denominated corporate market (in this chapter, "corporate" includes issues sold by industrial companies, utilities, and financial institutions). This is deliberate. High-grade corporates are the dominant market sector and look likely to remain so for some time. Nonetheless, other sectors are active and of considerable interest to market participants. Away from straight cash instruments, the euro-denominated spread product area also contains thriving credit derivatives and structured cash sectors. These are covered in other chapters of this book.

FOUNDING AND THE EARLY YEARS

For market practitioners, in the pre-European Monetary Union era, the term *Eurobond* meant a type of security rather than the currency of the obligation. Eurobonds could be sold in any convertible currency by issuers domiciled in any country. A Eurobond had—and still has—the following features:[1]

- Usually issued in bearer form, that is, not registered in a way that makes ownership known to national authorities
- Interest paid free of withholding taxes
- Underwritten and distributed by an international group of banks
- Free from national regulations
- Unsecured (usually)
- Listed on a stock exchange—usually Luxembourg or London (However, this is largely a formality. Almost all trading takes place over the counter. Most of this is over the telephone, but trading through electronic hubs is growing.)
- Cleared through a pan-European clearing system, that is, Clearstream Banking Société Anonyme or Euroclear Bank SA/NV, as operator of the Euroclear System

Eurobonds are distinct from domestic bonds sold in a country's home market. Such issues are sold in the country's currency, listed on the national stock exchange, cleared through the domestic system, and subject to national regulation. Domestic issues tend to have less protection for creditors in that they often carry very basic terms and lack features such as negative pledges. (We discuss bond covenants and other documentation issues later in the chapter.) In the Eurobond market's early days, the distinction between a Eurobond and a domestic security was of some importance—particularly for questions of tax. "Foreign bonds" also were popular. These were bonds sold in a domestic market but by

1. Peter Gallant, *The Eurobond Market* (London: Woodhead-Faulkner Ltd., 1988), p. 54.

nondomestic issuers—hence the Bulldog market in the United Kingdom, Rembrandts in the Netherlands, and Yankees in the United States. The old distinctions largely have fallen by the wayside as the Eurobond format has triumphed. At least in Europe, domestic corporate securities are extremely rare.

Since the establishment of European Monetary Union on 1 January 1999, the word Eurobond has taken on an additional meaning—that of a euro-denominated security. In this chapter I generally use *Eurobond* for issues that are both in Eurobond format and euro-denominated. There are, of course, markets for non-euro-denominated corporate issues, chiefly in dollars and sterling. Noncorporate borrowers, such as sovereigns, supranationals, and agencies, are also big issuers of Eurobonds in all the major currencies.

Early Developments

For the first few years of its life, the Eurobond market was largely the preserve of the dollar. Why were the early issues in dollars rather than in European currencies? For a start, the money was there to be invested. We have already mentioned the prudent Russians, who had good reason to keep their hard-earned dollars "offshore." The stock of dollars outside the United States was further built up by the country's dominant position in the postwar global economy.

On top of this, U.S. regulations (specifically Regulation Q) limited the interest rate that could be paid on domestic depository accounts. Thus holders of overseas dollars were in no hurry to repatriate them. Borrowing in European currencies was made difficult by a web of exchange controls and other limitations hard to imagine for today's market participants. Indeed, the gradual relaxation of these controls allowed the Eurobond market to expand to other currencies.

The late 1960s saw issuance in French francs, Deutschemarks, and Dutch guilders, whereas in the 1970s issues denominated in Australian and Canadian dollars, sterling, and yen made their debuts.[2] However, dollar-denominated issues retained their predominant position, accounting for around two-thirds of activity through the 1980s.[3]

London quickly established itself as the effective center of the Eurobond market. It benefited from a good location in terms of time zones, overlapping for at least part of the business day with New York, the Continental centers, and Tokyo. Language was important. U.S. banks were already established in London, and the ability to work in an English-language location made growth there attractive. There was already a critical mass of expertise in ancillary areas such as law and accountancy, from the city's role as an arranger of syndicated loans. On the regulatory front, the Bank of England was prepared to take a relaxed view toward growth of the new market. The United Kingdom also was largely free of market-limiting features such

2. *Ibid.,* p. 77.
3. *Ibid.,* p. 79.

as turnover taxes and exchange controls on international transactions. And lest we forget, the United Kingdom's lighter tax regime for individuals—at least compared with most continental European countries—was and remains an attraction for well-paid bankers.[4]

Private clients formed a major part of the investor base in the early days of the market. The bearer nature of the obligations was an important factor because money could be invested without the tax authorities knowing the principal existed.[5] As noted, interest on Eurobonds is paid free of tax, and it is up to the recipient to report the income earned to the authorities. Finally, many issuers are well-known, good-quality names, just the sort of borrowers that appeal to individual investors. While private clients are not nearly as important as they used to be, the stereotypical "Belgian dentist" was indeed a key provider of funds during the market's early development.[6]

The final milestone to note in the Eurobond market's formative years was the creation of securities clearing systems in the late 1960s. The lack of such systems caused a number of problems for market participants at the time. The transfer of paper securities between buyers and sellers was cumbersome, and the process was subject to the risk of theft or loss. The same problems arose in the presentation of clipped coupons for payment to the issuers' paying agents. A far better alternative would be to keep the securities in one place and transfer ownership and make coupon payments electronically. Settlement risk also would be reduced. These imperatives gave birth to Euroclear in 1968 and Cedel (since renamed Clearstream) in 1970. Both are owned by a consortium of banks.[7] Subsequently, the clearing systems have assumed key roles in the market for lending out Eurobonds under repurchase (repo) agreements.

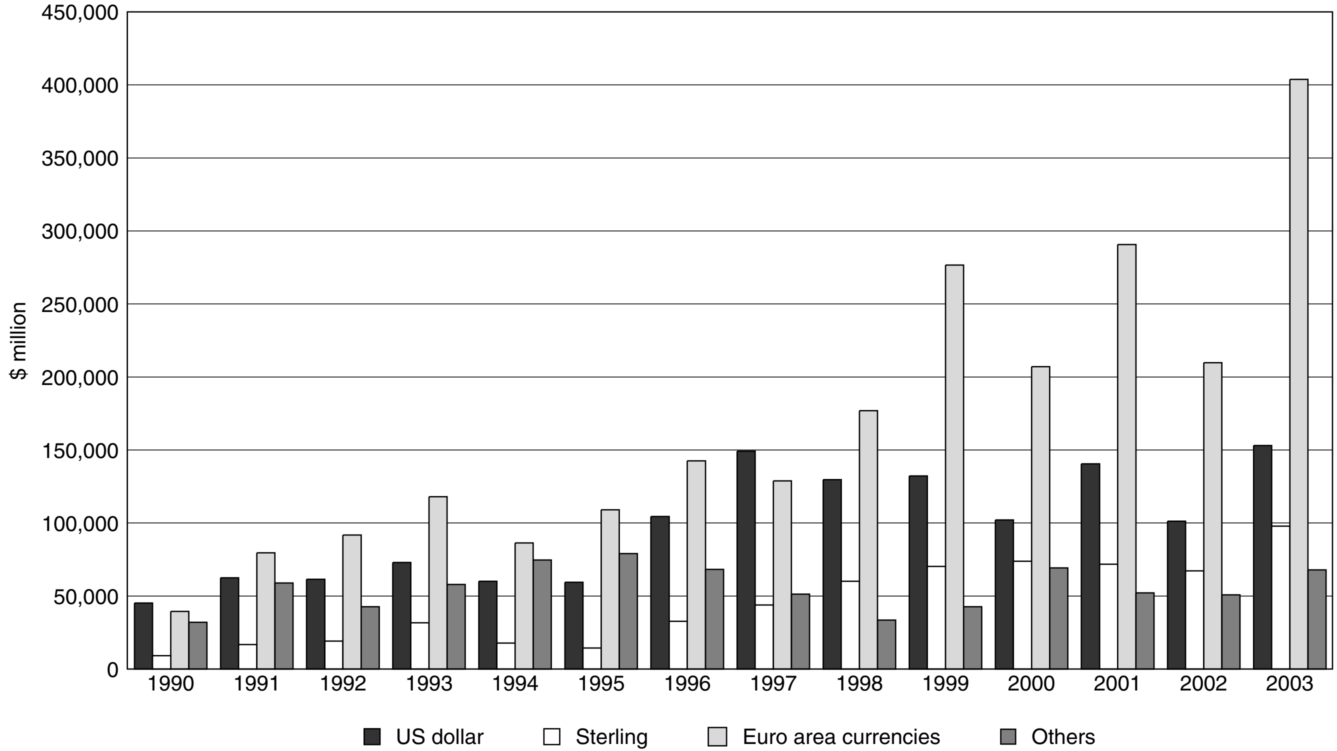
The 1990s

Throughout the 1990s, the Eurobond market grew at a slow but steady pace (see Exhibit 19–1). As the decade progressed, private clients formed a decreasing share of the investor base, reflecting the growth in demand from banks and big institutional investors. The expansion of the interest-rate swap market in the early

4. *Ibid.,* p. 19.
5. "Bearer" securities come in two forms. In the market's early days, bonds were physical definitive notes, with coupons attached. The owner, or more often the custodial bank, would clip the coupons and present them to the paying agent for the issue to receive payment. Now global notes are more common. Global notes preserve the anonymity of the owner but are more efficient to manage than physical definitive notes because they allow the owners to collect payments of interest and principal through the clearing systems. A global note represents the entire tranche of the note. It is held by a depository on behalf of the clearing systems.
6. For a good description of this and other aspects of the Eurobond market's sometimes colorful early days, see Ian Kerr, *A History of the Eurobond Market* (London: Euromoney Publications, 1984).
7. Gallant, *The Eurobond Market,* p. 17.

EXHIBIT 19–1

Annual Eurobond Issuance by Currency



Source: Capital Data Bondware.

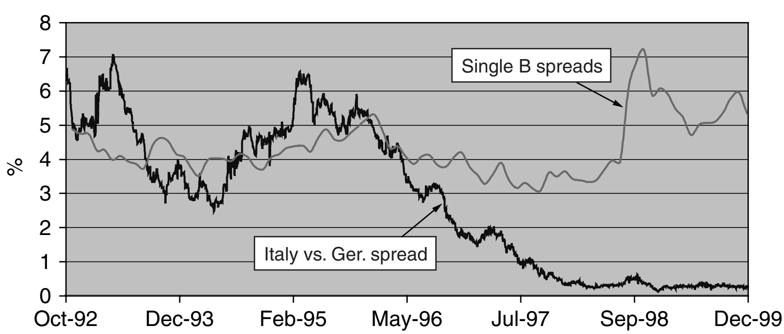
1990s paved the way for banks to invest in fixed-rate securities. At the time, banks were looking for good-quality corporate assets to offset the reduction in loan demand that was a consequence of the global recession. By combining an interest-rate swap with a fixed-rate bond (an asset-swap package), banks were able to create a floating-rate asset that matched their floating-rate liabilities.

The focus of institutional investors on corporate bonds rose as yields fell on government securities in the latter part of the 1990s. But demand was capped by the need for institutions such as insurance companies and pension funds to currency-match the bulk of their assets and liabilities. For example, Dutch pension funds, potentially important players in the international corporate bond market, had to place most of their funds in guilder-denominated assets. This largely limited their investment activities to government and local authority debt because at the end of 1998 there was only €60 billion (equivalent) in guilder corporate bonds outstanding. The situation was a bit better for the bigger countries such as Germany and France; in 1998, euro-DM and euro-FFr bonds outstanding totaled €130 billion and €164 billion, respectively. But the point remains. Supply was artificially constrained, meaning higher prices and less choice.

The extremely attractive opportunities available in government bonds in the second half of the 1990s was a second factor that diverted investors' attention from the corporate sector. Foremost among these was the famous "convergence trade"—the bet that yields in the "peripheral" European Monetary Union (EMU) candidate countries (mainly Italy, Spain, and Portugal) would converge toward those of the "core," mainly meaning Germany. As we show in Exhibit 19–2, in 1995 Italian government yields hit 625 basis points over those for Germany. They then rallied in more or less a straight line, to reach a yield differential of less than 30 basis points by the time the euro was launched. By way of comparison, in the

EXHIBIT 19–2

The European Government Market Convergence Trade* versus U.S. Single B Credit Spreads



*Yield differential between 10-year Italian and German goverment debt.

Source: Bloomberg, Lehman Brothers.

United States, the credit spread for single-B-rated bonds—issuers with a significant risk of default, according to the rating agencies—was 429 basis points over the Treasury curve in early 1995.[8] It has not traded inside 300 basis points over Treasuries since then (as of April 2004). In contrast to the credit risk on single-B-rated debt, in the mid-1990s, Italy's local currency debt was rated A1 by Moody's and AAA by Standard & Poor's.

With the benefit of hindsight, the Italy/Germany convergence play looks like the ultimate "no brainer" trade. But buying peripheral government debt against that of the core countries was not a risk-free proposition. Currency depreciation was a constant threat, as was the possibility that the countries would not qualify for the EMU. However, even with these risks, the convergence trade beat anything that the corporate market could offer, especially in Europe. It worked, of course, and proved to be an enormous money maker for investors who had put it on. By early 1998, though, it was largely over. Fund managers had to cast about for other ways to outperform the competition. For many, the expanded potential of the corporate Eurobond market looked like it would provide just the opportunity they needed.

THE EUROBOND MARKET POST-EMU: THE DRIVERS OF DEVELOPMENT

The Eurobond market changed significantly with the launch of European Monetary Union, which added a new impetus to its development.

The Eurobond Market at the Dawn of the EMU

Much as history is conventionally divided between the B.C. and A.D. eras, the development of the Eurobond market can be split between pre-EMU and post-EMU periods.

By the end of 1998, Eurobonds outstanding in EMU country currencies had reached the equivalent of €425 billion. The market was set to take off, and the launch of the euro provided the vital push. Investor demand reflected two factors, in addition to the need to boost portfolio performance. One was the expanded universe in which they could invest. Pension funds and insurance companies were still currency-constrained. But now they could buy securities across the Eurozone rather than just in their home country's currency.

The euro-denominated Eurobond market also included bonds denominated in legacy currencies (i.e., in the currencies that became subsumed into the euro).

8. Unless otherwise indicated, credit spread and bond volume data come from the Lehman Brothers Global Family of Indexes.

A slightly legalistic note is in order at this point. With the launch of EMU, outstanding Eurobonds in legacy currencies (e.g., Deutschemarks) were effectively redenominated so that payments were made in euros. However, the market practice still has been to refer to them in their original currencies. Not surprisingly, they are extremely illiquid and are traded only rarely. Until the member states' currencies disappeared from circulation in early 2002, investors could elect to receive payment either in euros or in an issue's original currency. Most institutions chose euros.

Eurobond Market Composition at the Launch of the EMU

When the euro was launched in January 1999, the Eurobond market's composition was far from what would be expected from a "corporate" market; some 75% of outstandings consisted of bank paper. This was due to the very tight credit spreads[9] at which banks could sell their paper. And this, in turn, reflected the influence of the Bank for International Settlements' (BIS) asset risk-weighting system. Banks could buy senior bonds issued by other banks and needed to set aside a much smaller amount of the capital (specifically one-fifth the amount) than was required for debt issued by industrial companies. The dominance of banks helps to explain why the average rating for the investment-grade market was so high—around Aa1 compared with A3 in the United States.

Why were there so few industrial or utility borrowers at the time of the market's launch? The reasons lie in the way the industrial and financial systems in Europe developed. It is worth digressing to explore these briefly, for they shape the market's direction even in the twenty-first century. A comparison with the very different history of the United States is also useful, because the American corporate market is often held out—sometimes too simplistically—as a model for Europe's future development.

A principal reason for the shortage of nonfinancial borrowers in the Eurobond market is the strength of the European banking system. Banks, rather than the bond market, have long been the major providers of credit in Europe. This stands in sharp contrast to the United States, where institutional investors are much more prominent. As can be seen in Exhibit 19–3, banks contribute 60% to 80% of national financial assets on the continent, compared with around 25% in the United States. The resulting deep relationships between European companies and their banks reduced the need for an active corporate bond market. And the small size of the institutional buyer base (compounded by the currency restraints

9. The term *spread* or *credit spread* refers to the yield differential, usually expressed in basis points, between a corporate bond and an equivalent-maturity government security or point on the government curve. It also can be expressed as a spread over the swap curve. In the former case, we refer to the *fixed-rate spread*. In the latter, we use the term *spread over EURIBOR*, or over the swap curve.

EXHIBIT 19–3

National Banking Systems

	Asset of Banks as a Percent of National Financial Assets	Branches per 1,000 Inhabitants
Austria	85	0.58
France	70	0.44
Germany	76	0.58
Italy	77	0.43
Netherland	57	0.44
Spain	75	0.94
Switzerland	79	0.50
United Kingdom	53	0.26
United States	26	0.27

Source: Bank for International Settlements.

noted earlier) meant that there were not many players to purchase the securities that otherwise might be sold.

The underlying reasons for these differences run deep. Largely for political reasons the American banking system is highly fragmented. Until recently, many states did not allow banks to have more than one branch. Even after a period of consolidation, there are still more than 9,000 banks and savings and loan institutions in America, according to the Federal Deposit Insurance Corporation (FDIC). As U.S. industrial growth accelerated in the first half of the nineteenth century, the banks were not able to provide the required funding. Corporate bonds were sold instead—with many purchased by European investors.[10] In Europe, most countries have long featured large banking groups that were better able to provide the amounts of capital needed in the new industrial era.

What America lacked in banking critical mass it more than made up for in the pension fund area. The U.S. pension system is "funded." That is, there are assets to meet the needs of retirees and to pay the future benefits of those still working. This is not to say that the funding is always adequate. Pension plan shortfalls frequently arise, especially during periods of market decline. However, there are still huge amounts of cash to be invested in the equity and bond markets, as well as in alternative areas such as real estate.

In contrast to Europe's strength in banking, its pension system is a very limited provider of investment capital. The situation varies from country to country,

10. For a good history of this period, see Ron Chernow, *The House of Morgan* (London: Simon & Schuster, 1990).

but most national pension systems are largely unfunded. That is, the money paid in by workers goes directly to pay retirees' benefits. Exhibit 19–4 summarizes the situation across Europe, with a comparison with the United States. The only Eurozone country with an extensively funded system is the Netherlands. Outside the EMU area, Switzerland, the United Kingdom, and the Nordic countries also have a good level of pension funding. This is changing slowly as the demographic pressures on the existing systems (more retirees living longer, fewer workers) prove unbearable. Moreover, the limits on national budget deficits imposed by membership in the EMU mean that countries no longer have the flexibility to cover shortfalls in pension plans, at least without making unpopular cuts in other benefits or raising social charges. The pension issue is highly

EXHIBIT 19–4

Pension Assets and Population by Country

	Population in Millions	Dependency Ratio* (%)	Value of Pension Assets ($bn)	Pension Assets as a % of GDP	Pension Assets per capita ($000s)
United States	267.6	19	5.571	78	21.4
EMU Members	281.1	22.4**	1,124	19	4.0*
Austria	8.1	N/A	8	4	1
Belgium	10.2	24.2	26	10	2.5
Finland	5.2	20.9	41	31	7.9
France	58.8	22.7	95	7	1.6
Germany	82.3	21.7	286	12	3.5
Ireland	3.7	19	35	43	9.7
Italy	57.4	23.2	195	19	4.3
Netherlands	15.7	18.8	558	141	35.5
Portugal	10	22.4	12	10	1.2
Spain	39.4	23.5	26	4	0.7
Other European Countries					
Denmark	5.3	22.4	166	89	31.2
Norway	4.4	25	39	24	8.9
Sweden	8.9	28.6	226	90	25.3
Switzerland	7.1	22.4	286	105	40.3
United Kingdom	59.1	24.6	1,241	86	21

*Population aged 65+ as a proportion of population aged 15–64.

** Weighted Averages for-EMU member states.

Source: WM Company, *US Statistical Abstracts, Pension and Investments.*

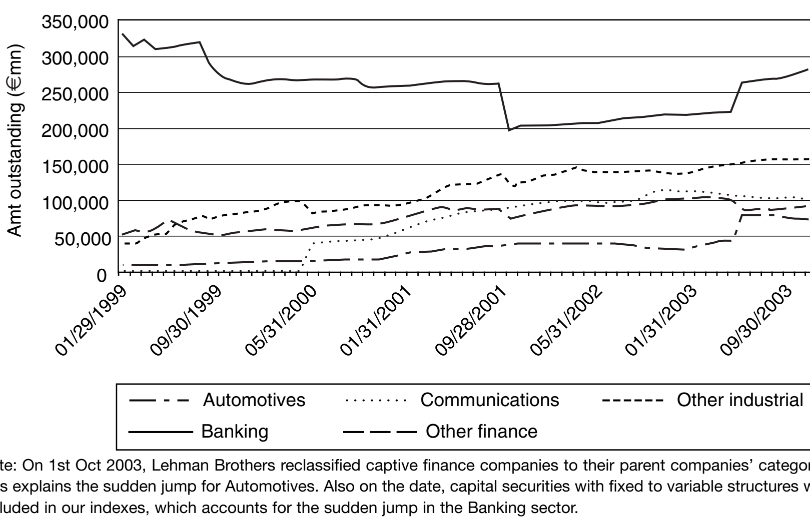
charged politically, and change is slow. But change is coming nonetheless, and it provides a key driver of the Eurobond market's long-term development.

Eurobond Issuance Since the Start of the EMU

On January 1, 1999, the average fixed-rate credit spread for the corporate Eurobond market was only 27 basis points. This reflected the predominance of banks, the market's high average rating, the lack of credit differentiation by investors, and the rarity value of the outstanding issues. The situation did not last long. The big borrowers were anxious to diversify their funding away from the banks that had long been their major providers of credit. Banks also were not able to provide longer maturity, fixed-rate money. At the same time, issuers in sectors such as telecommunications had increased funding requirements stemming from mergers and acquisition activity and higher levels of capital investment. Since the market's launch, diversification has increased at a fairly rapid pace, to the point that banks make up only 37% of outstanding issues as of April 2004. However, the spread of activity by issuer type has been limited. The strongest growth has been in telecommunications and auto issuers, as shown in Exhibit 19–5. Bank, auto, and telecom issuers accounted for 59% of outstanding debt. Again, the contrast with the United States is instructive. In the domestic

EXHIBIT 19–5

Euro Corporate Sector Breakdown



Note: On 1st Oct 2003, Lehman Brothers reclassified captive finance companies to their parent companies' categories. This explains the sudden jump for Automotives. Also on the date, capital securities with fixed to variable structures were included in our indexes, which accounts for the sudden jump in the Banking sector.

On 1st January 2002, the minimum liquidity criteria for Lehman Euro family of investment grade indexes was raised from €150m to €300m. This explains the sudden drop for most of the graphs as small sized issues fell out of the index.

dollar market, these three sectors make up 34% of outstanding debt. The growth of other industrial issuance in euros has been more muted, although it is beginning to accelerate.

Several drivers lie behind this pattern. For telecoms, the need to issue substantial amounts of long-term debt reflected the vast technological changes that swept over the industry at the end of the last millennium. The rapid spread of wireless communications led to the wave of partly debt-financed mergers among the major telecom service providers. In order to provide capacity for the expected boom in wireless use, in 2000, European governments sold licences to provide "third generation" (3G) universal mobile telephony services. Nicely timed at the peak of the technology bubble, the licence auctions brought in a total of €117 billion to the larger countries in Europe while adding substantially to the telecom service providers' debt levels. Much of this was refinanced in the bond market.

The story of auto company issuance is different. When discussing the auto sector, we include the finance subsidiaries of Ford, General Motors, and DaimlerChrysler (DCX). The U.S. "Big Three" (despite DCX's German ownership) traditionally have been heavy users of the bond market. This partly reflects the capital-intensive nature of the industry. More important are the activities of the Big Three's finance subsidiaries (especially Ford Motor Credit and General Motors Acceptance Corp.). These provide lease and purchase financing (often at very low interest rates) for their parents' products and are integral parts of their business models. The auto companies' large size and the short average maturities of the finance units' issues mean that they are among the largest corporate borrowers in the global debt markets. The growing depth of the Eurobond market provided an attractive new source of funds for them. For example, in 2001, DCX issued €7 billion in fixed-rate debt compared with €1 billion in 2000.

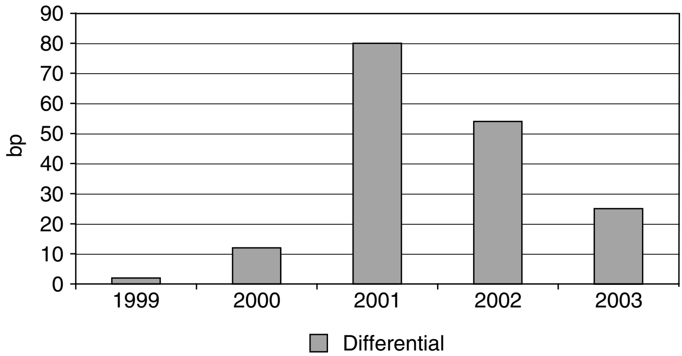
The steady rise of the "other industrial" sectors (i.e., the nontelecom and nonauto sectors) reflected the aforementioned desire to diversify the companies' funding sources away from banks, as well as the need to finance mergers. We should not take the bank disintermediation story too far, however, although the idea seems attractive. Banks, as financial intermediaries, stand between lenders and borrowers of funds. To earn a profit out of these activities, they take a margin from the difference between their cost of funds and what they earn on their loans. Why not cut them out and use the bond market to connect lenders of funds directly with borrowers?

In reality, this has not always happened, at least for the big, profitable companies that have access to the public bond markets.[11] European banks have been reluctant to loosen their ties with longstanding customers. Also, for many institutions, their lending to prime customers has been done in the hope that it will lead to future capital markets or investment banking business. Thus the spreads on

11. Despite our focus on the public debt markets, banks still provide the bulk of corporate Europe's credit needs. Bank loans to industrial and utility borrowers in Europe total around €3,000 billion, compared with €760 billion of euro-denominated public fixed-rate investment-grade debt.

EXHIBIT 19–6

Spread Differential between Bonds and Syndicated Loans



Note: Syndicated Loans longer than two years. Bond LIBOR spreads measured the month of each loan signing, using bonds of similar tenors.

Source: Loanware and Lehman Brothers Fixed Income Research.

loans to these favored borrowers usually are tighter than those on equivalent bond issues (see Exhibit 19–6). We should recall that the spread differential shown in Exhibit 19–6 is not a true like-for-like comparison. Syndicated loans contain various fees that raise the total cost of borrowing. Offsetting this, spreads on bilateral loans (arranged directly between a bank and a borrower) usually are tighter than those on syndicated facilities.

What is notable from Exhibit 19–6 is that the gap between the syndicated loan and bond markets has narrowed significantly since the wide point reached in 2001. This reflects two related factors. One is a greater focus on the bottom line on the part of bank lenders, which has led them to push up lending margins to many borrowers. The other is a more realistic assessment of the amount of additional business they can get as a result of making cheap loans. An outcome of this is a more defined tiering of the customer base; while some borrowers can still get access to cheap bank financing, their number is shrinking. And this is being reflected in the narrower average gap between the loan and bond markets. A related point is that Exhibit 19–5 shows that the amount of other industrial debt outstanding reached a plateau in mid-2002 as slower economic growth in Europe and a dearth of merger and acquisition (M&A) activity reduced firms' needs for external financing. The narrowed spread gap between the loan and bond markets indicates that a pickup in European economic expansion or a rise in mergers should lead to a sharp upturn in issuance from such entities.

The final reason for the slow rise of other industrial issuers is the more limited pool of potential companies to come to market. Exhibit 19–7 lists rated European companies by country, along with the number of potential rated entities, established by a broad screening approach. While the list is only a rough estimate,

EXHIBIT 19–7

Existing and Potential Rated European Issuers Industrial and Utility Companies Only

	Number of Companies		
Country/Region	**Rated**	**Potential Ratings Candidates([a])**	**Total**
Benelux	11	11	22
Nordic Region	25	17	42
France	34	15	49
Germany	20	14	34
Italy	6	10	16
Iberian Peninsula	11	6	17
United Kingdom	97	32	129
Others	101	18	119
Total	**305**	**123**	**428**
United States	**660**		

[a]Unrated stock exchange listed companies with at least $500m in equity and $150m in operating profits.

Source: Lehman Brothers.

it does establish that the potential size of the ratings universe in Europe is significantly smaller than in the United States, which we include as a basis of comparison. The reasons for this are easy to discover. Industrial development in European countries followed different paths than in the United States, which again is often held up as a model. Germany and Italy feature a large number of smaller, family-owned companies that are not the types to sell public-market debt. The Iberian peninsula industrialized late. France's postwar economy was dominated by a small number of large state-owned or state-affiliated groups. And so on. Also, many companies are sized to serve their national markets and not a pan-European one. This is slowly changing, with cross-border mergers taking place in several sectors. Despite this, there are still many potential issuers that are too small to access the public bond market.

Corporate Bonds: The Investors' Approach

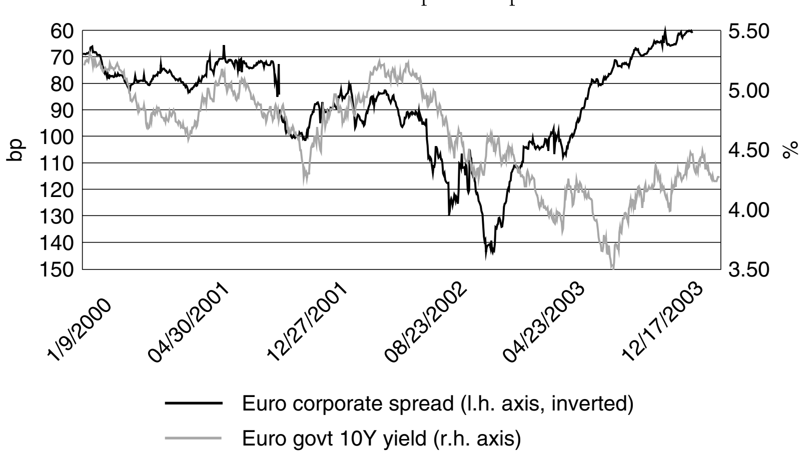
So far I have focused on the issuers' view of the market—why do they want to access it, and what are the barriers to their doing so? How about investors? What attractions does the European corporate bond market hold for them? As I discussed earlier, one draw is the scope to outperform. With yields among government markets all tightly compressed, the only way to add alpha (fund manager–generated outperformance versus a benchmark) in the government sector is via a yield curve or duration call. Making such "bets" offers significant possibilities, but the outcome is highly volatile. Agency and related debt trades at tight credit spreads, so there are few ways for a fund manager to distinguish herself in this regard. Pfandbriefe (bonds issued by specified German entities and backed by public-sector loans or mortgages) also offer only a small yield pickup over government debt.

A second attraction is diversification. Excess returns on corporate bonds are inversely correlated with total returns on government instruments. A corporate bond's excess return is a common performance metric for the asset class. It measures the difference between a corporate bond's total return and that on an equivalent-maturity government bond (or equivalent-duration section of the government curve), usually on a monthly basis. A corporate bond's excess return "should" be positive, reflecting the additional risks (mainly default, downgrade, and liquidity) that an investor bears when buying a corporate bond rather than a default-risk-free government bond. Excess return turns negative when a bond's credit spread widens (i.e., its yield increases), so its price falls in relation to a reference government bond or section of the government curve. Note that the price fall has to be enough to offset the "carry" (extra spread, or yield) earned on the corporate bond. Excess returns usually are calculated on a cumulative basis (i.e., adding the monthly figures over a period of time).

The benefits of diversification can be seen in Exhibit 19–8, which shows the relationship between the total return on government bonds and the spread on corporate assets. Most of the time they move in tandem (when the spread scale for the corporate market is inverted). That is, when government bonds are losing

EXHIBIT 19–8

Euro Government Yields and Euro Corporate Spreads



Source: Lehman Brothers Fixed Income Research.

their value in price terms, corporate bonds are gaining in a relative sense (i.e., the tightening spreads will generate excess returns), and vice versa. The relationship broke down during the rally in financial assets in late 2002 and early 2003 but since has reasserted itself. The data in Exhibit 19–8 underline the obvious point that investors should avoid or underweight corporate bonds when credit spreads are widening. However, I am discussing diversification benefits, not questions of market timing. And on this basis, the case for corporate bonds is clear.

Another factor that has driven the increased demand for corporate bonds has been changes in benchmarking practices. Bond indexes have a long history in Europe as well as in the United States. Prior to EMU, most indexes consisted of government bonds. These were calculated mainly on a national basis, although pan-European indexes also were common. Investors bought corporate bonds as ex-index "bets," that is, as a way to enhance performance versus their benchmarks. This changed considerably with the launch of the euro. The increased interest in corporate bonds, as well as improved data quality, gave rise to several aggregate (all-asset-class) indexes. These usually could be provided on a component basis, such as corporate bonds only. They also could be customized according to an investor's needs. A life insurance company might want a longer-duration index, for example, or one that excludes bonds sold by tobacco companies. These benchmarks increasingly came to be adopted by fund managers looking to match more closely their benchmarks to the investment style for each portfolio, although government bond–based funds and benchmarked funds with significant corporate holdings still exist.

The effect of the aggregate indexes has been to institutionalize the demand for corporate bonds. Before, it had fluctuated wildly. That is, when fund managers (usually with government benchmarks) thought that credit spreads would widen, they would divest their corporate bonds completely. Now, fund managers with aggregate indexes might hold smaller corporate positions at times, but they are unlikely to eliminate them completely. To do so would be to incur an unacceptably high level of tracking error.[12]

The Euro-Denominated High-Yield Market

So far our discussion of the euro-denominated corporate Eurobond market has focused on the high-grade sector, that is, on issuers rated Baa3/BBB– and above by Moody's and Standard & Poor's. This is only part of the corporate story. The high-yield, or sub-investment-grade, sector has developed in parallel since the mid-1990s. The divide between the high-grade and high-yield sectors is deeply rooted in U.S. regulation and practice, particularly as it involves insurance companies. The split has carried over to Europe. But it is less strongly felt, given the lack of significant

12. Tracking error, a common measure of portfolio risk, measures the expected volatility (in basis points of total return) of the portfolio against its benchmark over a specified period.

regulatory differentiation between high-grade and high-yield issuers. Investor guidelines also are written more loosely in Europe, allowing some fund managers to buy both high-yield and high-grade assets. A final point is that the large number of "fallen angels" (issuers that have been downgraded from high-grade to high-yield) in 2001 and 2002 has reduced the divisions between the two sectors.

Nonetheless, a lot of high-yield investing is done by funds dedicated to the asset class. Drivers of market performance also differ. For these reasons, we have chosen to discuss the high-yield asset class separately from high-grade.

Phases of the High-Yield Market's Development

The development of the high-yield market can be divided into three distinct phases. The market opened in earnest in 1997. Probably the first benchmark issue was sold by Geberit, a Swiss manufacturer of bathroom fixtures. A Deutschemark issue, it was in many ways a classic high-yield debt transaction. It was rated B2/B and partly funded a leveraged buyout of the company sponsored by Doughty Hanson, a private equity firm. The company's strong competitive position and stable earnings record made it an attractive non-investment grade issuer (the company's non-investment grade ratings reflected its high gearing following the buyout).

Other similar deals followed, although market growth was slow; by 2000, the high-yield sector had outstandings of €20 billion. This was small compared with the high-grade market (€417 billion at the time) but still encouraging given that European high-yield debt represented an entirely new form of financing. Note that the high-yield data include only issues rated Ba1/BB+ or below and thus understates the true size of the market. Unrated issues, many of which would be high-yield if rated, always have been more common in Europe than in the United States, where they are almost unheard of in the public market. The ability to execute transactions without the involvement of the rating agencies is largely due to the more relaxed guidelines at many investment funds, as noted earlier.

The second phase of the market's development began in early 1999, when emerging telecommunications companies began to sell debt. These included competitive local exchange companies (commonly known as CLECs), competitive long-distance carriers, emerging market wireless carriers, cable television companies, and at the final stage, Web-hosting companies. This was, of course, at the height of the telecom and technology bubble. The subsequent failure of growth to meet expectations—combined with the companies' leveraged capital structures—placed them under severe strain. Downgrades and defaults mounted rapidly. By the end of 2002, most emerging telecom issuers had defaulted or restructured their debt, with recovery rates as low as zero. By contrast, issues sold by the "phase 1" companies performed much better, with default rates no worse than for the U.S. high-yield area. The result was a heavily bifurcated market, with little issuance. Rated high-yield issuance fell from €9.4 billion in 1999 to €4.6 billion in 2002.

The third phase of the European high-yield market's evolution is following the U.S. market's model, with an increased focus on higher-quality issuers, more investor-friendly debt structures, and expansion of the asset classes accessed by institutional investors. Consistent with this, as well as better market conditions, issuance rebounded to €10.8 billion in 2003. Activity remained strong in early 2004 as well.

Bondholders increasingly demand that issuers meet certain size parameters, that debt issues meet minimum liquidity requirements, and that non-investment-grade debt achieve strong rankings within the companies' capital structures. Structural enhancements to the issues themselves are also becoming more common.

Other market drivers are also changing. New types of non-investment-grade debt are coming to the market. Beyond the usual public securities, types of financing include mezzanine debt and private loans. The emergence of new asset pools with more flexible investment parameters, including collateralized debt obligations (CDOs),[13] has increasingly driven demand in the market and improved the flexibility of financing structures. Many CDOs can invest in bonds, mezzanine debt, and loans and can make relative-value investment decisions among these asset classes.

THE CORPORATE EUROBOND MARKET TODAY

Trading and origination practices have evolved over the life of the market but would remain recognizable to market practitioners from earlier years. A much bigger change has come from the rise of the synthetic credit market and its knock-on effect on how cash securities are valued.

Trading Practices

Although the Eurobond market has changed hugely over time, in some ways it remains close to its roots. The way bonds are traded is one of these. Most transactions are still done over the telephone between market professionals. Salespeople take orders from institutional investors and relay them to the traders.

In the pre-euro days, traders usually were organized by currency. Now, sector specialization is the rule. For most issues, buy or sell indications are indicated initially on a yield-spread basis. The "spread" can be either over the swap curve or over a specified government benchmark. A corporate bond issue keeps the same benchmark for its entire life; they "roll down the curve" together. This is in contrast to the United States, where the convention is to quote a corporate bond's spread over the nearest "on-the-run" (most recently issued) 2-, 5-, 10-, or 30-year maturity Treasury bond.

13. CDOs are covered in Chapter 30.

The bid or offer from a dealer (depending on whether the customer wants to sell or buy bonds) is usually in competition with at least one other intermediary. The transaction is done on a price basis. This is usually straightforward. Disputes around prices are rare because the spread is agreed, the price of the underlying government security is known from marketwide information screens, and the price-calculation method is a matter of market practice.

The size of each trade varies considerably, but amounts under €5 million usually are considered "odd lots." They are less efficient for dealers to handle and are priced accordingly. Trades above €50 million are rare.

Intermediaries trade either with customers or with each other. In the latter case, trading is conducted via interdealer brokers (IDBs). Like all brokers, they match up buyers and sellers but do not take positions themselves. They provide a useful service by allowing intermediaries to adjust their positions without revealing them to other professionals. In the absence of a centralized exchange, IDBs provide dealers with market color around flows of securities. Related to this, they also provide information to allow dealers to price less liquid bonds.

Like most developments associated with the technology boom in the late 1990s, electronic trading systems did not live up to their initial hype. That said, by 2004, electronic trading platforms have come to play useful roles, especially around buying and selling smaller positions. For larger blocks of bonds, investors still get better execution by dealing directly with a selected number of intermediaries. The leading electronic platform is Market Axess. It is owned by a consortium of dealers. Other single-dealer platforms are also in operation. Generally, electronic platforms provide listings of dealers' bids and offers of securities. Customers then can choose electronically which bid to hit or offer to lift, and the order is transmitted directly to the bank's back office ("straight-through processing"). Alternately, an electronic or telephonic confirmation with the intermediary involved is required to execute the transaction. Market Axess and similar systems are designed to serve investors' needs. Platforms also exist to facilitate transactions and promote liquidity among intermediaries. These usually are owned by the interdealer brokers.

All active intermediaries keep inventories of bonds. That is to say, cash traders naturally are "long" securities. Corporate bond positions usually are financed in the repo market, and the interest-rate risk is hedged out by shorting government bonds or futures. This leaves dealers exposed to "spread risk"—the risk that credit spreads will widen, causing losses. This can be covered by shorting very liquid corporate assets, although this practice is itself subject to risks. The principal one is that changes in the shorted bond's credit spread will not match that of the dealer's portfolio of positions. There is also the related risk of a squeeze in the repo market. That is, the bond might become more expensive to borrow, with a resulting rise in price on the short position. Dealer inventories will go up and down depending on a number of factors. These include the time of year (inventories tend to drop around banks' reporting periods), perceived market direction (dealers carry less inventory if they think credit spreads will widen), the state of the repo market, and the slope of the yield curve (steeply sloped curves allow dealers to carry inventory more profitably).

Market Liquidity

Regardless of the currency market, corporate bonds are less liquid than most other public-market financial assets, such as equities, government bonds, and most derivatives. At the end of April 2004, there were 1,033 fixed-rate investment-grade bonds outstanding in the euro corporate market compared with 3,225 in the United States.[14] Yet no more than 20% of these issues trade regularly. The rest are locked away in investors' portfolios, often not marked to market, and happily earning a rate of interest until they mature at par. For most investors, the transaction costs on such securities are too burdensome, particularly if they have to be replaced with alternative assets. Also, for many bank and insurance investors, securities held in non-mark-to-market accounts are not available for sale except in unusual circumstances. Thus trading tends to be concentrated in newer and larger issues.

The relative liquidity of the Eurobond market compared with the United States is a hotly debated question. The general impression is that the Eurobond market is less liquid than the U.S. corporate sector. The average transaction size is greater in the United States, reflecting the market's larger size ($1,678 billion versus €992 billion) and the concentrated structure of the investor base. Other obvious liquidity metrics, such as bid-ask spreads are hard to track consistently. What is true is that secondary-market trading conventions have converged over time.

In both markets, dealers will bid for most securities in most cases. In the United States, this is often done through "bid lists." Big institutional investors send a selected group of dealers lists of securities on which the dealers are invited to bid. The time frame for this "bid wanted in comp" (i.e., competition) approach is short—usually a few hours. Each dealer is then notified of the securities for which they are the highest bidder. For less liquid bonds, it is also common for dealers to "work an order." Under this approach, an investor leaves an order with a dealer to buy or sell a set amount of securities within a spread range. The dealer then has a limited amount of time (usually one or two days) to source the bonds. In working an order, a dealer is functioning more like a broker.

Intermediaries usually are reluctant to offer securities if they do not have them in inventory. Exceptions are highly liquid issues, where the dealer is confident that he can obtain the bonds via the interdealer broker market. Generally, Eurobond dealers are more willing than their U.S. counterparts to make "short

14. Fixed-rate bonds with at least one year to maturity and minimum outstanding amounts (face value) of €300 million and $150 million.

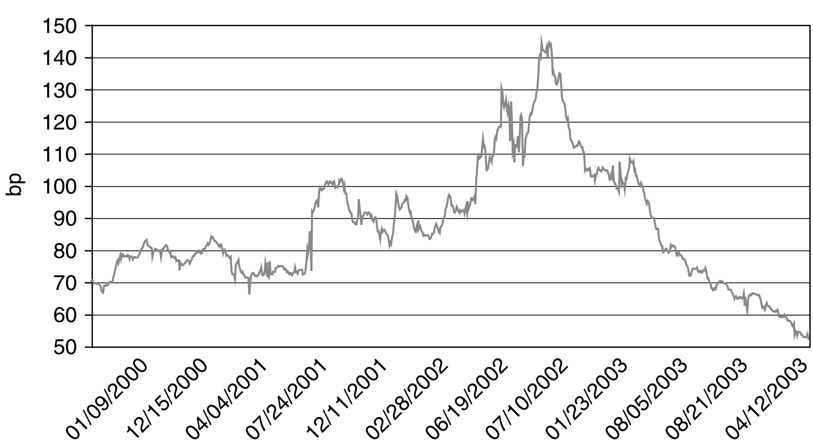
offerings," that is, to sell bonds they do not have in inventory. This mostly reflects the more competitive nature of the market—there are more dealers with smaller market shares than in the United States. But short offerings have become less common, and the U.S.-style order system is becoming seen more often.

A Changed Asset Valuation Paradigm

Euro corporate spread levels fluctuated widely in the period from 2001 to early 2004 (Exhibit 19–9). This reflects a number of factors, some unique to Europe and some common to corporate assets globally during that time. Common drivers include the rash of big corporate defaults in 2001 and 2002, as well as the depressed global economic climate. This was followed by the big rally in risky assets that started in October 2002. What was special to the euro corporate market was the sharp shift in the quality composition of the universe, with the Baa portion of the investment-grade corporate market rising from 2% in January 1999 to around 25% in 2003 (it has since stabilized at that level). While the composition of all indexes changes over time, this is an unusually fast evolution. Similarly, banks, which used to trade at very tight spreads, have dropped sharply as a percent of the index, as I have mentioned. (The bank data only include senior and dated subordinated debt. Subordinated debt trades at wider spreads than senior paper and has increased as a percent of the bank total.) These developments were significant contributors to the rise in the average market spread from 2000 to the end of 2002. Not surprisingly, spread volatility has fluctuated as well (see Exhibit 19–10), although it has come off in line with the absolute level of spreads.

EXHIBIT 19–9

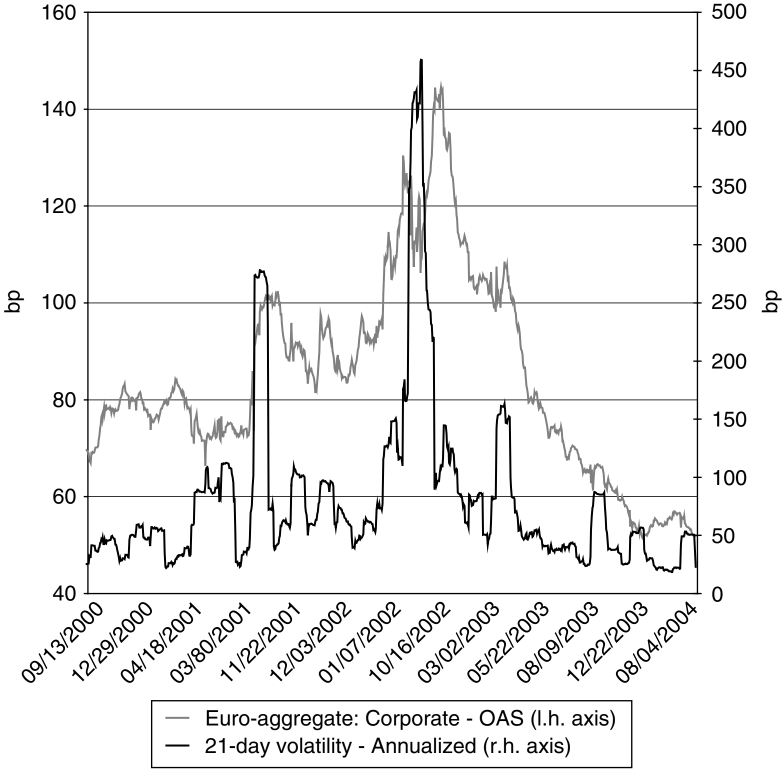
Euro-Aggregate Corporate Fixed-Rate Index Spread



Source: Lehman Brothers Fixed Income Research.

EXHIBIT 19–10

Euro-Aggregate Corporate Fixed-Rate Index Spread History and Spread Volatility



Source: Lehman Brothers Fixed Income Research.

Another factor was at work as well. The rapid growth of the credit default swap (CDS) market led to a fundamental change in the trading pattern in the market. CDSs allow investors to take long and short positions in individual issuers. A number of new players, principally credit hedge funds, have taken advantage of this. The result has been rapid shifts in buying and selling pressure, with resulting swings in credit-spread volatility.

Beyond this, the synthetic CDO[15] market has created a substantial bid for credit risk. This really only began in 1999. Synthetic CDOs substitute credit default swaps (CDS) for cash assets in all but the mezzanine and equity portions of their structures. Sponsors of synthetic CDOs are selling default protection

15. Synthetic CDOs are discussed in Chapter 31.

(i.e., creating credit risk), just as if they were issuing bonds. This results in short positions for the parties on the other side of the trade (i.e., the buyers of protection). These are usually the investment banks that originated the transactions. By covering their short positions, investment banks increase the demand for credit—at least for the companies included in the structures. But some issuers are excluded from CDOs, meaning that their credit spreads will not perform as well. The result is an increased bifurcation of the market and greater spread volatility for the "have nots" excluded from synthetic structures. However, the level of CDO origination can fluctuate sharply depending on factors such as the spread differential between highly rated and lower-rated assets. Thus the impact of the CDO sector on cash credit spreads can be quite dynamic.

The final piece of the puzzle is the merger of cash and credit derivatives trading desks at most intermediaries. This has changed fundamentally how trading desks view and manage credit risk. Before the rise of the CDS market, mark-to-market risk on trading desks chiefly came from credit-spread fluctuations. And since cash desks are naturally long, their downside risk usually came from spread widening. Cash books are still "naturally" long credit. But this is offset by short positions on synthetic (i.e., CDS) positions on the same names owing to the origination of synthetic CDOs.

The upshot is that integrated trading desks now see their risk mainly as a portfolio of basis trades, the "basis" in this case being the differential between the spread on a company's CDS and the corresponding cash instrument (swapped to LIBOR or EURIBOR). Buying protection on a credit in the CDS market is essentially the same as buying a put option on the company's debt. This is so because, on default, the buyer of protection delivers an asset of the defaulted entity to the protection seller in exchange for a payment equal to the par value of the CDS. Thus, if a dealer is long a bond of the same issuer, that dealer is holding a covered put on the company. This becomes a bet that spread volatility will rise because this usually will cause the spread on an issuer's CDS to widen more quickly than the spread on its bond. In other words, a rise in spread volatility will increase the basis, improving the profitability of the trade for the dealer. If a dealer believes that spreads will tighten, she will quickly cover many of her short positions, causing a rapid contraction in spread levels.

The Primary Market

So far in this section I have discussed the secondary market transactions involving outstanding issues. Let's now turn to the primary sector, through which bond issues are originated and priced. The new-issue sector provides the lifeblood of the Eurobond market by supplying new issues to replace those that have matured or been called. Also, bond issues become less liquid as time passes, so greater origination has a directly beneficial effect on the secondary market as well. This is so because credit spreads contain an illiquidity component. What we mean by this is that the illiquid nature of much of the corporate market makes it hard for participants to know the clearing levels for many issues. A successful new issue adds substantially to the market's price-discovery process. This happens because establishing a clearing level for the issue allows the spreads of many other issues in the sector to be reassessed in relation to the spread on the new deal.

Nonfinance companies sell bonds mainly as alternatives to bank finance. However, there are also other advantages. Bond issues can be of longer maturities than bank loans and can serve to diversify a company's investor base.

Often in determining to use the bond market an issuer will approach one or more investment banks to serve as advisors in the issuance process. In any event, in most cases new issues come to market through a syndicate, or group of banks. A common approach is a "negotiated transaction." This means that an issuer invites a number of banks to present their ideas on how best to bring the company's bond issue to market. This "beauty contest" can go through several rounds as the issuer narrows down the banks to a short list from which the lead managers are chosen. (These transactions usually are large, and sole lead mandates are rare.) The negotiated part refers to the fact that the level (in credit-spread terms) at which the bonds are issued is negotiated between the underwriters and the issuer. The negotiation takes place after a marketing period, during which the issuer often embarks on a "road show" to present the company to investors. Following the marketing period, the lead managers solicit orders from investors and "build a book" for the issue within spread parameters. Other issue details, such as size and maturity, also can change as a result of investor feedback received during the marketing campaign. Before launch, the syndicate usually is enlarged to include banks with good placing power among specialized investor groups.

Alternately, "bought deals" are common in good market conditions, especially for smaller transactions. Under this structure, a small number of banks bid for the bonds being offered for sale by the company. The bank offering the highest price (i.e., the lowest yield) wins the mandate and owns the bonds. They are then offered out to the market, usually without the involvement of additional banks.

Occasionally, new issues are withdrawn prior to their scheduled launch, usually because of unfavorable market conditions. In most situations, the issuer returns to the market once things have settled down.

Regardless of the approach chosen, new issues are underwritten by the intermediaries. That is, once an issue is launched, the intermediaries own the bonds and are responsible for placing them with investors. The underwriting risk is small with a negotiated transaction but can be substantial with bought deals. The fee earned by the dealers for underwriting a deal is simply the difference between the price paid to an issuer for the bonds and the price at which they are reoffered (and hopefully sold) to investors. The "all-in rate" to the issuer is the yield (or spread) that reflects the price paid to the issuer.

If a deal clears "within fees," it means that the bonds were sold at a level that allowed the underwriters to earn their full fees. This is not always the case. Underwriters can suffer substantial losses if they misjudge the clearing level for a bought deal or if the market suffers a disruption between the time a deal is underwritten and when it is fully placed.

Bond Covenants and Other Documentation Issues

The debate around bond prospectus covenant packages, in terms of the relatively poor protection they offer bondholders, has been one of the hardy perennials of the Eurobond market. The primary reason for the lack of strong covenants is the extremely diffuse investor base, which makes it difficult for bondholders to form a consensus on what covenants are truly desirable.

Linked to this is the absence of agreement on the part of investors on the topic of just how much they would be willing to pay for covenant protection. That is, companies can issue bonds with a standard covenant package at the current market spread. This is usually determined with reference to their existing issues or those of similar companies. But how much would investors be willing to pay in the form of a tighter spread over the swap or government curve in exchange for covenant protection? Except for some special situations such as the jumbo telecom deals in 2000 and 2001, this question has never been answered.

Eurobond documentation for investment-grade issues is reasonably standardized, although the wording of some terms and conditions has varied over time. We list the key terms and conditions below. Note that sterling issues, particularly long-dated transactions, offer additional protection in some instances.

- *Governing law*. Most transactions are governed by U.K. law, although New York state law is an occasional alternative.
- *Security*. As a rule, issues are not secured by the company's assets.
- *Negative pledges*. Negative pledges are common. They prohibit an issuer from creating security interests on its assets unless all bondholders receive the same level of security.
- *Subordination*. Except for bank or insurance capital issues, most bonds are sold on a senior basis.
- *Cross-default clauses*. Cross-default clauses state that if an issuer defaults on other borrowings, then the bonds will become due and payable. The definition of which borrowings are covered can vary. The cross-default clause usually carves out defaults in borrowings up to a certain threshold (e.g., €10,000) to prevent a minor trade dispute or overlooked invoice from allowing the bondholders to put the bonds back to the issuer.
- *Prohibition on the sale of material assets*. In order to protect bondholders, most documentation prohibits the sale or transfer of material assets or subsidiaries. The definition of *material* can vary considerably.

In addition, many of the jumbo telecom issues from 2000, 2001, and 2002 were sold with coupon step-ups or step-downs. That is, their coupons increased in the event of a ratings downgrade and then stepped back if they were upgraded. For issuers, these inducements were necessary to sell huge amounts of debt (several of the multitranche transactions were in the €7 billion range) at a time when their credit outlooks were uncertain. A limited number of other issuers in the telecom and technology area also included step-ups in their documentation. However, step-ups and step-downs have not become widespread in the market. (Perpetual bank capital issues have long had coupon step-ups, but their structures are heavily influenced by regulatory considerations.) Indeed, since 2001, several telecom issuers with outstanding step-up, step-down issues have been able to do deals—albeit smaller—without this feature.

BEYOND HIGH-GRADE EURO CORPORATES: THE OTHER EUROBOND SECTORS

So far this chapter has concerned itself mostly with euro-denoninated Eurobonds sold by corporates (including financial institutions). In this section we look at other sectors, such as sovereigns, supranationals, and agencies.

Eurodollar Bonds

As noted before, dollar-denominated Eurobonds (usually referred to as *Eurodollar bonds*) were the original Eurobonds. The market is quite large—$2,063 billion in outstanding debt. This reflects two factors. One is that it includes almost all sectors; in addition to corporates, sovereign, agency, and supranational issuers are also big issuers (see Exhibit 19–11). The second development has been the rise of dollar-denominated global issues, that is, issues registered and sold in more than one country. These are often included in the Eurodollar bucket.

EXHIBIT 19–11

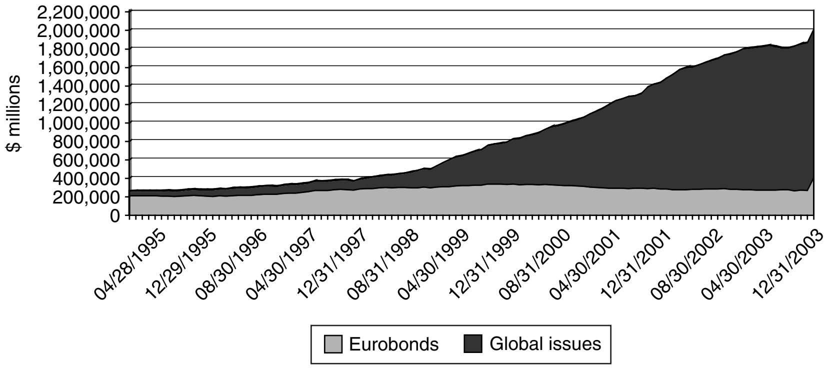
Eurodollar Index

	Amount Outstanding ($ millions)
Industrials	492,666
Utilities	46,322
Financials	467,545
Sovereign/Agencies	1,047,672
Total	2,054,205

Source: Lehman Brothers Fixed Income Research.

EXHIBIT 19–12

Eurodollar Bonds (Dollar Global Issues and Eurobonds)



Source: Lehman Brothers Fixed Income Research.

Exhibit 19–12 shows the breakdown of the two broad categories and emphasizes the shrinkage of the classic Eurodollar sector. This mirrors the relative decline of the private client part of the investor base. Private clients traditionally have been big buyers of Eurodollar bonds because of the popularity of the currency and the bearer nature of the obligations. The European tranches of dollar-denominated global bonds sold by U.S. entities—which account for most of the origination in this regard—do not carry the same tax advantages.

The Eurosterling Market

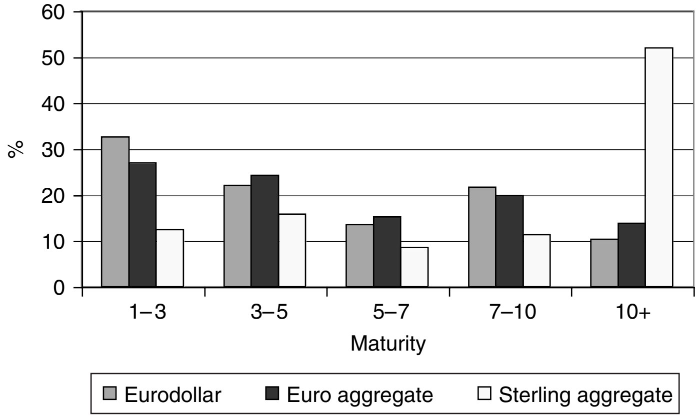
Sterling is the other main noneuro currency bucket. Most issues are in Eurobond form, as opposed to domestic market form, in order to broaden the potential investor base for new issues.

In many ways the sterling market is most like the U.S. domestic dollar market. It has a relatively long history and a good level of sector and quality differentiation. The investor base also has similarities to that of the United States, with the United Kingdom's tradition of funded pension plans providing a solid base of institutional demand that has developed only recently in the Eurozone. This is evident from the strength of the long-dated sterling market, which mirrors that of the United States. By contrast, until the 30-year sector of the market opened in January 2003, issuance beyond 10 years was almost unknown in euros (see Exhibit 19–13).

Like the Eurodollar market, the Eurosterling sector is quite diversified by issuer type (Exhibit 19–14). Issuance of top-quality paper with long maturities has been especially large, mainly because issuers can achieve very tight funding in LIBOR terms given the relatively wide 30-year sterling swap rate.

EXHIBIT 19–13

Eurodollar, Euro Aggregate, and Sterling Aggregate Maturity Breakdown



Source: Lehman Brothers Fixed Income Research.

Investors have had a very strong bid for 30-year paper owing to the need to match their pension liabilities. Beyond this, the market has been strongly affected over the years by regulatory schemes imposed on issuers and investors. Two such regimes pertain to the pension-fund sector. The first is the Minimum Funding Requirement (MFR), which came into force in 1995. In addition to setting funding requirements for pensions, it established a long-end gilt benchmark for the fixed-rate portion of pension funds. Sales of longer-maturity Gilts (U.K. government bonds) soared as a result, causing the sterling yield curve to invert. The second development is the proposal to implement a new reporting standard for company pension fund obligations (FRS-17). For a U.K. company, this will

EXHIBIT 19–14

Sterling Market

£	Amount Outstanding
Industrial	72,228
Utilities	41,804
Financials	17,448
Sovereign/Agencies	64,307
Total	195,787

Source: Lehman Brothers Fixed Income Research.

require it to carry the net overfunded or underfunded position of its pension plan on either the asset or liability side of the balance sheet, depending on the plan's status. Changes in the net level of funding will be reported through the profit and loss statement on a three-year average basis. FRS-17's discount rate is the Aa long-maturity corporate yield. The greater volatility of reported pension-fund balances introduced by FRS-17 poses challenges for company managers. One way to reduce this is to buy more sterling corporate bonds. In this way, the yield on the assets will more closely match the Aa corporate yield used as a discount rate.

More recently, U.K. insurance companies, big buyers of sterling-denominated assets, have had to contend with the potential impact of Consultative Paper (CP) 195, which proposes a stress test for the amount of regulatory capital they are required to set aside against their assets. Because price fluctuations are naturally less in shorter-maturity paper, this has shifted investor preference to somewhat shorter-maturity paper, specifically the 10- to 15-year maturity part of the curve.

Sovereign, Supranational, Local Authority, and Agency Issuers

Top-quality issuers have long been a part of the Eurobond scene. In euros, however, they have been eclipsed by the growth of the corporate market. Sovereign issuance in particular has fallen as countries have shifted activity back to their domestic issuance mechanisms. This has been done mainly to increase liquidity and size in domestic market format so as to compete better within the Eurozone.

Exhibit 19–15 provides a breakdown of issuance among the five principal sectors. The definition of what is an agency can be contentious. For our purposes, we count issues as agency debt if the issuer is either 100% owned by a central government or if the debt is guaranteed by a central government.

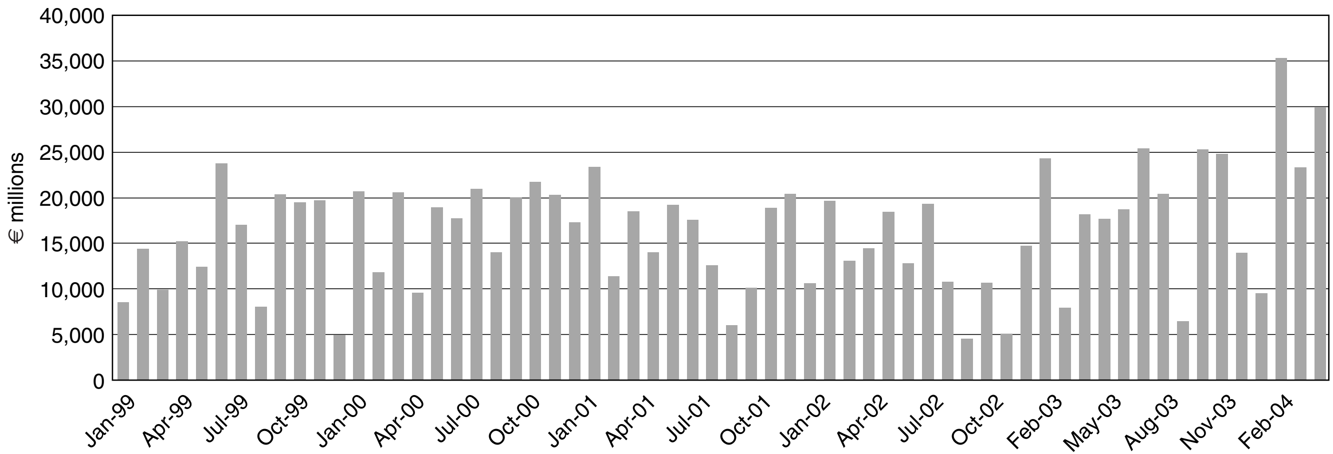
EXHIBIT 19–15

Euro-Denominated Non-Corporate Bonds Outstanding

	Amount Outstanding (EUR m)
Local Government	170,492
Supranationals	76,285
Sovereigns	48,964
Pfandbriefe	408,724
Asset Backed	14,290
Other Mtgs	177,169
Total	895,924

EXHIBIT 19–16

Euro FRNs Monthly Issuance



Source: Dealogic Bondware 2.80.

Floating-Rate Notes

Floating-rate notes (FRNs) are Eurobonds that have their coupon levels reset periodically, with reference to a money market rate. For dollar-denominated assets, this is the LIBOR (London Interbank Offer Rate), as determined by a group of 16 reference banks. The mechanism is run by the British Bankers Association (BBA). The BBA also supervises LIBOR fixings in a number of other currencies. For euros, the most common reference rate is EURIBOR, as determined by the a reference group of around 50 banks chosen by the European Banking Federation. In both cases, most issues are priced off the three-month rate, although one-month and six-month rates are also used.

Issues are priced and sold initially at a fixed spread over the reference rate. The price of an FRN can fluctuate considerably during the life of the issue, mainly depending on trends in the issuer's credit quality. The frequent resets in the reference rate mean that changes in market interest levels have a minimal impact on an FRN's price. For investors, movements in an FRN's price are reflected in changes in the discount rate. The discount rate is effectively the yield needed to discount the future cash flows on the security to its current price. It thus functions in the same way as the yield-to-maturity for a fixed-rate instrument. And like a fixed-rate bond, the market convention is to use a constant spread to a constant EURIBOR (or LIBOR) rate to discount future cash flows rather than a forward curve.

Most FRNs have been issued by sovereign-type entities and financial institutions. Industrial and utility activity has been relatively low. (see Exhibit 19–16).

THE OUTLOOK FOR THE EUROBOND MARKET

It is easy to focus on the Eurobond market's limitations at the expense of just how far it has come. From the perspective of its early days, the market has changed and grown beyond all recognition. As we have seen, the launch of the euro has provided a critical step up to a new level, on which the market is still consolidating. Indeed, the strong recovery of investor demand in late 2002, following the shocks of WorldCom and the like, is an indication of the market's resilience.

Corporate bond valuations always will fluctuate, of course. But to stay in the market, investors have to believe that it offers a decent level of risk-adjusted reward compared with other sectors. It also needs to satisfy the related needs of diversification and liquidity. Particularly regarding the question of diversification, progress has been slower than many thought would be the case. But to return to the point made at the opening of this chapter, the market is still early in its evolution. Trends regarding growth generally are positive. Indeed, we expect issuance to accelerate going forward as competing sources of funds (mainly bank loans) become more expensive for borrowers. On the demand side, the slow movement toward funded pension plans is creating new pools of investors, including insurance companies that manage many pension plans. Other fixed income markets, such as governments and Pfandbriefe, provide neither the yield nor the volatility (away from yield-curve movements) required by fund managers if they are to outperform their benchmarks. The fundamentals for growth are in place. All that is needed is time.

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CHAPTER

TWENTY

EMERGING MARKETS DEBT

Jane Sachar Brauer
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Emerging markets are comprised of nations whose economies are viewed as developing, or emerging, from underdevelopment. It usually includes most or all of Africa, eastern Europe, Latin America, Russia, the Middle East, and Asia (excluding Japan). Additionally, some investors use credit rating as a criterion, viewing an investment-grade credit rating as an indication that the country has fully emerged. Some of these emerging economies are heavily dependent on commodity exports, whereas others have extensive service and manufacturing sectors. Emerging markets debt includes sovereign bonds and loans issued by governments, as well as fixed income securities issued by public and private companies in emerging market countries. The assets could be denominated in any currency. Many of these countries had defaulted on bank loans in the 1980s and began the 1990s by converting defaulted commercial bank loans to restructured sovereign bonds, known as *Brady bonds*. While the early to middle 1990s might be thought of as the era of defaulted loans to global restructurings, the late 1990s onward will be thought of as the era of defaulted bonds to new bond restructurings. We discuss the defaults, restructurings, and current status of the asset class.

THE DEBT UNIVERSE

Emerging markets tradable debt stock is over US$3 trillion. The tradable debt universe expanded throughout the 1990s, but the rate of growth of debt generally was slower than the annualized growth rate of the economies. This is partly due to a collective improvement in fiscal stances throughout emerging markets that led to a reduced need to borrow.

I would like to thank Ryan McDuffy and Manmohan Singh for their review and helpful comments.

Domestic versus External Debt

Domestic debt is issued locally under the local laws of the country in which it is issued, whereas external debt is issued externally under the laws of a foreign country. Domestic debt comprises 77% of the total emerging markets tradable debt universe. The lower liquidity, frequent investment restrictions, varied practices, and higher convertibility risk make trading in domestic bonds more difficult for foreign investors than trading in external bonds. As a result, most emerging market investments by foreign holders are concentrated in external debt.

Among external bonds, the majority are sovereign bonds. The outstanding face value of external sovereign bonds in the market has reached US$440 billion as of year end 2003, with the vast majority of growth through issuance of *global bonds* or *Eurobonds,* terms that are often used interchangeably.[1] At the same time, the outstanding face value of sovereign Brady bonds has declined from US$170 billion to US$42 billion as a number of governments have either retired their more expensive Brady debt or defaulted.

Debt Stock by Region

Latin America and Asia continue to dominate the external tradable debt universe. Tradable debt excludes nontradable debt such as International Monetary Fund (IMF) loans but is not necessarily liquid debt. Tradable debt should not necessarily be considered debt qualifying for benchmark indexes because the latter has an additional requirement of liquidity for valuation purposes. Since 1999, the regional breakdown of outstanding debt has been relatively stable. Latin America now represents 48% of total debt outstanding; Asia, 25%; emerging Europe, 20%; and the Middle East and Africa, 7%. In the case of Latin America, high sovereign refinancing needs have resulted in higher levels of new issuance, and corporate borrowers continue to gain access to the international capital markets. In Asia, as countries have repaid emergency multilateral financing packages, they have issued increasing amounts of domestic bonds relative to external bonds, causing domestic debt to comprise 89% of the outstanding emerging Asian debt. In contrast, domestic debt is only 57% of the outstanding debt in Latin America. While the majority of external sovereign debt is from Latin America, domestic debt is large in both Latin America and Asia.

Diversification of Issuers

Since the early 1990s, there has been an expansion of the stock of external debt in terms of both the amount of debt per country and the number of countries issuing external debt. External debt issuance since 1996 has been running at an average rate

1. A Eurobond is a bond that is issued and sold to international investors and is not subject to registration. A global bond is a bond that is registered in the jurisdictions of the major financial centers.

of about US$70 billion annually compared with about US$30 billion during the early 1990s. Over half the issuance is sovereign debt. The increase in the number of issuing countries has been beneficial to investors seeking diversification whose investment performance is benchmarked against an index, because it has reduced the concentration of the largest countries in any of the major emerging market indexes. The major market indexes typically are comprised of outstanding external sovereign debt with sufficient liquidity to provide daily pricing. External bonds have few trading restrictions and therefore are of greatest interest to nonlocal investors. In contrast, local bonds in many countries have trading restrictions, preventing foreign investors from easily entering or exiting the market. In addition, sovereign bonds are more liquid than most corporate bonds and offer more accurate index valuation. In the last few years, investors have become increasingly interested in local currency investments, and such local market indexes are beginning to play a role in the asset class as well.

Since 1991 when the external debt market indexes began, the number of emerging market countries has increased from 4 to over 35. This was a result of large countries with bank loans converting those loans to bonds and smaller countries beginning to tap the external debt markets. For example, the Merrill Lynch Emerging Markets Sovereign Plus Index (IGOV) includes all emerging countries rated BBB+ or below and currently has a face value of about US$238 billion as of 2004. In this index, the five largest countries comprised 98% of the index in 1993 but only 66% over a decade later.

While 98% of the market capitalization at inception of the IGOV was concentrated in Latin America, over the last 12 years, eastern European, African, Middle Eastern, and Asian markets have gained market share. This has left Latin America with only 58% of both the face value and market capitalization of external debt qualifying for index inclusion. A similar diversification phenomenon is true of other major dealers' external debt indexes.

Quality of Emerging Market Countries

Emerging markets as an asset class actually have improved in credit quality. It is now a diverse asset class ranging from investment-grade credits to defaulted debt. The asset class was created from weak economies that were struggling to improve after the 1980s. Many countries have pursued macroeconomic policies that allow them to better weather external shocks and reduce their sensitivity to changes in capital flows; their credit quality has improved as a result.

Despite the difficulties surrounding the Russian default in late 1998, there have been many more positive than negative ratings actions since 1998. Emerging market indexes retain many of the improved countries owing to their historical presence in the asset class. Thus the percentage of investment-grade bonds in the major benchmark indexes has risen from about 8% in 1997 to a much larger representation in the 25% to 50% range depending on the particular index. The average credit quality also rose a notch from BB–/Ba3 to BB/Ba2.

The Investor Base

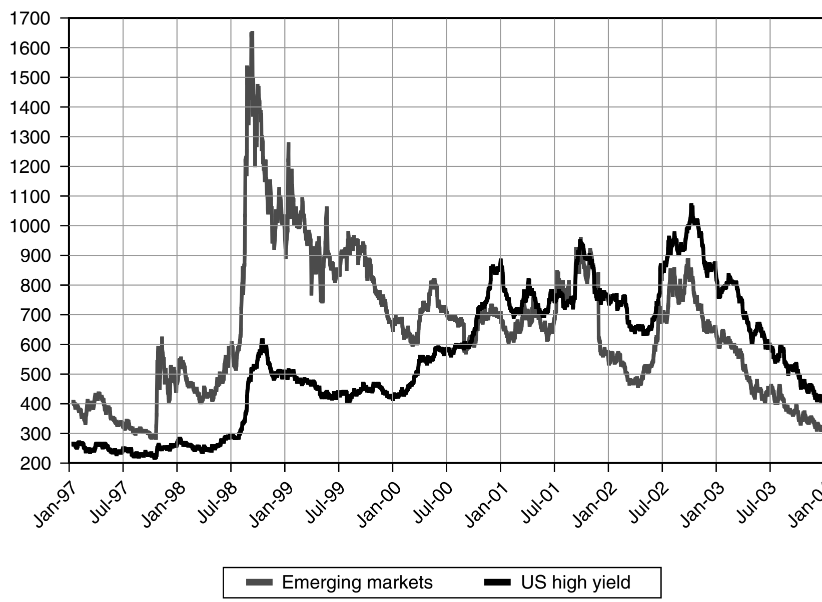
As a result of the growth of emerging markets debt and excess historical returns, the profile of the emerging markets' sovereign investor base has become more diverse. Ownership was once concentrated in the hands of a few creditor banks and dealers but now is distributed more widely through actively traded global bonds.

Thirty years ago, emerging markets debt was in the form of loans from commercial banks. In the 1980s, intermarket dealers traded participations in those loans. Originally, the principal nonbank investors were high-net-worth individuals from emerging markets countries. They were the first to realize that these countries had begun to "turn the corner," and in the late 1980s, they began to repatriate their funds by buying distressed assets. This, in turn, triggered a steady recovery in asset values, which was further supported by the subsequent issuance of Brady bonds.

The high returns on these bonds increasingly attracted institutional interest. The first institutional investors were the more aggressive fund managers (hedge funds, global growth funds, dedicated emerging markets funds, etc.) and broker-dealers (including major Wall Street firms and several of the original lending banks that had participated in the Brady exchange). Soon after, "crossover" investors from the domestic high-yield bond market (where yields were no longer as attractive) began to view emerging markets as an asset class to include in their portfolios (see Exhibit 20–1).

EXHIBIT 20–1

Emerging Markets and U.S. High-Yield Spreads (Basis Points)



Source: Merrill Lynch.

With the upgrade of Poland's Brady bonds to investment grade in 1996, U.S. corporate, Asian, and European investors became interested as well. The subsequent upgrades of Mexico and Korea to investment grade in 2000 and 2002 upgraded the asset class still further, with substantial high-grade investors then comfortably crossing over into emerging markets debt. *Higher returns play a key role as well.* Emerging markets outperformed, with a 41% return in 1996, bringing in more investors.

After the Asian financial crisis of 1997 and the Russian debacle in the summer of 1998, capital flows to emerging markets diminished drastically. Investors quickly reduced their willingness to assume risk (flight to quality) and deserted higher-yielding assets for safer, more liquid bonds. The fear of contagion only worsened the financial crisis because developing countries were unable to raise new financing in the international capital markets. With global markets under severe pressure, the hedge-fund community collapsed and was forced to liquidate, resulting in massive price declines.

In succeeding years, however, the market has matured, as evidenced by the increase in the quality of the investor base and of the issuer base. Liquidity has improved, and volatility has declined. In addition, despite the size of Argentina's default, most of the countries "decoupled" from contagion during the year prior to its collapse, lending confidence to investors that some crises can be avoided.

As U.S. interest rates reached 45-year lows toward the middle of the 2000 decade, demand for emerging markets assets appeared from more conservative investors. A broader range of insurance companies and pension funds, in search of higher yields and diversification, began investing in emerging markets. With relatively low financing costs and many newly formed hedge funds offering the potential of levered returns, the demand for assets grew even greater.

In addition, crossover investors are motivated by the composition of the indexes against which they are benchmarked. The increasing use of broader indexes that include the BBB or better emerging markets sovereign bonds, such as the Merrill Lynch U.S. Broad Market Index or the Lehman Aggregate or Universal indexes, has brought crossover investors into emerging markets.

Since the end of the stock market bubble in 2000, pension and insurance portfolio managers have sought greater diversification. This has taken the form of nontraditional investments, such as emerging markets debt and equity, hedge-fund investments, real estate, and commodities. The wider distribution of investors provides further support for emerging markets as an asset class.

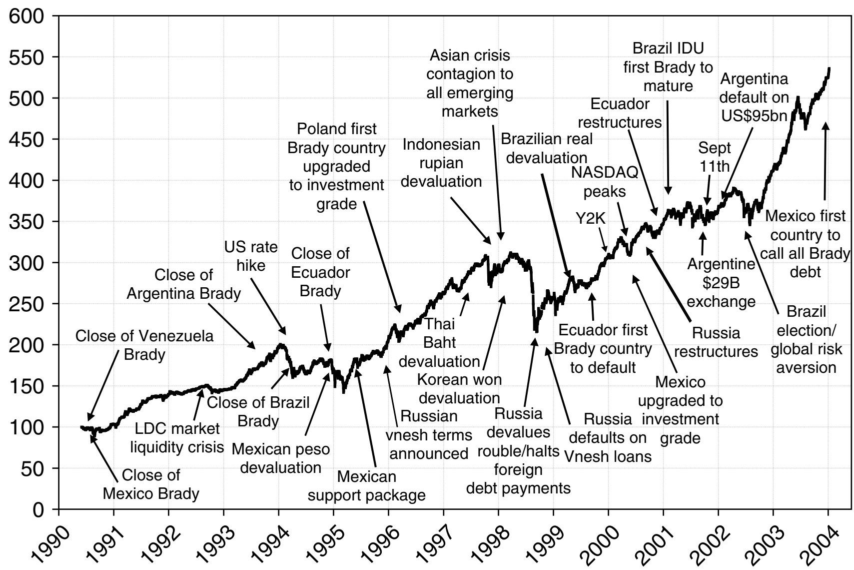
EMERGING MARKETS DEBT PERFORMANCE HISTORY

Historical Returns

Emerging markets debt has produced one of the highest returns among major asset classes. The performance of the Merrill Lynch sovereign IGOV index since December 1991 is shown in Exhibit 20–2. For the first 12 years, cumulative returns for the asset class have totaled 368%, far above the average cumulative

EXHIBIT 20–2

Total Return of Merrill Lynch Emerging Market Index as a Percent of Original Investment



Source: Merrill Lynch. The IGOV index was extrapolated to 1990 based on prices of the few Brady bonds that were outstanding before the index was created.

returns of 178% for U.S. high-yield bonds or 125% for U.S. Treasuries over the same time period. In comparison, cumulative returns of U.S. equities were approximately 106%, whereas emerging market equities posted a 6% decline. Over these 12 years, on an annualized basis, emerging markets debt has provided a 13.7% return compared with 8.9% for the U.S. high-yield market (see Exhibit 20–3).

A small part of this return is due to the Treasury rally. From the inception of the indexes, U.S. Treasury rates have fallen less than 300 basis points, or less than 25 basis points per year for the first 12 years. This accounts for about 1% of the annual return.[2] The remainder of the return can be attributed to the coupon income and price appreciation (due to spread tightening and the steady aging of low-priced bonds as they accrete to par). The end of this period came with Treasury yields reaching historic lows and emerging markets spreads simultaneously touching historically *tight* levels, providing annualized returns that could not be replicated over the subsequent 12 years.

2. A spread tightening of 25 basis points would increase the index value by 1%.

EXHIBIT 20–3

12-Year Total Return, Volatility, and Sharpe Ratio (Annualized)

	Total Return	Volatility	12-Year Sharpe Ratio
EM debt	13.7%	16.0%	0.58
U.S. high yield	8.9%	6.4%	0.70
U.S. Treasury	7.0%	4.6%	0.57
U.S. corporates	8.0%	4.8%	0.76
U.S. mortgages	7.0%	3.0%	0.88
Equity			
S&P equity	10.7%	14.7%	0.43
Europe equity	7.7%	17.4%	0.19
EM equity	5.9%	23.1%	0.06

Note: Equity indexes with dividends.

Source: Merrill Lynch, Bloomberg. Sharpe ratio is excess return over a risk-free return divided by volatility.

Volatility and Sharpe Ratios

Periodic crises in emerging markets have brought volatility along with high returns. Over the long term, while emerging markets debt has provided an annualized 13.7% return, it has come with a 16% annualized volatility (see Exhibit 20–4). Higher risk should come with a higher return. A risk-adjusted return measure, the Sharpe ratio, is used often for equity investments. It is measured as the ratio of the return in excess of the risk-free rate divided by the volatility.

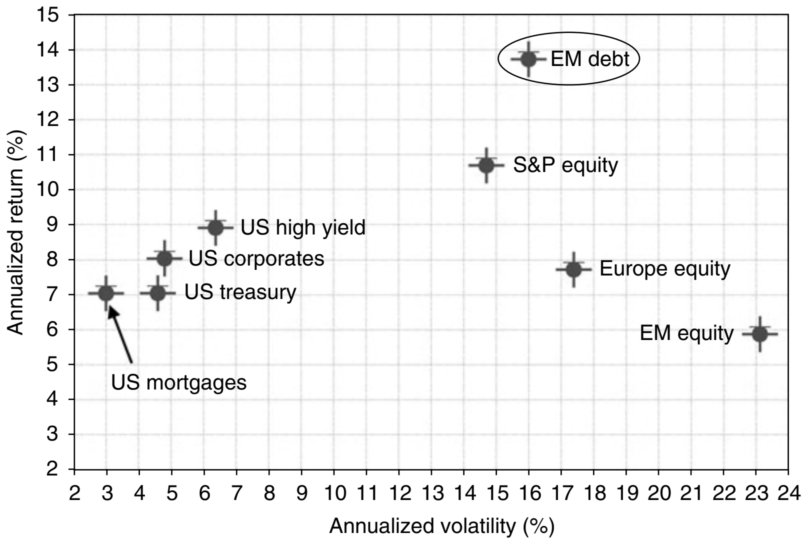
The Sharpe ratio for the last 12 years in emerging markets debt is about the same as that of U.S. Treasuries owing to the high emerging markets volatility. Mortgages have had the highest Sharpe ratio. From a Sharpe ratio perspective, emerging markets debt would have been a better investment than European or emerging markets equity, the latter two having historically high volatility and low returns.

Correlation with Other Asset Classes

Emerging markets debt has had a weak correlation with U.S. Treasury bonds, as well as with U.S. corporate bonds and mortgages (see Exhibit 20–5). The highest correlation is with the U.S. high-yield market (0.52). Low correlations give emerging markets an important role in a global portfolio. Until late 1997, emerging markets debt was very highly correlated with U.S. Treasuries. But the flight to quality during the Russian debt crisis ended that relationship. Since the Russian crisis, emerging markets returns have been far less correlated with those of the U.S. Treasury market.

EXHIBIT 20–4

12-Year Annualized Return versus Volatility



Note: Equity indexes with dividends.

Source: Merrill Lynch.

EXHIBIT 20–5

Intermarket Correlations after the Russian Crisis

	EM Debt	U.S. High Yield	U.S. Treasuries	U.S. Corpo-rates	Mort-gages	S&P Equity	Europe Equity	EM Equity
Emerging markets debt	1	0.52	0.09	0.34	0.17	0.47	0.47	0.61
U.S. high yield		1	–0.07	0.34	–0.01	0.46	0.37	0.57
U.S. Treasury			1	0.85	0.82	–0.35	–0.46	–0.37
U.S. corporates				1	0.76	–0.08	–0.26	–0.10
Mortgages					1	–0.25	–0.31	–0.31
S&P equity						1	0.85	0.75
Europe equity							1	0.72
EM equity								1

Note: Equity indexes with dividends; period from 1999–2003.

Source: Merrill Lynch, Bloomberg.

Liquidity

Average trading volume of emerging markets debt is usually about US$16 billion per day. There have been exceptions, with a temporary decline in the year following the Russian crisis to only US$9 billion per day and another drop in 2002 when global equities declined and risk appetite was low.

Many high-yield bond portfolios include some emerging markets debt, and thus high-yield managers represent an important source of "crossover" investors. Important to many fund managers is the debt in benchmark indexes. While the Global Emerging Market External Sovereign Plus Debt Index (IP00) is less than half the size of the Global High Yield Index (HW00), the liquidity is better in emerging markets. There are fewer but larger issues in emerging markets debt indexes; the average issue size is over four times larger, making pricing more transparent and bid-ask spreads narrower. Thus emerging markets debt plays a key role in high-yield portfolios, offering greater liquidity when needed.

BRADY BONDS

In 1989, the Brady Plan was introduced, named after former U.S. Treasury Secretary Nicholas Brady. It provided debtor countries with debt relief through restructuring their commercial bank debt at lower interest rates or allowing them to write it down, enabling them to exchange that debt for tradable fixed income securities. In return, the developing countries agreed to adopt macroeconomic reforms. Banks were given the choice of mainly debt (face) or debt-service (interest) reduction options. By the late 1980s, many banks had provisioned as much as 60% of the face value of their commercial loans to less developed countries (LDCs). Since some commercial banks at that time held these assets at face value, an equal face exchange enabled these banks to participate in a restructuring in which the LDC obtained some formal debt relief.

The Brady Plan grew out of the LDC debt crisis of 1982–1988. In the early 1980s, sluggish growth of industrial countries, rising global interest rates, and falling commodity prices triggered a significant economic contraction in developing countries. As a consequence, isolated from the international capital markets and lacking the level of domestic savings needed to service external obligations, most developing countries began to experience severe debt-servicing problems. The first strategy adopted to address the crisis was a program of new lending by commercial banks and multilateral organizations combined with structural adjustment efforts by the debtor countries. By 1988, it had become clear that this strategy was less than successful; the LDCs were not emerging out of the debt crisis, and a new strategy involving "debt relief" was necessary.

A total of 17 countries took advantage of the program from 1989 to 1997, issuing a cumulative face value of US$170 billion of Brady bonds.[3] The majority

3. Russia is often considered part of the collection of Brady bonds because it was restructuring defaulted debt during the era of Brady restructurings. It did not, however, conform to the actual Brady Plan.

EXHIBIT 20–6

Original Brady/Exchange Issue Amounts (US$ billion) and Multilateral Debt Relief Agreements with Commercial Banks

Country	Total Brady Debt Issued	Percent of All Bradys	Official Debt and Debt Service Reduction Agreement Date	Debt Forgiveness in Exchange Agreement	Moody's Update	Standard & Poor's Update
Latin America						
Argentina	25.45	15.0%	Apr-93	35%	Default	Default
Brazil	50.66	29.9%	Apr-94	35%	B2	B+
Costa Rica	0.59	0.4%	May-90	na	Ba1	BB
Dominican Republic	0.52	0.3%	Aug-94	35%	B2	CCC
Ecuador	6.13	3.6%	Feb-95	45%	Caa2	CCC+
Mexico	36.90	21.7%	Mar-90	35%	Baa2	BBB–
Panama	3.22	1.9%	May-96	45%	Ba1	BB
Peru	4.87	2.9%	Nov-96	45%	Ba3	BB–
Uruguay	1.07	0.6%	Feb-91	na	B3	B–
Venezuela	18.55	10.9%	Dec-90	30%	Caa1	BB–
Non-Latin America						
Bulgaria	5.13	3.0%	Jul-94	50%	Ba2	BB+
Poland	7.90	4.7%	Oct-94	45%	A2	BBB+
Ivory Coast	1.33	0.8%	May-97	50%	NR	NR
Jordan	0.74	0.4%	Dec-93	35%	Ba2	BB
Nigeria	2.05	1.2%	Jan-92	na	NR	NR
Philippines	4.21	2.5%		na	Ba2	BB
Vietnam	0.55	0.3%	Dec-97	50%	B1	BB–
Russia	26.0	na*	Dec-97	0%	Baa3	BB+
TOTAL	169.88	100%				

Source: World Bank, Global Envelopment Finance, 1999 Analysis and Summary Tables, Merrill Lynch.
*Russia was not technically a Brady structure but was similar and is often included in the amount of global debt issued in the 1990s in exchange for defaulted bank loans from the 1980s.

of Brady debt was issued by Latin America, with Brazil, Mexico, Argentina, and Venezuela representing 78% of all issued Brady bonds (see Exhibit 20–6). Almost all countries with defaulted commercial bank debt from the 1980s exchanged that debt for Brady bonds or restructured loans. Since then, most countries have been able to improve their financing budget and subsequently have been able to raise more funds in the Eurobond market. The notable recent exceptions are Argentina, Ecuador, Ivory Coast, and Uruguay. The first three countries defaulted, whereas

Uruguay conducted a successful restructuring of its debt at a time of distress without having to default. The well-known default of Russian restructured debt in 1998 was not issued under the Brady Plan but was noteworthy because of the short period that the restructured debt paid coupons (less than two years), the size of the default, and the disastrous impact it had on global markets.

Types of Brady Bonds

The term *Brady bond* refers to a series of sovereign bonds issued by these developing countries in exchange for their rescheduled bank loans. The Brady market is unique in several respects. First, yields always have been higher than on non-Brady bonds. Second, some issues were extremely large and liquid, especially compared with typical sovereign Eurobonds. Third, since the goal of restructuring the debt was to give the sovereign debt service relief in the early years, no bond was a simple fixed-rate bullet bond with all principal paid in a single maturity year. Instead, every bond had at least several combinations of features, including step-up coupons, floating-rate coupons, amortizations, long grace periods before principal began to be repaid, capitalizations, and principal and interest collateral.

Typically, in a Brady exchange for the illiquid defaulted loans, the banks were given several options, one of which included an exchange of defaulted loans for partially collateralized "discount bonds," also known as "principal-reduction bonds." These bonds required 35% to 50% forgiveness on the face value of the defaulted loans, thus providing the sovereign with debt relief (in terms of the principal amount, or "stock of debt"). They offered a "market" coupon rate of LIBOR+13/16, although a true market coupon would have been hundreds of basis points higher. "Par bonds" were issued at "par," in exchange for the original face value of the rescheduled loans, but carried a fixed, below-market interest rate. In addition, investors were given a "past-due-interest bond" whose face value was the amount of past-due interest that had accrued between the payment prior to default and the exchange date.

As each successive Brady exchange took place, the terms typically progressed more in favor of the sovereign. "Haircuts," or forgiveness (the reference to the reduction of principal due to restructuring), crept higher, collateral decreased, and creative ways were used to implicitly reduce the past-due interest calculation.

The particular bond types were chosen by creditors to provide debt and debt-service relief to the sovereign issuer. During the negotiations, creditors were presented with a choice of possible debt restructurings and were given several months in which to choose. At the time of the presentation, all options were equally attractive and produced roughly the same net present value. In their selection, some creditors were constrained by their own internal accounting requirements, whereas others were able to select the bond that provided the highest present value. Typically, these decisions were influenced mainly by the expectation of the sovereign's spread risk and movements in the U.S. Treasury market. A description of the types of Brady bonds that were issued can be found in the Appendix to this chapter.

Exchanges from defaults in the post-Brady era also have included significant haircuts. Investors have had fewer choices, and pressure to participate has been great for a variety of reasons addressed later. Exhibit 20–6 lists the Brady countries with their respective exchange dates, debt forgiveness, and current credit rating.

Brady Bond Valuation

Because almost all restructured bonds offered lower debt service in the early years, no Brady bond was a simple fixed-rate bullet bond with the principal paid entirely in a single maturity year. To account for the complicated features, emerging markets investors need to be more bond-structure-savvy than comparable investors in the high-grade or high-yield markets.

For example, a bond with collateral requires a somewhat different method of assessing value rather than merely calculating yield-to-maturity based on price. Investors value collateralized bonds by "stripping out" the collateral, giving rise to the terms *stripped yield* and *stripped spread*. Similarly, valuation of amortizing or capitalizing bonds requires a more sophisticated approach because the timing of any cash flow is crucial in determining its value. A description of the most common methods for bond valuation can be found later in this chapter.

Retirement and Exchanges of Brady Bonds

Since the issuance of the first Brady bond in 1989, many countries have implemented economic reforms sufficiently to enable them to access the capital markets in the form of Eurobonds and global bonds, which are issued and sold to international investors. Simultaneously, many countries have made a concerted effort to retire their expensive Brady debt through various forms of buybacks. The Brady bonds that were retired through exchanges typically had lower coupons and lower prices but higher spreads than the Eurobonds that replaced them, thereby offering the sovereign net present value (NPV) savings, important economically as well as politically.

Most of the retirements were made possible by the regained confidence of the international capital markets. This enabled investors to exchange complicated structures of Brady bonds with a tainted history for clean, simple global bonds. After describing the main mechanisms for positive exchanges, we discuss in detail several distressed exchanges—as well as exchanges out of default—since 1999. The details of these exchanges are instructive in that they set precedents for future exchanges.

Public exchanges, which began on a small scale with Argentina in 1995 and on a much larger scale with Mexico in 1996, offered specific Eurobonds in exchange for one or more Brady bonds. Most of the exchanges, while keeping market capitalization fairly constant, replaced Brady bonds priced much below par with new Eurobonds priced close to par, resulting in smaller face of the new issue. These exchanges had the added benefit of reducing the total stock of debt (face) outstanding. The exchanges produced large multi-billion-dollar issues that are liquid and actively traded, led by the Brazil 2027, Mexico 2026, and Venezuela 2027.

Since issuance, sovereign issuers of Brady bonds have been able to retire Brady debt through several main approaches:

- The issuer may exercise the call option on the bond, as Mexico has done with all its Brady debt and Poland with much of it. All Brady bonds are callable at par, usually on coupon payment dates. If the bonds are called, they must be retired.
- The sovereign country may discreetly buy back their Brady bonds in the open market, as did Argentina, Brazil, Mexico, Panama, and Poland.
- A sovereign issuer may initiate a formal Brady exchange program, whereby a price or spread is preset, and bids are solicited for an exchange into a new Eurobond issue. In 1996, Mexico was the first sovereign country to participate in a large-scale Brady-to-Eurobond exchange. At that time, emerging markets were providing extremely high returns, spreads were consistently tightening, and investors were glad to have an opportunity to exchange their collateralized Mexican par and discount bonds for a noncollateralized global issue that would outperform if spreads continued to tighten. This set the tone for subsequent formal exchanges that included Argentina, Brazil, Mexico, Panama, Uruguay, Venezuela, and the Philippines.
- The issuer may offer a formal exchange into local debt. Argentina swapped numerous external bonds for local debt, with a commitment to pay the debt service from tax revenues.
- The sovereign may agree to a private exchange, whereby two to four holders of a sizable block of Brady bonds would agree to an exchange for a reopening of an existing sovereign Eurobond.
- The sovereign may accept Brady bonds as payment in certain privatizations, particularly in Brazil.
- The sovereign may default on the bonds (Argentina, Ecuador, Ivory Coast, and Russia, although the Russian default was on debt that was not technically part of the Brady Plan).
- The issuer pays amortizing principal on schedule. Most amortizing Brady bonds have been repaying large amounts of principal. In 2001, Brazil's IDU (Interest Due and Unpaid) bond became the first Brady bond to actually mature.

This trend of replacing Brady bonds for global or Eurobonds has been favorable to investors because the new bonds are far less complex than the Brady bonds they replaced, thus appealing to a wider audience.

At the beginning of 2004, only about 25% of the original $170 billion Brady bonds remain outstanding. Simultaneously, most countries have issued global bonds and Eurobonds as one of their main sources of external funding, overtaking the Brady debt as the most liquid bonds in emerging markets debt.

DEFAULTS, EXCHANGES, RESTRUCTURINGS, WORKOUTS, AND LITIGATION

Successful Distressed Debt Exchanges

Any exchange in an emerging market can set a precedent for future exchanges. This includes both distressed debt, prior to and averting a default, as well as defaulted debt exchanges. Just as each new Brady exchange offered terms that may have been less beneficial to the bondholder, each successive defaulted global bond restructuring is likely to get similar or less favorable treatment than the restructurings before it. Below is a description of the major distressed and defaulted restructurings since 1999.

Pakistan, 1999: Orderly Exchange Avoided Default

Pakistan, which did not have Brady debt, was current on its external bonds prior to its 1999 voluntary exchange. At that time, it rescheduled over US$600 million in external global bonds. It exchanged three bonds maturing over the next three years for new securities maturing in six years. About 90% of the bonds were exchanged. Investors were concerned about Pakistan's ability to make the next debt-service payment. The bond exchange was part of a larger restructuring of US$3 billion in debt, including that from government and development bank creditors, increasing the likelihood that bondholders would get paid. The bond offer prompted Standard & Poor's to downgrade the nonexchanged bonds to a default rating (D) because the exchange prevents the existing debt from being repaid on time. It was the first time Standard & Poor's had downgraded a country to the default level.

Ukraine, 2000, and Moldova, 2001: Avoided Default

Both the Ukraine and Moldova proposed a reasonable restructuring prior to payment default. Both countries had only a very small amount of global (non-Brady) debt, which was not widely held. Both countries were cash-poor, and investors were pessimistic regarding any solution to the sovereign crisis without international support, despite the fact that this support included the extension of external principal payments for several years.

Uruguay, 2003: Orderly Exchange Avoided Default

Uruguay was current on its debt service prior to its 2003 voluntary exchange, but there was great concern that the spillover effect from the contraction in neighboring Argentina was making it impossible for Uruguay to maintain its fiscal accounts because Uruguay's primary trading partner is Argentina. Prior to Argentina's default, Uruguay had an investment-grade rating. Uruguay exchanged US$4.9 billion of Brady and global debt for new securities that mature later and pay lower interest, stretching out debt payments. The exchange gave Uruguay a fiscal surplus and enabled it to draw on IMF loans, regaining investors' confidence in its ability to pay debts and revive the economy. Over 95% of the eligible bonds were exchanged, one-third of which were issued under local law.

Standard & Poor's called the swap a default and rated the nation's long-term foreign currency debt at about five levels below investment grade after investors received the new bonds. The rationale was that the new bonds, with both a longer maturity and a lower coupon, were worth less than the old bonds in NPV terms.

Unsuccessful Distressed Debt Exchange

Argentina, 2001: Exchanges Not Sufficient to Avoid Default

In the year preceding its December 2001 default, Argentina conducted two large exchanges of debt in an effort to reduce near-term debt service by extending maturities and lowering cash coupon rates. In June of 2001, Argentina conducted its "megaswap," exchanging close to US$30 billion of local, external global and external Brady debt, much of it coming due in the near future. It swapped that debt for four external bonds, most of which paid no cash coupon for five years but instead capitalized and then stepped up to a high 12% coupon (Exhibit 20–7). Some investors, mostly local investors, hailed the exchange as the solution to Argentina's debt problem. Others were less optimistic, fearing the country's borrowing costs would soar after 2006.

Argentine local banks and pension funds were active participants in that exchange. The attractive feature for Argentina was that it significantly reduced debt service for close to five years. Yet investor confidence did not rise sufficiently, and Argentina's continued funding needs could not be sustained. In November it subsequently exchanged Brady and Eurobond debt for local loans. This exchange originally was only open to local investors, but participant restriction eventually was relaxed. The exchange was viewed as coercive; Standard & Poor's downgraded all eligible bonds to a default rating (D). Within a month, the sovereign declared a moratorium on the payments of US$95 billion of external debt, the largest sovereign default in history.

EXHIBIT 20–7

Argentina's "Mega" Exchange, June 2001

Face	Maturity	Currency	Initial Coupon	Step-up Coupon
US$11.5 billion	2008	USD	7%	15.5%
US$7.5 billion	2018	USD	Capitalizing	12.5%
US$8.5 billion	2031	USD	Capitalizing	12.0%
ARP0.9 billion	2008	Peso	10%	12.0%

Source: Merrill Lynch.

Restructuring after a Default

Below is a summary of the large Russian and Ecuadorian defaults and subsequent restructurings, together with a description of the much larger and more complex Argentine default in late 2001.

Russia, Ecuador, Ivory Coast, and Argentina defaulted on their restructured debt in 1998, 1999, 2000 and 2001, respectively. Russia's debt was not formally under the Brady Plan, but it was restructured debt that was current for only slightly over a year. Ecuador was the first country to default on Brady bonds. In 2000, both countries restructured their US$40 billion defaulted debt into US$27 billion of Eurobonds. Ivory Coast defaulted in 2000, but creditors did not vote to accelerate the bonds, likely because the size was small, as was their ability to pay.

Russia Defaulted Debt Characteristics

Russia defaulted on local debt and US$32 billion in two external debt obligations from the Soviet era Vnesheconombank, a loan and a bond, neither of which cross-defaulted to Russian federation external bonds. Russia did not default on any of its Russian-issued Eurobonds. The principal debt obligation was a participation loan that traded as low as $6.

Ecuador Defaulted Debt Characteristics

Ecuador was more diverse, with six bond issues totaling US$7.7 billion face. The PDIs (Past-Due Interest Brady bonds) were the only liquid, noncollateralized Brady bond. The Ecuador 2002 was an extremely illiquid global bond issued in 1997 and held primarily by banks. The only other global bond outstanding never traded. In the end, the two global bonds received preferential treatment, but the time frame in which investors could address inequities was too short to allow them to act on it. The "haircuts" for all but the IEB bond were determined in a consistent fashion—all cash flows of defaulted debt of these bonds were discounted at 11.25% (the rate of the most recently issued fixed-rate Eurobond). Investors received new bonds whose face value was based on this NPV.

The IEBs (Interest Equalization Bonds) had differential treatment. Since over 50% of the IEBs were held by a single investor, in order to encourage participation in the exchange, the bond received better terms than the other Brady bonds. For the new bonds, nonfinancial terms were used as leverage to encourage participation. In addition, investors were caught by surprise with only about two weeks between the exchange offer announcement and the date in which to accept the offer. A minimum participation rate was specified. If there was a failure to meet the minimum participation rate, additional past-due interest would accrue, and the structure would no longer be viable. This forced investors to act rather than to argue over inequities.

In addition, if Ecuador defaults on this new debt, bondholders can revert to their original claims (higher face value) that existed before this exchange took place, thus offering further protection.

EXHIBIT 20–8

Status at the Time of Default (US$ billion)

Country	Argentina	Russia	Ecuador
Debt stock at time of default	$148	$171	$17
Defaulted stock of debt	$95	$25 external $40 local	$6.4
Debt/GDP shortly after default	113%	63%	124%
Debt/exports shortly after default	416%	241%	313%

Source: Merrill Lynch.

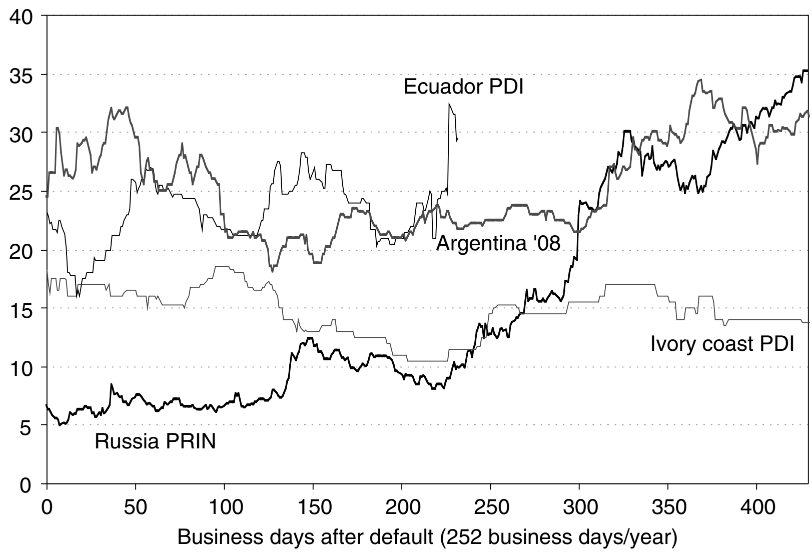
Argentina Defaulted Debt Characteristics

While the agreements of the Russian and Ecuadorian exchanges offer a guide to investors on how the next restructuring might unfold, the Argentine restructuring is more complex for several reasons. First, the size and disparity are enormous—US$95 billion total face defaulted external debt obligations cover over 80 individual external bond issues in eight legal jurisdictions and in multiple currencies. Second, there are many more disparate parties with their own agendas coming to the negotiating table. Many of the investors are original or early holders, who need a less negative return on their investments. They thus may push hard to get better terms than those of the recent Russian exchange. The Russian debt originated from Soviet loans and had a tumultuous history, having been through a default, a restructuring, and another default. Most of the debt had turned over and, at the time of the restructuring, was held by investors who bought it at extremely depressed prices. Restructured values in Argentina likely will be lower than those in Russia. A comparison of Russia, Ecuador, and Argentina's debt ratios at the time of default is shown in Exhibit 20–8. Defaulted bonds do trade, although far less than paying bonds. A view of bond prices after default is shown in Exhibit 20–9. A description of the new bonds and the terms of the exchanges from defaulted debt to new bonds is found in Exhibits 20–10 and 20–11, which describe the important precedent-setting terms for future exchanges. An indication of spreads of new bonds after an exchange is given in Exhibit 20–12. At the end of 2003, Argentina owed multilaterals (such as the IMF and World Bank) US$30 billion and subsequent to the default had issued a sizable amount of senior local market U.S. dollar–denominated debt (over US$20 billion).

Exchanges typically have three components: principal, past-due interest, and cash. *Principal* often has a "haircut," or reduction in face, and is replaced with a long bond. *Past-due interest* typically is treated better than principal, with part of it paid on exchange in the form of *cash,* little or no haircut, and with exchange bonds that are typically intermediate bonds rather than the longer principal bonds.

EXHIBIT 20–9

Defaulted Bond Prices Immediately Following Default (Day 0 = Default Date)



Source: Merrill Lynch.

Because of its complexity and depth, the terms of the Argentine restructuring could be worse than in prior exchanges. As an example, Argentina suggested 75% forgiveness of debt, which was unprecedented by historical standards. Argentina also suggested total forgiveness of past-due interest. With an average coupon of 10% and likely three years between default and restructuring, investors who expected to get \$30 face of an intermediate bond for every \$100 face of defaulted debt immediately rejected the suggestion.

Several lawsuits were brought on the payment of the currently outstanding debt. This sovereign bankruptcy on bonded debt marked the first time many disparate foreign bondholders united in an organized committee in the United States and another in Europe, with strong objections to the framework proposed by Argentina.

Foreign and local investors have different objectives. Argentine pension funds were allowed and even encouraged to invest up to 50% of their assets in sovereign debt, thus ensuring large demand for the many global bonds that were issued in the 1990s. During most of that time, Argentina's peso was pegged one-for-one with the U.S. dollar. One month before Argentina defaulted on its external debt, most of the pension fund holdings of external debt were exchanged for local loans that were senior to the external debt, although the coupons were lower and the maturities had been extended. The focus of the Argentine restructuring is equitable burden sharing.

EXHIBIT 20–10

Description of Newly Restructured Bonds

	Date of Default and Years to Restructure	Principal Bond	Past-Due Interest Bond
Russia	1998	30-year (Russia 2030)	10-year (Russia 2010)
	1.9 years to restructure	US$18.4 billion	US$2.8 billion
		Amortizing	Amortizing
		Step-up coupon 2.25% to 7.5%	8.25% coupon
		Noncallable	Noncallable
		Obligation of Russian Federation, though PRINS were Soviet obligations	Obligation of Russian Federation, though PRINS were Soviet obligations
Ecuador	1999 default	30-year (Ecuador 2030)	12-year (Ecuador 2012)
	1 year to restructure	US$2.5 billion	US$1.25 billion
		Step-up coupon 4% to 10%	12% coupon
		Callable at par	Callable at par
		Sovereign must pay down principal on a schedule through par call or open market	Sovereign must pay down principal on a schedule through par call or open market

Source: Merrill Lynch.

The Role of the IMF

The Western nations established the International Monetary Fund (IMF) and the World Bank after World War II as "permanent machinery" to anchor the Bretton Woods system. When developing countries began experiencing debt problems in the late 1960s, the Paris Club was formed to restructure debt from export credit agencies. A decade later, the London Club was formed to deal with workouts of commercial bank debt. After the decade of the 1990s, during which countries had a significant amount of outstanding bonds rather than loans, restructuring defaulted debt required a new process. The IMF and the U.S. Treasury have played significant roles in proposing a permanent mechanism to deal with defaulted bonded debt.

A sovereign default can have global implications. Sovereigns issue their own currency and indirectly backstop the banking system. Sovereign debt is a more important asset in a country's financial system than the debt of a company,

EXHIBIT 20–11

Summary of Terms of Ecuador and Russia Foregiveness and Features

	Bond	Principal Collateral (PV)	Price 1 Month before Default	Price 2 Months before Restructuring	Principal Haircut of Face	Amount PDI and Past Due Principal	PDI Foregiveness	Cash Payment
Ecuador	Par (principal Brady)*	23.5*	37	35	60%	5.0	0	4.1
	Disco (Principal Brady)*	23.5*	42	38	42%	8.2	0	4.7
	PDI (Brady)	0	29	21	22%	5.5	0	2.0
	IEB (Brady)†	0	NA	NA	0	23.5	0	22.2
	2002 (Eurobond)	0	NA	NA	0	15.7	0	12.0
	2004 floater (Eurobond)	0	NA	NA	0	15.0	0	11.3
Russia	PRIN (principal restructured loan)	0	8.75	31.125	37.5%	10.7	0	1.0
	IAN (restructured interest arrears note)	0	10.4	30.625	33%	9.1	0	0.9
Argentina	80 different bonds		43–50	Under 30 by1/04		20–25 by 1/04		

*Principal collateral was paid in cash at approximate market price; description of Brady bonds is in Appendix to this chapter.

†Majority held by a single investor.

Source: Merrill Lynch.

EXHIBIT 20–12

Sovereign Spreads (Basis Points) Just after Issue

	Time After Exchange		
	1 Week	**1 Month**	**1 Year**
Russia			
PDI (2010)	882	1043	883
30-year bond	925	1083	981
EM IGOV index	578	619	758
30-year spread over index	347	464	223
Ecuador			
PDI (2012)	1343	1202	1428
30-year bond	1309	1286	1405
EM IGOV index	645	620	753
30-year spread over index	664	666	652

Note: Merrill Lynch IGOV index consists of emerging markets sovereign bonds rated BBB or below and denominated in U.S. dollars.

Source: Merrill Lynch.

and it plays an important role in the banking system. The IMF can provide a means of providing new money in the absence of any established or enforceable system of priorities. Historically, the condition for receiving IMF support is that a sovereign must not only adhere to IMF targets for inflation, fiscal deficits, and exchange-rate controls, but also the sovereign *must* repay the IMF. There has never been IMF debt forgiveness, except in the case of some highly indebted poor countries (HIPCs), such as Nicaragua or Rwanda.

Consider the case of a sovereign that is having a liquidity shortage, perhaps stemming from fears of the country's solvency. In such a case, the IMF can offer credit, linking the financing to policy adjustments to address fears about solvency. When that support is sufficient, the sovereign can regain investor confidence (e.g., Brazil, Uruguay). At other times, when the support is insufficient or when there is no agreement by the sovereign, a default or moratorium on payments could occur (e.g., Argentina, Russia).

Distressed Debt Market-Related International Litigation

No Bankruptcy Court

There is no bankruptcy court for sovereign defaults, such as that for corporate defaults. Therefore, the outcome of most sovereign defaults is either the resumption of payments or, in most cases, a distressed exchange. The absence of a formal bankruptcy process clouds sovereign debt restructuring. There is a debate on reforming the international financial system, with a primary focus on the need for a sovereign debt-restructuring process that would limit the risk that litigation could disrupt or delay a debt restructuring. Yet, in many cases, progress is impeded by interference from "holdout" investors. These investors do not participate in the restructuring, yet will demand payment on the original contractual agreement or will negotiate a preferred settlement for themselves through litigation. These investors typically are distressed debt funds that have large enough positions and the means to engage attorneys to sue the sovereign and then to attach assets. Furthermore, no restructuring would be possible if too many creditors did not participate. Therefore, there is a need for making the sovereign debt-restructuring process swift and orderly, reducing the holdout risk. Without a process in place, there is a fear that concerned investors would be inclined to sell their bonds before the event of default, thus actually speeding the decline and preventing the sovereign from constructing a solution.

Pari-Passu Clauses and Sovereign Immunity

Investors have won judgments against a sovereign issuer in default. However, in contrast to corporate defaults, it is very difficult to attach the assets of a sovereign.

There is a more favorable legal climate in continental European law than that in Britain and the United States for attaching assets. In continental Europe, successful litigators have attached the Central Bank's assets of a sovereign whose claims they are holding.[4] In addition, central banks that are incorporated separately for commercial purposes do not enjoy immunity; only the sovereign does. The Foreign Sovereign Immunities Act of 1976 precludes a waiver of immunity of prejudgment attachment of the accounts of a foreign central bank. Since then, a number of common-law countries have adopted similar legislation on sovereign immunity. On the other hand, in continental Europe, foreign central banks generally are treated as entities separate from the foreign state, and as a consequence, the assets of central banks enjoy little or no protection. Deutsche Bundesbank, during one litigation case, considered amending the law (via Parliament) on the nonimmunity provided to a sovereign whose assets are deposited with a German bank.[5]

These laws have an impact on nonparticipants in distressed exchanges. Another avenue open to nonparticipants involves wire transfers. In the United States, an attachment order can only reach wire transfer either before it is initiated or after payment is completed. However, Europe does not have an equivalent law. A distressed investor was able to intercept payments from a sovereign on restructured debt to bondholders in Europe.[6]

4. Cardinal versus Yemen and Leucadia versus Nicaragua.
5. Cardinal versus Yemen.
6. Elliot versus Peru.

Two Well-Known Holdout Cases Have Set Adversarial Precedents

Dart versus Brazil

The Dart family held US$1.4 billion principal claim of defaulted Brazilian loans before the Brady exchange in 1993, for which they had paid about 30 cents on the dollar. The face value-of-claim was US$2.2 billion of principal plus interest. In the litigation, there were no attachments or accelerated payments. The original debt instruments were securitized in a pass-through trust vehicle, and payment is being made in full by Brazil on the original maturity schedule.

Elliot Associates versus Peru

The practices of “vulture funds” that buy cheap sovereign debt in the secondary markets and then sue for full repayment plus interest came to international attention in the case of Peru. Elliot Associates LP, a New York–based hedge fund, purchased pre-Brady loans at a deep discount in 1996 and then actually took the government of Peru to court instead of opting for a restructuring agreement. It won the legal battle, and the Peruvian government eventually paid it more than US$58 million.

This incident is one of the few times a single bondholder has taken a government to court and collected complete repayment of defaulted debt. Elliot’s successful litigation was based on an interpretation of the *pari-passu* clause. *Pari-passu* means that unsecured creditors are ranked equally. Therefore, the argument goes, if nonholdouts get their (new) claim, holdouts also should get their original (full) claim. A claim is only as good as the claimant’s ability to collect. Unlike corporations, sovereigns generally do not have assets outside the country without sovereign immunity, and thus, even with a judgment, it is difficult to collect.

Elliot located what were technically and legally Peruvian assets in Belgium. This is where the clearing agent, Euroclear, is located and where Brady payments are transferred prior to crediting the bondholders. Elliot went to court to prevent Euroclear from crediting investors with any amounts originating from Peru before Peru paid the Brady bondholders.

Implications from These Cases Caused Ecuador to Be Cautious

As a result of the Elliot versus Peru case, Ecuador decided to become current on payments to the small fraction of original Brady holders who did not participate in the 2000 exchange. These and other litigations have enabled some holdouts to get paid. In some cases, these holdouts have sued for full payment on the nonrestructured debt even after a restructuring has taken place. Uruguay also chose to continue paying the small percentage of investors that did not participate in the exchange, although there was no default. Without the ability to develop a restructuring plan that would be approved by a supermajority of creditors binding on a minority, there is no way to fully protect a sovereign from the risk of holdout litigation.

Changing the Provisions of a Bond

To deal with the holdout problem and encourage maximum participation in an exchange, all contractual proposals seek to change the restructuring process by changing the provisions found in sovereign debt contracts, allowing a supermajority to vote on restructuring terms.

New York Law Documentation

A standard New York law contract requires the unanimous consent of all creditors to change "key financial terms" (payment dates and amounts). All other terms typically can be amended with the support of one-half or two-thirds of the outstanding bondholders. Some New York law bonds also require that 25% of the bondholders agree before litigation can be initiated.

English Law Documentation

A standard English law contract allows a supermajority of bondholders (typically 75%) present at a meeting that meets quorum requirements to amend all the bond's terms, including the bond's payment dates and amounts. Many English law bonds also have provisions that make it difficult for an individual bondholder to initiate litigation.

Collective Action Clauses

Collective action clauses (CACs) under New York law have begun to be included in many bonds since Mexico introduced them in 2003. A collective action clause defines how many bondholders are needed to agree on a change in the repayment terms of a bond, in order to effect the change and make it applicable for all bondholders. The CACs were introduced to deal with rogue creditors. CACs already exist in bonds sold under the laws of the United Kingdom.

The Mexican terms specify lower percentages required to change both financial and nonfinancial terms of the bonds. The typical structure allows 75% to 85% of bondholders to amend a bond's financial terms, as long as no more than 10% of the bondholders object. Financial terms could include payment dates and amounts. The remaining nonfinancial terms could be amended only with the support of 75% of the bondholders. Also, certain provisions that relate to the ability of creditors to sue to collect on their bonds could not be amended at all.[7]

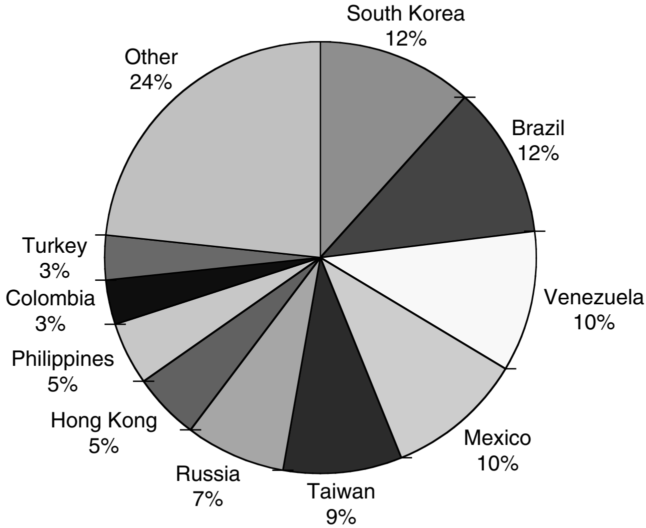
DERIVATIVES

In addition to cash bonds, active derivatives and repo markets in both Brady bonds and Eurobonds, have given institutional investors leverage and enhanced opportunities to express a view or take advantage of relative mispricings in the market.

7. Issuers use only a few jurisdictions for international bond issuance. New York is by far the largest jurisdiction, followed by England and Germany. German law bonds traditionally also have lacked clauses, but German law is being used less in new issuance following introduction of the euro.

EXHIBIT 20–13

Emerging Market Credit Default Swaps (Over US$1 Billion Volume per Day)



Source: Emerging Markets Traders Association.

Credit Default Swaps

Emerging markets credit derivatives evolved alongside the rapid growth of the corporate credit derivatives market.[8] Credit default swaps (CDS) have grown to play a major role in emerging-markets investing and hedging. CDS exposure is similar to the exposure of a floating-rate note investment. Both bond spreads and CDS spreads relate to credit default risk. A CDS offers investors an alternative way of going long or short a particular credit. Exhibit 20–13 shows the distribution by country of the US$1 billion CDS that trade daily. South Korea and Brazil are by far the most actively traded countries.

In some countries, a CDS offers opportunities to short the market that might otherwise not be possible because, for example, the available bonds have long maturities. Shorting a bond in many countries can be difficult or expensive owing to lack of liquidity or lack of a term repo market, but taking a short market position via a CDS is not only easier, but the cost is known. Companies with investments in emerging countries have used the sovereign CDS market extensively to hedge the overall sovereign risk or to determine what return they should target when lending to various private projects or valuing the purchase of a local asset.

8. Credit default swaps are discussed in Chapter 58.

Creating a long position via an emerging market CDS almost always offers higher returns than investing in a cash bond. Other uses are to obtain exposure to a maturity in which there is no cash bond, for leveraged investing, for trading strategies on a relative value or curve mispricing basis, and for risk management purposes for emerging market lenders or investors. Furthermore, CDS has offered the market a tool for assessing relative value among bonds.

A CDS is analogous to insurance on the price loss of an investment due to default. In a CDS of a given credit, counterparty A pays counterparty B a periodic payment (CDS spread), which can be thought of as an insurance premium. In exchange, party B agrees to pay par for one of the issuer's eligible bonds should a default occur, which would be akin to making a claim on the insurance policy. The counterparties generally are referred to as the "protection buyer" (who pays a premium) and the "protection seller" (who makes the contingent default payment or buys the eligible bond for par in the event of default). The CDS contracts specify what credit events are considered default, for purposes of making the contingent claim, and what assets are deliverable for par. Dealers use documentation from the International Swap and Derivatives Association (ISDA).

CREDIT-LINKED NOTES (CLNs)

A credit-linked note (CLN) is a common emerging markets asset that offers investors credit exposure to an issuer in a structure resembling a synthetic corporate bond or loan but typically with a higher spread. Similar to a bond, a CLN allows an investor to take credit risk on a bond in return for payment of interest and repayment of par. A common structure is issuance by a special-purpose vehicle (SPV) that holds collateral securities financed through the issuance proceeds. The credit-derivative CLNs are created by embedding credit derivatives in an SPV.

The CLN has three main components: the SPV, the collateral, and the credit default swap. The issuance proceeds from the CLN are used by the SPV to purchase preagreed collateral to fund the CDS. The SPV simultaneously enters into a CDS with a highly rated swap counterparty (such as a dealer), whereby it sells credit protection in return for receiving an ongoing premium. The SPV grants a security interest in the collateral against the SPV's future performance under the preceding default swap. The SPV also may need to enter into an interest-rate swap (or a cross-currency swap) to reduce interest-rate risk and to tailor the required cash flows of the note. The package is a CLN that performs similarly to a sovereign bond. CLNs are bought by investors who appreciate the increase in yield versus a sovereign bond and do not need liquidity.

Credit Exposure of the Investor

An investor in a CLN has exposure to the CDS reference issuer, credit risk associated with the collateral securities, and counterparty risk associated with the protection buyer or swap counterparty. However, to the extent that the preagreed collateral is highly rated and also that the swap counterparty is highly rated, most of the emphasis is on the credit risk of the CDS.

Repos

Emerging markets debt tends to be more technically driven than other low-quality markets because of the large issue sizes and liquidity. It is one of the few bond markets in which investors can take either long or short positions. As such, the emerging market repo market developed depth long before the high-grade repo market. When financing rates were high, in the 5% to 7% range, it was common to be able to finance or borrow the more liquid bonds for three- or six-month terms, with financing desks providing liquidity as they traded the financing curve. Bonds that were in high demand from investors' short positions could be borrowed at rates hundreds of basis points below general collateral financing rates. This provided an opportunity for a repo desk to profit from part of the spread of the special rate of the borrowed collateral. Low financing rates close to 1% diminish the activity and liquidity of the emerging market repos.

VALUATION METHODS

Zero Spread

The common approach to valuation in emerging markets is to spread off the zero-coupon curve Every bond's cash flows are modeled, with projections of future coupons on floating-rate bonds based on the forward LIBOR curve. After the cash flows are projected, each resulting risky, noncollateralized cash flow is discounted by a zero-coupon Treasury rate plus a spread. This spread is the "spread over the curve" or "stripped spread." Dealers vary according to the particular Treasury curve they use, and many investors now use the spread over the zero-coupon curve implied by the swap curve. This spread is often called *spread over swaps.*

Modified Cash Flow

The modified cash flow (MCF) method offers a way to account for the rolling interest guarantee (RIG) of a bond with interest collateral. The interest payments in these bonds are partially collateralized by amounts sufficient to cover a specified number of coupon payments. The interest guarantee is characterized as a rolling interest guarantee because the guarantee "rolls" forward to the subsequent interest period if not used.

Although the interest collateral does not currently cover the later coupons, these coupons still benefit from the RIG as each interest payment is made. The objective of the MCF approach is to simulate the rolling nature of the interest collateral as each successive coupon is paid. For example, if two semiannual coupons were guaranteed, a coupon that was due in five years would have sovereign risk for the first four years but would have the AA-rated collateral risk during the fifth year.

To reflect this and measure sovereign risk only, the coupons are modified through a continuous manner of discounting and moving forward each coupon by the specified number of periods in which the coupon would be guaranteed if the collateral rolled. This effectively simulates the process of selling each coupon for its present value as soon as each successive interest payment becomes guaranteed.

In this example, at the end of year four, the tenth coupon could be sold at a discount with no sovereign risk. The set of proceeds generated from the sales represents the modified cash flows. The investor can now calculate an internal rate of return on a collateralized Brady bond using the MCF and a stripped price. The stripped price is the price of the bond less the present value of its principal collateral (discounted at the U.S. Treasury STRIP rate) and the present value of its interest guarantee (discounted using the swap curve to reflect the AA-rated collateral). In the preceding example, the first two guaranteed coupons are discounted to the settlement date and subtracted from both the price and the cash flows. The stripped yield and stripped spread (the spread over the U.S. Treasury zero-coupon curve) are perceived as a representation of the market's view of that country's level of sovereign risk. Using these calculated risk values, an investor is able to identify relative value between collateralized Brady bonds and noncollateralized bonds.

Valuing Floating-Rate Bonds

Unlike most corporate bonds, many Brady bonds pay floating-rate coupons that reset at six-month LIBOR plus a constant spread for some or all the coupon periods. To value these bonds, investors project coupon cash flows that are based on forward LIBOR. These forward rates are derived from the LIBOR swap curve or the Eurodollar futures curve. As U.S. Treasury rates rise or fall, forward LIBOR rates also rise and fall. Thus floating-rate bonds are significantly less sensitive to interest-rate movements in the U.S. market than are fixed-rate bonds.

Embedded Options

Aside from the par-call feature of all Brady bonds, certain par and discount bonds carried *value recovery rights* (VRRs) or *warrants*. VRRs give bondholders the opportunity to "recapture" some of the debt and debt-service reduction provided as a result of the exchange if future economic performance and the debt-servicing capacity of the sovereign debtor improve. The rights are a mechanism by which the issuing country shares with its creditors a portion of the incremental revenue generated by, for example, a consistent increase in oil prices (Mexico, Venezuela, Nigeria) or the sovereign's GDP (Bulgaria). Often, these warrants are linked to indexes of oil export prices, the country's oil export receipts (e.g., Mexico, Venezuela, and Nigeria), or the level of a terms-of-trade index (e.g. Uruguay). Mexican VRRs paid holders for over two years due to the high price of oil.

CONCLUSION

The Brady restructurings of the 1990s transformed illiquid commercial bank loans into liquid, globally traded bonds. The issuance of Brady bonds transformed emerging markets debt into an asset class in its own right.

As the asset class has evolved, defaults have occurred on external bonds since 1999, and the restructurings of those defaulted bonds have not been part of the Brady program. However, the concept has been similar in its efforts to forgive debt and reduce debt service going forward, which provides the sovereign an opportunity to rebuild its economy.

Emerging markets debt has evolved into a sophisticated market with global investors ranging from pension funds to hedge funds. It has grown tremendously over the last 12 years as it has opened its doors to international investment. While it has had well-known market shocks, it has weathered each of them as investors return to the market for its generous returns compared with other asset classes. Emerging markets debt has taken its place as a viable asset class, with product choices as extensive as those in the corporate debt markets.

APPENDIX 20

Types of Brady Bonds

COLLATERALIZED BRADY BONDS

Two principal bonds, pars and discounts, were 25- to 30-year registered bullet bonds and were the largest, most common assets, representing over half the issued Brady market. Issue size ranged from US$90 million to US$22.4 billion and, in some cases, was larger than the most liquid U.S. Treasury securities. Par bonds were issued at "par," in exchange for the original face value of the rescheduled loans, but carried a fixed, below-market interest rate.

Discount bonds, on the other hand, carried a floating interest rate and were exchanged for fewer bonds than the original loan amount but with a higher coupon. At the time of the exchange offers, the par and discount options offered about the same net present value. Most of the par and discount bonds have been retired.

Pars and discounts generally had principal secured by U.S. Treasury zero-coupon bonds,[9] which were funded originally by a combination of International Monetary Fund (IMF) and World Bank loans and the country's own reserves.

9. Collateralized bonds denominated in a currency other than U.S. dollars may have their principal collateral guaranteed by another G10 government issue.

In addition, the interest portion of the pars and discounts was partially collateralized by securities rated at least AA, to cover some of the interest (usually 12 months) on the outstanding principal. The interest guarantee is characterized as a rolling interest guarantee (RIG) because the guarantee rolls forward to the subsequent interest period if not used. Both the interest and principal collateral are maintained by an assigned collateral agent and held in escrow at the Federal Reserve Bank of New York. In the event the country misses an interest payment, the trustee pays the investors out of the interest collateral until the guarantee has been exhausted. Bondholders do not have recourse to the principal collateral until maturity.

NONCOLLATERALIZED BRADY BONDS

The types of bonds included in a given plan were determined during the debt restructuring negotiations between a consortium of creditors and the debtor country. The bonds often have varying coupon schedules and amortizations and sometimes include capitalization of interest. The bonds often were of large issue sizes and typically were referred to by name rather than by coupon and maturity, neither of which was constant throughout the life of the bond.

The most liquid emerging market bond[10] has been the Brazil C-bond, a capitalization bond that paid a portion of the coupon in cash and the remainder of the coupon in more bonds. It was issued in 1994 and did not start amortizing for 10 years. Most of the floating-rate bonds that also had long grace periods, in which no amortization payments were scheduled, have passed the grace period. Amortizations can pay down over 10 years.

As a result of the frequent capitalization or amortization, each bond carries with it a factor reflecting the proportion of the original face (excluding retired bonds) still outstanding. When purchasing a bond, *face* value of the purchase is referred to in terms of the *original* face value of the purchase at the time of issue, but the *price* is referred to in terms of the *current* face. Thus the factor is needed to determine the proceeds, as well as the interest payments.

For example, a purchase of US$10 million of a 7% bond and a factor of 0.6 and a quoted price of $80 on a coupon date would cost US$4.8 million and would pay the investor an interest payment of 7% on US$6 million bonds, or US$420,000 per year. Almost all the floating-rate amortizing bonds currently outstanding have no interest collateral. The most liquid ones are *debt-conversion bonds (*DCBs), *new-money bonds* (NMBs), *eligible interest bonds* (EIs), *interest arrears bonds* (IABs), *front-loaded interest-reduction bonds* (FLIRBs), *past-due-interest bonds* (PDIs), and *floating-rate past-due-interest bonds* (FRBs).

10. The largest and highly liquid emerging markets issue is currently the US$19.6 billion Russia 2030, a bond that emerged from defaulted debt but was not part of the Brady Plan.

CHAPTER

TWENTY-ONE

STABLE VALUE INVESTMENTS

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The rapid formation and widespread use of defined-contribution pension plans in the United States over the last 15 to 25 years has had a significant impact on the U.S. financial markets. The key feature of these plans that has profoundly affected investment management trends has been the shift in responsibility for investment decision making from plan sponsors to individual plan participants. For conservative participants whose primary investment objective is preservation of capital, stable value investments have been used widely in both the corporate and public-plan sectors because of their attractive yields, stability, and safety.

A *stable value investment* is an instrument in which contractual terms provide for a guaranteed return of principal at a specified rate of interest. Examples of stable value assets include fixed annuities and traditional guaranteed investment contracts (GICs), bank investment contracts (BICs), and GIC alternatives such as separate-account GICs and synthetic GICs. Stable value pooled funds, which are professionally managed collective trusts investing in these assets, are also used, and more recently, stable value mutual funds have attracted assets. Growth in stable value assets has paralleled that of the overall defined-contribution market, rising to over $320 billion by December 2003.

A key feature of a stable value asset is its treatment from an accounting standpoint. According to generally accepted accounting principles (GAAP), stable value instruments can be held at contract value, provided that established criteria are met. *Contract value* is the acquisition cost of the contract plus accrued interest, adjusted to reflect any additional deposits or withdrawals. This is also referred to as *book value.* Book-value accounting eliminates the market value fluctuations experienced by other asset classes and contributes to the risk-adjusted returns of stable value instruments.

We acknowledge Leela Scattum for her contributions to this chapter.

Initially, traditional GICs were the dominant stable value instrument. The perceived risk in these products was minimal, and they faced little, if any, competition until the insolvency of several major GIC issuers. While these defaults proved to be a great challenge to an industry unaccustomed to such difficulties, they also proved to be the catalyst for tremendous change, resulting in the development of a new generation of products popularly known as "synthetic" GICs. Investors, and ultimately plan participants, now benefit from a broader variety of products, providers, and strategies.

In this chapter we review the various instruments used in today's stable value portfolios with an emphasis on GIC alternatives, the most rapidly growing segment of the market. Also discussed are contract terms and portfolio management considerations, along with some thoughts on the future direction of the stable value asset class.

STABLE VALUE PRODUCTS

Stable value products include investment contracts (GICs and BICs); GIC alternatives, which include separate-account GICs or synthetic GICs (buy-and-hold synthetics, actively managed synthetics); and stable value pooled funds/mutual funds.

Investment Contracts

Traditional *guaranteed investment contracts* (also called *guaranteed insurance, interest,* or *income contracts*) were the foundation of today's stable value industry. A GIC is issued by an insurance company using a group annuity contract format. As insurance contracts, the obligation is backed by the general account of the issuer. In an effort to diversify its depositor base and obtain funding at attractive rates, the banking industry began issuing competing bank investment contracts (BICs) in 1987. While providing stable value portfolios with industry diversification, BICs achieved only modest market share because a limited number of issuers constrained supply.

While different in legal structure and regulatory purview, GICs and BICs are similar functionally in that the issuer of the contract receives a deposit of funds from a qualified investor and, in return, guarantees a specified rate of interest for a predetermined period of time. Interest is accrued on either a simple-interest or a fully compounded basis and paid either annually or at the end of the contract term. The contracts include a variety of terms (discussed later), the most important of which is a guarantee that payments will be made at the contract's book value for qualified participant withdrawals. This feature allows these contracts to be valued at their book value rather than at some calculated market-value equivalent.

While traditional GICs still play a role in most stable value portfolios, diversification considerations relative to life insurance industry exposure have led to their diminishing use vis-à-vis GIC alternatives. Although some portfolios have fairly modest investments in traditional GICs, more often these products are evaluated versus other investment alternatives and purchased on the basis of their relative value—similar to corporate bonds issued by financial institutions in a marketable bond portfolio.

GIC Alternatives

Designed to preserve the benefits of traditional GICs while providing added portfolio diversification and investor control, GIC alternatives now account for a significant and increasing amount of the stable value marketplace. The two primary forms of alternatives are separate-account GICs offered through life insurance companies and synthetic contracts issued by insurance companies, banks, and other financial institutions.

Separate-Account GICs

Separate-account GICs are the closest cousins to traditional GICs in that they are contractually issued as a group annuity policy with terms negotiated between the parties. However, unlike a GIC—which is backed by the general assets of the issuer—in a separate account, the insurance company segregates the assets on its balance sheet for the exclusive benefit of the contract holder. Legal ownership remains with the insurance company, but the contract holder's beneficial interest in the securities has been established clearly in most states. Therefore, in the event of insolvency, the assets are not subject to claims of general policyholders.

The separate-account assets may be managed by the insurance company or, in some cases, by an outside money manager selected by the contract holder with the approval of the insurance company. An initial crediting rate of interest is established that reflects the yield of the underlying securities, as well as the insurance company's underwriting, administration, and investment management fees.

The contract may have a specific maturity date, or the assets may be managed to a constant duration, in which case the contract has no specified maturity date. Additional flexibility is provided to the contract holder within this structure to establish individual investment guidelines for maturity, credit quality, and diversification. A variety of terms and conditions may be included in the contract, but the key feature is the provision for payments to plan participants at book value for qualified withdrawals.

Synthetic GICs

Synthetic GICs provide the features of a separate-account GIC with the additional advantage that the contract holder retains actual ownership and custody of the assets underlying the contract. In a typical synthetic structure, the investor purchases a fixed-income security (or portfolio of securities) and enters into a contract with a third-party guarantor. This third party is typically a bank or an insurance company that agrees to accommodate benefit payments and other qualified participant withdrawals at the contract's book value. The contract typically is referred to as a "wrapper agreement," and the issuer is called a *wrap provider.*

The investor retains ownership of the underlying pool of securities and receives an interest-crediting rate equal to the annualized effective yield of the securities, with an adjustment for fees and other factors. Additionally, the contract guarantees the investor a minimum rate of interest, usually 0%, to protect against a loss of principal. In exchange for these considerations, the wrap provider receives a fee that varies according to the risk assumed.

A synthetic GIC arrangement may involve as many as four parties, including an investor, a wrap provider, an outside money manager, and a trustee/custodian. One financial institution may provide all services for an investor (bundled product), or the service providers may be different entities (unbundled product). Regardless of the parties involved, the structural mechanics are similar. The terms of the wrap agreement transform a portfolio of marketable securities, whose values fluctuate, into a synthetic GIC.

Buy-and-Hold Synthetics. In a buy-and-hold synthetic structure, the investor purchases a single security that is usually held to its final maturity. The contract's crediting rate is set originally as the yield-to-maturity (or the internal rate of return) of the bond. The contract value is reduced as principal and income payments occur. In this respect, buy-and-hold synthetics closely resemble traditional GICs. To date, asset-backed and mortgage-backed securities have been used heavily in buy-and-hold structures owing to their high credit quality and relatively attractive yields. The crediting rate is reset if the cash flows change as a result of changes in prepayment speeds of the underlying bond due to market conditions. The contract terminates when the book value of the contract becomes zero. The buy-and-hold synthetic also can be structured with an interest-rate swap embedded within a wrap agreement. With this version of the product, a floating-rate security is purchased, and the floating interest rate is exchanged for a fixed rate. A large number of features have been used in these arrangements, although use of callable, extendible, or amortizable (based on the performance of an index) structures has been most common.

Owing to the phenomenal growth in stable value investments and increased use of synthetics, portfolios rarely do a single-security wrap today. Instead of a single security, a pool of securities is wrapped by a single wrap provider or by multiple wrap providers (this arrangement is referred to as a "global wrap"). In a global wrap agreement, the wrap providers share their risk proportionately while providing identical contract terms. Among the many benefits of a global wrap are reduced contract fees, administrative ease, fewer contracts to monitor, and additional provisions to move the wrap contract to a new party in case of a credit event with one of the wrap providers. Most portfolios reinvest the cash flows from the underlying securities within the portfolio, further reducing the number of contract withdrawal transactions. The crediting rates for these global wraps are reset quarterly or semiannually using the internal rate of return (IRR) formula or the active formula (discussed in the following section) as prescribed in the contract. Cash flows may trigger nonperiodic resets.

The crediting rate using the IRR method is calculated using the formula

$$\text{PBV} = \sum_{i=1}^{n} \frac{C_i}{\left[(1+\text{IRR})^{1/365}\right]^t}$$

where

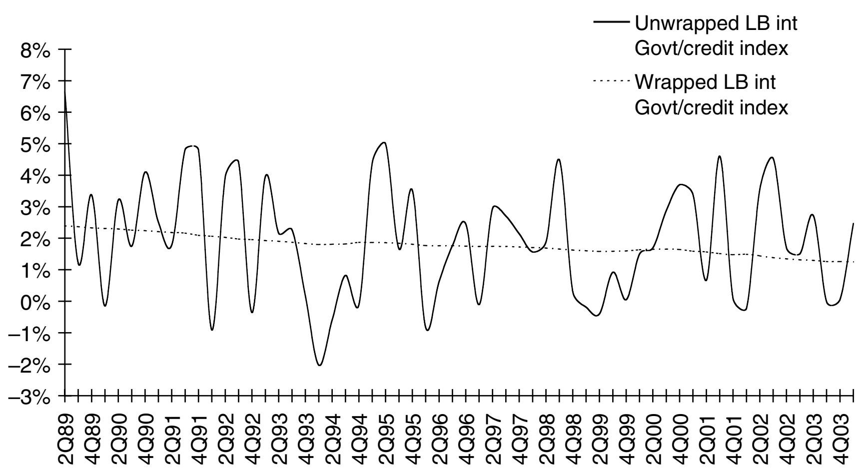
PBV = the portfolio contract or book value on reset date
n = the total number of expected cash flows from the portfolio
C_i = the amount of the cash flow from the portfolio expected at time i
t = time period

Actively Managed Synthetics. The rationale behind the use of managed synthetics is the belief that active investment management enhances investment returns and leads to higher contract crediting rates. Added benefits include broader diversification and the ability to buy and sell securities or adjust the portfolio's duration, which enhances flexibility. Portfolios are constructed using the full range of fixed income securities including U.S. Treasuries and agencies, mortgage-backed and asset-backed securities, and corporate bonds.

More complex instruments, such as interest-rate swaps, futures, and options, are also used, although to a lesser degree. The interest earned by investors over time equals the total return on the underlying portfolio of securities, less wrap and investment management fees. With managed synthetics, the volatility of annual returns is greatly reduced because of book value accounting. Exhibit 21–1 illustrates the

EXHIBIT 21–1

Quarterly Return Comparisons (June 1987–March 2004)



smoothing effects of a wrap contract on a portfolio of marketable securities. Quarterly returns from the Lehman Brothers Intermediate Government/Credit Bond Index are charted over a recent 10-year period. Overlaid on this exhibit are the returns that would have resulted in each period had the index been wrapped, net of annual wrap fees of 8 basis points. As can be seen, the wrapped portfolio's quarterly returns are considerably more stable.

Managed synthetics are available in two forms, immunized and constant duration (referred to as "evergreen"). An immunized contract has a fixed maturity, and hence the duration of the underlying portfolio is lowered over time to meet the maturity date. Evergreen contracts are managed to specific investment guidelines and a specific benchmark. To date, evergreen contracts have been the most commonly used managed synthetic.

The crediting rate is calculated using the *active formula* (often referred to as the "compound formula"):

$$\mathrm{MV}(1 + \mathrm{YTM})^D = \mathrm{BV}(1 + \mathrm{CR})^D$$

Assuming that everything remains static for the duration of the portfolio, this is the rate that will allow the book value or the contract value of the portfolio to converge to the market value (i.e., they will be equal), assuming that the market value continued to earn the current portfolio yield at the current duration of the portfolio. Solving it for crediting rate CR gives

$$\mathrm{CR} = [(\mathrm{MV}/\mathrm{BV})^{(1/D)}\,(1 + \mathrm{YTM})] - 1$$

where

CR = crediting rate
MV = portfolio market value
BV = portfolio book value or contract value
D = weighted average duration of the portfolio
YTM = weighted average yield-to-maturity of the portfolio on an annualized basis

Stable Value Pooled Funds

Individual stable value portfolios typically may invest in most, if not all, of the products described in this chapter. However, many employee benefit plans have opted to use a professionally managed stable value collective fund rather than attempt to manage their own portfolio. This is especially true of small to midsize plans, where it is increasingly difficult to attain appropriate portfolio diversification without incurring significant transaction costs. In addition, many larger plans use a pooled-fund vehicle as a buffer within their stable value portfolio to provide immediate liquidity for qualified withdrawals. Such a liquidity fund, or buffer, is often a contractual requirement stipulated by the issuer to minimize the likelihood of tapping its contracts for book value payments.

For this reason, investing in a stable value collective funds can serve to enhance a portfolio's overall yield given that, over time, it outperforms shorter-term investments such as money market funds.

Stable value pooled funds operate similarly to mutual funds except that they are exempt from registration as securities with the Securities and Exchange Commission (SEC). The funds are collective trusts offered through banks and trust companies to fiduciary clients and can accept only qualified employee benefits plans as investors—including any plan qualified under section 401(a) of the Internal Revenue Service Code and deferred compensation plans described in Section 457 of the code. The funds typically are valued daily in the same way as mutual funds and therefore offer substantial flexibility to a plan sponsor for investing participant contributions and paying out plan benefits. Pooled funds invest in the full range of stable value products, provided that the plan has ongoing professional management, broad diversification, higher credit quality, and competitive returns. According to Hueler Analytics, synthetic GICs accounted for an increasing share of pooled fund investments, now approximately 79% as of December 31, 2003.

THE EVOLUTION OF STABLE VALUE

Having defined the various stable value products available today, a review of the market from a historical perspective may provide some insight into both the current use of these products within the context of portfolio management and where stable value may evolve in the future.

The Beginnings

Following enactment of the Employee Retirement Income and Security Act of 1974 (ERISA), the concept began to emerge of plan participants directing their own investments in defined-contribution plans. A significant result of this legislation was the increased use of guaranteed annuity contracts (GACs), which would hold a dominant position within these plans for years to come. Offered by the life insurance industry, which has been in the forefront of pension development and management in the United States, the GAC (also referred to as an "immediate participation guarantee contract") was a nonmaturing contract featuring a fixed rate of interest that was convertible to an individual annuity on retirement. This option was popular until the substantial rise in interest rates in the late 1970s and early 1980s, when the comparatively low rates of interest of the GAC created dissatisfaction among participants versus the double-digit short-term market rates available at the time. These events prompted the creation of the guaranteed investment contract (GIC) of today, which retained the fixed-rate feature while offering relatively short, set maturity dates to allow for more rapid reinvestment and competitive returns.

Concurrent with these events, there were significant overhauls in the U.S. tax code ultimately providing for tax-deferred contributions by participants to qualified employee benefit plans—including the 401(k) plan. These modifications prompted explosive growth in defined-contribution plan formation and rising employee participation and placed the investment decision-making responsibility in the hands of the individual plan participant. GICs were easy to understand. The fixed-rate, fixed-maturity structure was quite similar to bank certificates of deposit (CDs), so they were a likely beneficiary of the changes and grew rapidly. This growth attracted competition, and in 1987, a limited number of banks began issuing BICs to compete with GICs.

During this period, many plan sponsors managed their GIC portfolios internally and purchased GIC and BIC contracts directly from the issuers or through consultants or GIC brokers. Some plans used a single insurance company's GIC, offering either a class-year structure (participants received a new rate each year on their contributions) or a blended rate, which changed each year. In an effort to provide a diversified GIC option to smaller plans or to larger plans in their startup phase, many banks began offering GIC pooled funds in the mid-1980s. These funds featured independent professional management, credit oversight, diversification, and a mutual fund type of structure and liquidity (subject to certain restrictions).

The Rise of Alternatives (Synthetics)

Traditional GICs were thought to be relatively safe, offering a guarantee of principal and interest to the participant. This perception began to change in the wake of the savings and loan crisis of the late 1980s, which was accompanied by credit concerns about banks and insurance companies as well. It culminated with the default and seizure of Executive Life by the California state insurance commissioner in 1991.

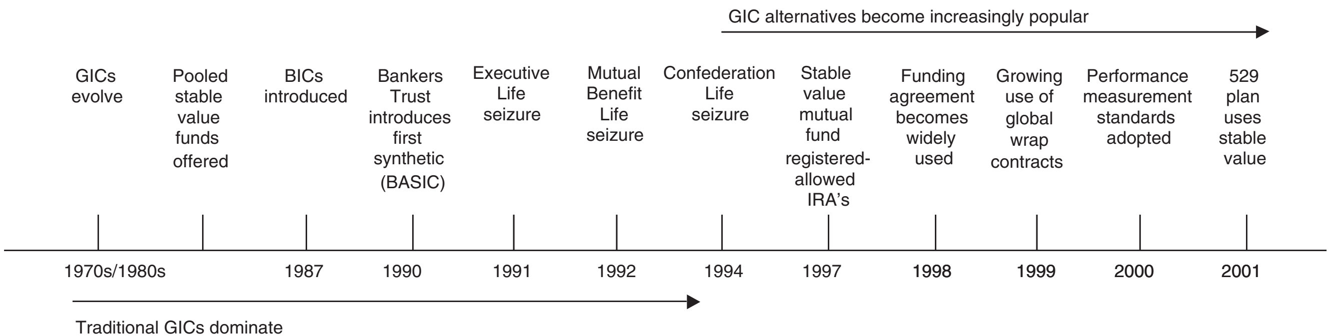
In response to the growing credit and diversification concerns of GIC investors, Bankers Trust began offering the first synthetic GIC alternative in 1990, called *BASIC*—*b*enefits *a*ccessible *s*ecurities *i*nvestment *c*ontract—which provided a book-value guarantee (wrapper) on an individual marketable fixed income security. Bankers Trust followed in 1991 with the managed BASIC, which wrapped a portfolio of securities.

As synthetics gradually filtered into the marketplace, Bankers Trust was one of a limited number of active issuers. Purchasers of these early products tended to be more sophisticated investors, such as plan sponsors that managed their pension plans internally or professional stable value managers. Following the highly publicized defaults of Mutual Benefit Life (1992) and Confederation Life (1994), however, synthetic GICs became used widely to enhance portfolio diversification and to reduce credit risk.

A time line of key market developments appears in Exhibit 21–2. The insurance industry quickly followed Bankers Trust's lead. It responded with a wrap contract of its own, as well as increased efforts to market separate-account GICs that offer features similar to wrapper agreements, although asset ownership and custody remained with the insurance company. Pooled funds also grew in popularity as plan sponsors sought to hire outside fiduciaries to manage their portfolios following issuer defaults. The larger, well-diversified pooled funds were found to be an attractive alternative to in-house management. And more recently,

EXHIBIT 21–2

Evolution of Stable Value



mutual funds have offered stable value in a mutual fund format to smaller plans and IRAs.

The Stable Value Market Today

Because of its unique position in the defined-contribution market, the stable value market has evolved from the old GIC mantle to an entire industry with its own association. Many stable value professionals are now advancing the argument that stable value is an asset class separate to itself, given its unique risk/return characteristics. Indeed, many plan sponsors and plan participants must agree because stable value assets, by some estimates, now exceed $320 billion. Over the last few years, stable value has expanded from retirement plans into the IRA and 529 college savings plan markets.

While traditional GICs historically captured the largest share of invested assets within the stable value market, they have been eclipsed recently by synthetic GICs as the dominant asset as investors have been attracted to the diversification and improved flexibility synthetics provide. According to data released by the Life Insurance Marketing and Research Association (LIMRA) and the Stable Value Investment Association (SVIA), synthetic GICs now have a 64% market share ($172 billion) as compared with traditional GICs, which have shrunk to a 28% market share ($74 billion). The migration toward synthetics has been especially prevalent among professional stable value managers.

Enticed by rising demand and relatively attractive fees, numerous wrap providers entered the market in the 1990s. Owing to mergers in the banking and insurance industries, plus lower wrap fees today, the number of wrap providers has decreased to about 13 as of the end of the first quarter 2004. A list of active wrap providers as of March 2004 appears in Exhibit 21–3.

STABLE VALUE PORTFOLIO MANAGEMENT

Stable value portfolio management has changed dramatically in recent years as the combination of innovative products and new providers has virtually redefined how portfolios are structured and managed. The increased use of GIC alternatives such as synthetics has advanced portfolio management to the point where most traditional bond management strategies can be emulated within stable value portfolios while maintaining the low return volatility characteristics of stable value through book-value wrappers. In fact, major bond market participants such as multinational banks, securities dealers, and fixed income managers have been at the forefront of product development and industry change as they have sought ways to apply their expertise to a market that, until recently, had been dominated by insurance companies.

This section highlights some general considerations in managing the traditional stable value portfolio, with an emphasis on the use of synthetics. It also discusses some of the relevant contract terms and considerations affecting the portfolio structuring process.

EXHIBIT 21–3

Synthetic GIC Issuers and Wrapped Assets Outstanding as of December 31, 2003

Insurance Companies	$ Amount Outstanding (millions)
Aegon	31,945.9
AIG Financial Products	24,364.6
Metropolitan Life	5,200.0
Pacific Life	4,983.1
Prudential Life	244.4
Security Life of Denver	100.1
SUBTOTAL	66,838.1
Banks	**$ Amount Outstanding (millions)**
JPMorgan Chase Bank	29,501.0
State Street Bank and Trust	27,377.2
Union Bank of Switzerland	22,890.0
Bank of America	21,300.0
Caisse des Depots FP	19,100.0
Rabobank Nederland	18,511.7
Royal Bank of Canada	3,600.0
SUBTOTAL	142,279.9
TOTAL	209,118.0

Source: Galliard Capital Management.

Stable Value Portfolio Objectives

Consistent with the role of stable value as the safe option in most defined-contribution plans today, the overriding objective in managing these portfolios is preservation of principal. Liquidity to meet participant withdrawals is an additional factor, as is earning a fairly stable return that exceeds that of shorter-maturity alternatives. Portfolio management strategies should address these objectives and should guide the selection of individual issues.

Credit Quality

All holdings in a stable value portfolio—whether traditional GICs/BICs, wrap contracts, or assets underlying wrap contracts—must be high-quality instruments. A stringent credit review process is used initially to review issuers and to monitor them on an ongoing basis. Most managers establish minimum credit quality rating standards of single-A or double-A and require that the overall quality rating of the portfolio exceed Aa3, as measured by Moody's Investors Service or AA– by Standard & Poor's. Synthetic GICs can improve portfolio credit quality because their underlying securities often are obligations of the U.S. government or its agencies, well-structured mortgage/asset-backed securities, or higher-quality corporate bonds. Investors must look deeper than the financial statements and the opinions of the rating agencies, however. Factors including the issuer's mix of business, amount of leverage, investment portfolio structure and liquidity, and the breadth and depth of management also must be explored.

Diversification

Diversification is a critical element in any portfolio management process and was a particularly thorny issue in stable value portfolios prior to the advent of synthetics. Fiduciaries of employee benefit plans are charged with adequately diversifying portfolios under ERISA to minimize the risk of large losses. It could be argued that many stable value portfolios historically did not fulfill this obligation because they were exposed almost entirely to financial services companies, often with large exposures to single issues. As discussed earlier, defaults in the early 1990s drew attention to the diversification issue, however, and led to the propagation of synthetics.

Prudent diversification standards limit portfolio assets invested in a single issuer to no more than 2% to 3%. Most fixed income practitioners limit holdings of non-U.S. government issuers to no more than 1% to 2% and broadly diversify among different fixed income sectors, industries, and security types. A similar result can be achieved in stable value portfolios by applying the same criteria for securities underlying the synthetic contracts. Traditional GICs/BICs should be viewed as a corporate sector of the portfolio but limited by industry diversification guidelines similar to other holdings.

Diversification constraints should be measured according to the net exposure to an individual issuer or sector. For contract issuers, full principal exposure of traditional issues and the difference between the market and book values of their synthetic contracts should be totaled. Likewise, credit exposure is measured for all underlying holdings.

Maturity Structure

The maturity structure of stable value portfolios must ensure that liquidity is adequate for meeting participant withdrawals. Generally, a buffer of available cash equal to 5% to 10% of the portfolio is invested in a stable value collective fund, a money market fund, or other liquid short-term instruments. Individual portfolio holdings are then structured with longer maturities to provide funds at regular intervals. Laddering the portfolio in this fashion ensures that funds are available to accommodate liquidity needs and reinvest at current market rates. Portfolio maturity structures typically are short, averaging two to three years, with the longest maturities rarely exceeding five or seven years.

Synthetic contracts, however, have greatly improved the flexibility in portfolio maturity structuring, because the underlying securities are highly marketable. Liquidity may be constrained if the underlying securities' market value is significantly below their book value. When market value is near book value or higher, however, the portfolio manager is more able to meet unusual withdrawal requirements or shift the composition of the portfolio.

When structuring maturities, actively managed synthetics with constant durations must be factored into the equation. The average duration of each active portfolio may be used as a proxy for the contract's maturity. However, managed contracts neither mature nor provide cash-flow contributions within the broader portfolio structure.

Duration and Convexity

Previously, the exclusive use of traditional GICs precluded the need to understand duration or convexity. However, the use of synthetics requires portfolio managers to track the duration characteristics of the securities underlying synthetics within a stable value fund. Sophisticated analytical systems are required for this effort. Again, given the principal protection objective of stable value funds, the price volatility of underlying securities to changes in interest rates should be consistent with a two- to three-year average maturity. Volatility measurement is especially important when securities that possess various cash-flow characteristics, such as mortgage pass-throughs or mortgage/asset-backed securities, are used. Guidelines must be established for active managers to ensure that the use of higher-risk mortgage securities is limited. The negative convexity in these instruments can affect cash flows dramatically, which affects the market value of the underlying portfolios and thus the crediting rate of the contract.

Asset Allocation among Synthetic Structures

Portfolio strategies devised at the aggregate portfolio level must specify the allocation levels for different types of synthetic contracts as well as different issuers. No specific formula for allocation exists, for it depends on the manager's level of comfort with synthetics, as well as her expertise. One approach is to determine allocations to cash and traditional GIC contracts and then to allocate remaining assets to synthetic structures with a balance between buy-and-hold and actively managed contracts. The buy-and-hold structures provide cash flow to the broader portfolio and should be structured with portfolio guidelines for credit quality, diversification, and maturity in mind.

Actively managed synthetics are structured to achieve certain return objectives but also must comply with the aggregate portfolio guidelines. A benchmark is commonly selected, and management guidelines are established relative to that benchmark. The amount of latitude given to investment managers should be considered carefully. Wrap providers that are liable for the shortfalls incurred when a portfolio's market value drops below book value typically will limit the investment manager's ability to move the portfolio's duration away from its benchmark. Wrap providers also limit, if not ban completely, the use of higher-risk securities, which allows them to quantify potential liabilities and contain risk.

Portfolio Management: Another View

More recently, larger plan sponsors have taken a less traditional approach in managing their stable value portfolios, choosing to view them in a way that is more similar to their other fixed income options, only with a book-value wrapper. This allocation strategy involves hiring one or more active fixed income managers for the fund, each with a particular area of expertise or style, to actively manage all the assets in the plan option—similar to the way they would structure their marketable bond fund or their defined-benefit plan fixed income portfolio. The plan sponsor then secures one or more book-value wrapper agreements to provide for portfolio valuations at contract book value.

Each manager must adhere to a set of investment guidelines agreed on with the plan sponsor and wrap provider. The sponsor may maintain a liquidity reserve for payment of normal plan benefit payments to reduce the likelihood of book-value payments from the active synthetic contracts.

If the plan's cash-flow history consistently has been positive, the plan sponsor may retain little or no reserve. However, the sponsor will be required by the wrap provider to purchase only experience-rated (participating) contracts so that any shortfall between the market value of the portfolio and book value in the event of a payout will be recovered from the plan rather than absorbed by the wrap provider.

Contract Considerations

Given that there are no industry standards governing the various types of stable value contracts, they may vary materially from one issuer to another. As such, a thorough contract review is imperative and should be completed prior to the contract's final execution. All contracts will have terms dealing with the legal representations and warranties of the parties, as well as provisions relating to the calculation of the credited rate of interest, contract withdrawals, terminations, including formulas for market-value adjustment, and the hierarchy for withdrawals within the total plan (i.e., pro rata or last in, first out).

Synthetic contracts are more complex, requiring additional provisions relating to the treatment of any losses realized from liquidation of the underlying securities in the event of a withdrawal or termination. Synthetic contracts may be *experience-rated* or *non-experience-rated* (also called *participating* or *nonparticipating*) or *hybrid* (a combination of both). If the contract is experience-rated, any losses realized from security sales to fund a withdrawal would be borne by the portfolio and recovered through a lower crediting rate of interest to participants. By the same token, any gains realized by the sale of a security inure to the plan and are earned through a higher crediting rate in the following period. For non-experience-rated contracts, the risk of loss is borne by the contract issuer. As might be expected, non-experience-rated contracts have a somewhat higher fee than experience-rated contracts to compensate the issuer for the additional risk. Any loss or gain realized from the liquidation of a security to fund a withdrawal is passed on to the contract issuer. A hybrid contract is typically 20% experience-rated and 80% non-experience-rated, and the percentage resets in a rolling 12-month period or calendar year. In a hybrid contract, loss attributable to the 20% withdrawal is borne by the portfolio, and any loss from subsequent contract withdrawals during the 12-month period is borne by the contract issuer. Today, experience-rated and hybrid contracts are more popular. As of December 31, 2003, Hueler Pooled Fund Universe participants reported that synthetic holdings had approximately 65% in experience-rated contracts, 5% in non-experience-rated, and 30% in hybrid contracts.

THE FUTURE OF STABLE VALUE

The tremendous change occurring recently in stable value products, providers, and strategies will continue to reshape the market in coming years. While aggregate industry assets more than likely will experience only modest growth until the long-awaited retirement of baby boomers begins sometime around the year 2007, significant shifts will continue within the market in terms of product use and development, portfolio management strategies, and players themselves. This section briefly highlights some of the market's major trends and provides some thoughts about the future.

From a product standpoint, pooled funds and actively managed synthetics are likely to continue to experience solid growth at the expense of traditional GICs, the use of which is expected to decline further. Separate-account GICs will be used, but to a lesser extent than synthetics. Fixed income managers are the clear beneficiary of the movement to managed synthetics, and they will continue to play a bigger and bigger role in the marketplace. Indeed, one of the more interesting developments to watch will be the vanishing distinction between fixed income managers and stable value managers.

For the stable value asset manager, market growth in the immediate future will be attained largely by successfully capturing other segments of the defined-contribution market, such as public deferred compensation plans (457) and retirement plans for tax-exempt organizations (403b). These sectors are just beginning to follow the corporate market in offering more diversified stable value options including synthetic GICs and pooled funds at the expense of bank savings vehicles and fixed annuities.

Product innovations are continuing as well. With the emergence of 529 plans in 1999, stable value again has found a place in the conservative segment of these age class funds. Innovations continue as well within synthetic structures, including wrapping of specialized fixed income styles and other asset classes such as high-yield international bonds and even equities.

While these newer structures are still a comparatively small part of the market, the quest for higher yields is beginning to manifest itself in riskier strategies. Plan sponsors must take care to understand all the strategies that are used in their stable value option and make sure that they are comfortable that appropriate risk levels are maintained given the objective of principal preservation stated for this investment option.

On the issuer side, wrap fees have continued to plummet because these contracts virtually have become commoditized. Fees for wrapper agreements are averaging 7 to 10 basis points, and many deals have been struck at lower levels. It is likely that continued declines in wrap fees will cause consolidation on the issuer side of the industry, with the emergence of a few very large players.

A final trend that is being promoted within the industry relates to stable value as a distinct asset class, highly efficient in terms of risk and return. With attractive yields and low volatility of returns, many in the industry are beginning to recommend stable value as a substitute for balanced funds for traditional bond portfolios. Given the higher risk-adjusted returns, investors could reduce risk (volatility) in their portfolios by using stable value in place of marketable bonds. Likewise, investors could increase their exposure to equities and improve expected returns while maintaining the same level of return volatility by using stable value in balanced account options.

Whether stable value becomes a staple in balanced account strategies remains to be seen. What is clear is that participants applaud the high-return/low-volatility nature of stable value investments and likely will continue to allocate a large portion of their fixed income investments to this asset class in the future.

CHAPTER

TWENTY-TWO

AN OVERVIEW OF MORTGAGES AND THE MORTGAGE MARKET

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As a corollary of the American dream of home ownership, the mortgage market in the United States has emerged over the last decade as one of the largest asset classes. As of the fourth quarter of 2003, the total face value of one- to four-family residential mortgage debt outstanding was approximately $7.3 trillion, with roughly $4.2 trillion having been securitized into a variety of investment vehicles. As a point of comparison, at the same point in time, the outstanding amount of U.S. Treasury notes and bonds totaled $3.7 trillion. For a variety of reasons, such as product innovation, technological advancement, and demographic and cultural changes, the composition of the primary mortgage market continues to evolve on a fairly dynamic basis. The mortgage-lending paradigm continues to be refined in ways that have led to lenders offering a large variety of products designed to appeal to consumer needs and tastes. This evolution has been facilitated by attendant increased sophistication in pricing that has allowed for the quantification of the risks inherent in such loans. The purpose of this chapter is to define the various products originated in the mortgage markets, discuss the ongoing evolution in the development of such products, describe the process of determining mortgage lending rates, and discuss the risks associated with mortgage products.

PRODUCT DEFINITION AND TERMS

In general, a *mortgage* is a loan that is secured by the underlying real estate that can be repossessed in the event of default. For the purposes of this chapter, a *mortgage* is defined as a loan made to the owner of a one- to four-family residential dwelling and secured by the underlying property. Such loans generally are level-pay "fully amortizing" mortgages, indicating that the obligor's principal and interest payments are calculated in equal increments to pay off the loan over the stated term. There are, however, a number of key characteristics that are considered critical in understanding the instruments, and they are differentiated along the following attributes.

Lien Status

The lien status dictates the loan's seniority in the event of the forced liquidation of the property owing to default by the obligor. The overwhelming preponderance of mortgage loans originated have first-lien status, implying that a creditor would have first call on the proceeds of liquidation of the property if it were to be repossessed. Borrowers often use second-lien loans as a means of liquefying the value of a home for the purpose of expenditures (such as medical bills or college tuition) or investments (such as home improvements). A second-lien loan also may be originated simultaneously with the first-lien in order to maintain the first-lien loan-to-value (LTV) ratio below a certain level; this allows the obligor to avoid the need for mortgage insurance, which is required for loans with LTVs greater than 80% and hence increases the monthly payment.

Original Loan Term

The vast majority of mortgages are originated with a 30-year term and amortized on a monthly basis. A variation to this theme is the biweekly payment loan. With a biweekly loan, the borrower makes a payment every other week, or a total of 26 payments per year instead of the typical monthly payment. The two extra payments per year (which are treated entirely as principal payments) serve to amortize the loan faster, resulting in the effective maturity of a biweekly loan of approximately 22 years. In addition to such synthetically shorter mortgages, loans with stated shorter terms of 10, 15, and 20 years also have become popular with borrowers who are motivated by the desire to own their home earlier. Among these mortgages, where the monthly mortgage payment is inversely related to the term of the loan, the 15-year mortgage is the most common instrument. Some loans are also structured to have so-called balloon payments. The loan amortizes over a 30-year term; however, at a preset point in time (the "balloon date," generally five or seven years after issuance) the borrower must pay the balance of the loan in full.

Interest-Rate Type (Fixed versus Adjustable Rate)

As is indicated by the nomenclature, *fixed-rate mortgages* have an interest rate that is set at the closing of the loan (or, more accurately, when the rate is "locked") and is constant for the loan's term. Based on the loan balance, interest rate, and term, a payment schedule effective over the life of the loan is calculated to amortize the principal balance. Note that while the monthly payment is constant over the life of the loan, the allocation of the payment into interest and principal changes over time. During the earlier years of the loan, the level-pay mortgage consists mainly of interest, whereas the constant payment is composed mainly of principal in the later years of the life of the loan.

Adjustable-rate mortgages (ARMs), as the name implies, have note rates that change over the life of the loan. The note rate is based on both the movement of an underlying rate (the *index*) and the spread over the index (the *margin*) required for the particular loan program. A number of different indexes, such as the one-year Constant Maturity Treasury (CMT) and the London Interbank Offered Rate (LIBOR) or the less popular 11th District Cost of Funds (COFI) can be used to determine the reference rate. ARMs typically adjust or *reset* annually, although instruments with one- and six-month resets also are originated. Owing to competitive considerations, the initial rate is often somewhat lower than the so-called fully indexed rate. In this case, the initial rate is referred to as a "teaser rate." In any case, the note rate is subject to a series of caps and floors that limit how much the note rate can change at reset. Structurally, the cap serves to protect the consumer from the payment shock that might occur in a regime of rising rates, whereas the floor acts to protect the interests of the holder of the loan by preventing the note rate from dropping below predefined levels. The vast majority of adjustable-rate loans have 30-year terms.

An increasingly popular innovation is the fixed-period or hybrid ARM. These loans have fixed rates that are effective for longer periods of time (3, 5, 7, and 10 years) after funding. At the end of the period, the loans reset in a fashion very similar to that of more traditional ARM loans. Hybrid ARMs appeal to borrowers who desire a loan with lower initial payments (because ARM rates generally are lower than rates for 30-year fixed-rate loans) but without as much payment uncertainty and exposure to changes in interest rates as ARMs without the fixed-rate period. A recent variation of this mortgage product is the interest-only (IO) hybrid ARM, which is a mortgage that involves only the payment of the interest associated with the loan until the reset date. While the interest-only option is also available with fixed-rate mortgages, the majority of interest-only production currently is in hybrid ARMs. At the end of the fixed period, the principal is amortized at a floating rate over the remaining life of the loan. Since such mortgages involve lower monthly payments, obligors typically use IO hybrid ARMs as a financing vehicle to either reduce the monthly mortgage payment or to purchase a more expensive property.

Credit Guarantees

While our discussion has centered on the basics of mortgage loans, one of the considerations that also distinguishes various mortgages is the form of the eventual credit support required to enhance the liquidity of the loan. While a complete discussion of secondary markets is beyond the scope of this chapter, the ability of mortgage banks to continually originate mortgages is heavily dependent on the ability to create fungible assets from a disparate group of loans made to a multitude of individual obligors. Therefore, mortgage loans can be further classified based on whether the eventual credit guaranty associated with the loan is provided by the federal government, quasi-governmental agencies such as the Federal

National Mortgage Association (Fannie Mae, or FNMA) or the Federal Home Loan Mortgage Corporation (Freddie Mac, or FHLMC), or private entities.

One of the dimensions into which loans can be classified is along the nomenclature of government versus conventional loans. As part of housing policy considerations, the Department of Housing and Urban Development (HUD) oversees two agencies, the Federal Housing Administration (FHA) and the Department of Veterans Affairs (VA), that support housing credit for qualifying borrowers. The FHA provides loan guarantees for borrowers who can afford only a low down payment and generally also have relatively low levels of income. The VA guarantees loans made to veterans, allowing them to receive favorable loan terms. These guarantees are backed by the U.S. Treasury, which provides these loans with the "full faith and credit" of the U.S. government. These loans are referred to under the generic term of *government loans*. Loans that are not associated with government guarantees are categorized as *conventional loans*.

Government loans are securitized largely through the aegis of the Government National Mortgage Association (Ginnie Mae, or GNMA), an agency also overseen by HUD. Conventional loans can be securitized either as so-called private-label structures or as pools guaranteed by the two government-sponsored enterprises (GSEs), namely, Freddie Mac and Fannie Mae. The GSEs are shareholder-owned corporations that were created by Congress to support housing activity. As of this writing, the GSEs are regulated by the Office of Federal Housing Enterprise Oversight (OFHEO), which is also under the aegis of HUD. The issue of GSE regulation is currently a matter of significant debate and is potentially subject to change, particularly with respect to whether the regulatory umbrella remains with HUD or is moved to a different department. However, any potential changes with respect to the regulatory framework are unlikely to affect the secondary market funding activities of the GSEs. The actual choice of the vehicle (GSE versus private label) used to securitize a particular loan depends on a number of factors, such as conformance of obligor credit attributes and property features with GSE loan requirements, the cost of credit enhancement, and loan balance.[1]

Loan Balance (Conforming versus Nonconforming)

As noted earlier, mortgage balance often determines the vehicle used to securitize a loan. This is due to the fact that the agencies have limits on the loan balance that can be included in agency-guaranteed pools. The maximum loan sizes for one- to four-family homes effective for the following calendar year are adjusted every November. The year-over-year percentage change in the limits is based on the October-to-October change in the average home price (for both new and existing homes)

1. A note with respect to terminology: throughout this chapter, we will use the term *agencies* to refer to Freddie Mac, Fannie Mae, and Ginnie Mae; the term *GSEs* refers to Freddie Mac and Fannie Mae only.

EXHIBIT 22–1

Conventional Loan Limits for 2004

Property Type	Loan Limit
Single-family properties	$333,700
Two-family properties	427,150
Three-family properties	516,300
Four-family properties	641,650

published by the Federal Housing Finance Board. Since their inception, Freddie Mac and Fannie Mae pools have had identical loan limits because the limits are dictated by the same statute. Exhibit 22–1 shows the GSEs' conforming limits for 2004 for one- to four-family homes. Note that the loan limits are 50% higher for loans made in Alaska, Hawaii, Guam, and the U.S. Virgin Islands. Exhibit 22–2 shows the GSEs' single-family conforming limits since 1982, along with year-over-year percentage changes.

The loan limits on Ginnie Mae pools are more complex. The FHA and VA have different ways of calculating maximum loan limits. FHA limits vary by state and are based on housing costs within a state subject to the following constraints.

- A ceiling of 87% of the GSEs' conforming limit in high-cost states
- A ceiling of 48% of the GSEs' limit in low-cost states

For 2004, the maximum allowable size of FHA loans in high- and low-cost states were $290,319 and $160,176, respectively. The VA changes its limit periodically. This limit was last changed effective for 2002, when the VA maximum loan balance was changed to $300,700 to match the prevailing GSE limit. Prior to this change, the previous VA limit was $203,000 and had not changed for a number of years.

Loans larger than the conforming limit (and thus ineligible for inclusion in agency pools) are classified as *jumbo loans* and are securitized in private-label transactions (along with loans, conforming balance or otherwise, that do not meet the GSEs' required credit or documentation standards). While the size of the private-label sector is significant (as of the fourth quarter of 2003, approximately $843 billion in balance was outstanding), it is dwarfed by the market for agency pools. Moreover, as the conforming balance limits have risen owing to robust real estate appreciation, the market share of agency pools relative to private-label deals has grown.

Loan Credit and Documentation Characteristics

Mortgage lending traditionally has focused on borrowers of strong credit quality who were able (or willing) to provide extensive documentation of their income and assets. However, owing to technological advances with respect to

EXHIBIT 22–2

Conforming Limit Over Time

Year	Conforming Limit	% Change
2004	$333,700	3.4%
2003	322,700	7.3%
2002	300,700	9.3%
2001	275,000	8.8%
2000	252,700	5.3%
1999	240,000	5.7%
1998	227,150	5.8%
1997	214,600	3.7%
1996	207,000	1.9%
1995	203,150	0.0%
1994	203,150	0.0%
1993	203,150	0.4%
1992	202,300	5.8%
1991	191,250	2.0%
1990	187,450	–0.1%
1989	187,600	11.2%
1988	168,700	10.2%
1987	153,100	14.9%
1986	133,250	15.6%
1985	115,300	1.1%
1984	114,000	5.3%
1983	108,300	1.2%
1982	107,000	

pricing the inherent risk in mortgage loans, the industry has increasingly expanded product offerings to consumers who had been outside the boundaries of the traditional credit paradigm. For instance, some of the fastest-growing sectors of the mortgage markets are the so-called subprime and alternative-A (Alt-A) sectors. *Subprime* refers to borrowers whose credit has been impaired, in some cases due to life events such as unemployment or illness. At the same time, these borrowers have sufficient equity in their homes to mitigate the lender's exposure, thereby allowing the lender to place lesser weight on the credit profile. *Alt-A loans* refer to loans to borrowers who generally have high credit scores but have variable incomes, are unable or unwilling to document a stable income history, or are buying second homes or investment properties.

As the underwriting process for these loans continues to be refined, these categories of mortgages are becoming increasingly important parts of the primary mortgage market. The ability of the mortgage banking community to originate such products has been facilitated by the investor acceptance of securitized structures collateralized by such loans. Subprime loans generally are securitized as short- and intermediate-duration securities popular with banks and depositories. Mortgage-backed securities collateralized by Alt-A loans appeal to investors because of the perceived reduced sensitivity to prepayment risk.

MECHANICS OF MORTGAGE LOANS

With the exception of interest-only loans, mortgage loans generally are structured as immediately and fully amortizing instruments, where the principal balance is paid off over the life of the loan. As noted previously, fixed-rate loans generally have a monthly payment that is fixed for the life of the loan, based on loan balance, term, and interest rate. A fixed-rate loan's monthly payment can be calculated using the following formula:

$$\text{Monthly payment} = \text{original balance} \times \frac{\text{interest rate }(1+\text{interest rate})^{\text{loan term}}}{(1+\text{interest rate})^{\text{loan term}}-1}$$

(Note that the interest rate as used in the formula is a monthly rate calculated by dividing the loan's rate by twelve.) Using this formulation, the allocation of the level payment into principal and interest over time provides insights regarding the buildup of owner equity in the property. As an example, Exhibit 22–3 shows the total payment and the allocation of principal and interest for a $100,000 loan with a 5.5% interest rate (or *note rate,* as it is often called) for the first 60 months.

The exhibit shows that the payment consists mostly of interest in the early period of the loan. Since interest is calculated from a progressively declining balance, the amount of interest paid declines over time. In this calculation, since the aggregate payment is fixed, the principal component consequently increases over time. In fact, the exhibit shows that the unpaid principal balance in month 60 is $92,460, which means that of the $34,067 in payments made by the borrower to that point, only $7,539 was composed of principal payments. However, as the loan seasons, the payment is increasingly allocated to principal. The crossover point in the example (i.e., where the principal and interest components of the payment are equal) comes in month 210. A graphic representation of principal and interest payments, along with the balance of the loan, is shown in Exhibit 22–4.

Loans with shorter amortization schedules (e.g., 15-year loans) allow the buildup of equity in the home at a much faster rate. Exhibit 22–5 shows the outstanding balance of a $100,000 loan with a 5.5% note rate using 30-, 20-, and 15-year amortization terms. Note that while 50% of the 30-year loan balance is paid off in month 246, the halfway mark is reached in month 151 with a 20-year term and month 107 with a 15-year loan. In the case of balloon loans, the monthly payments are calculated to amortize the principal balance over a 360-month term. The balloon payment occurs at either month 60 (for a five-year balloon) or month 84 (for a seven-year balloon) and refers to the unpaid principal balance at the balloon date.

EXHIBIT 22–3

Payment Analysis for $100,000 30-Year Loan with a 5.5% Rate

Month	Payment	Interest	Principal	Unpaid Balance
1	$567.79	$458.33	$109.46	$99,890.54
2	$567.79	$457.83	$109.96	$99,780.58
3	$567.79	$457.33	$110.46	$99.670.12
4	$567.79	$456.82	$110.97	$99,559.15
5	$567.79	$456.31	$111.48	$99,447.68
6	$567.79	$455.80	$111.99	$99.335.69
7	$567.79	$455.29	$112.50	$99,223.19
8	$567.79	$454.77	$113.02	$99,110.17
9	$567.79	$454.25	$113.54	$98,996.63
10	$567.79	$453.73	$114.06	$98,882.58
11	$567.79	$453.21	$114.58	$98,768.00
12	$567.79	$452.69	$115.10	$98,652.90
13	$567.79	$452.16	$115.63	$98,537.27
14	$567.79	$451.63	$116.16	$98,421.11
15	$567.79	$451.10	$116.69	$98,304.41
16	$567.79	$450.56	$117.23	$98,187.18
17	$567.79	$450.02	$117.77	$98,069.42
18	$567.79	$449.48	$118.31	$97,951.11
19	$567.79	$448.94	$118.85	$97,832.27
20	$567.79	$448.40	$119.39	$97,712.87
21	$567.79	$447.85	$119.94	$97,592.93
22	$567.79	$447.30	$120.49	$97,472.44
23	$567.79	$446.75	$121.04	$97,351.40
24	$567.79	$446.19	$121.60	$97,229.81
25	$567.79	$445.64	$122.15	$97,107.65
26	$567.79	$445.08	$122.71	$96,984.94
27	$567.79	$444.51	$123.28	$96,861.66
28	$567.79	$443.95	$123.84	$96,737.82
29	$567.79	$443.38	$124.41	$96,613.42
30	$567.79	$442.81	$124.98	$96,448.44
31	$567.79	$442.24	$125.55	$96,362.89
32	$567.79	$441.66	$126.13	$96,236.76
33	$567.79	$441.09	$126.70	$96,110.05
34	$567.79	$440.50	$127.29	$95,982.77
35	$567.79	$439.92	$127.87	$95,854.90
36	$567.79	$439.33	$128.46	$95,726.44
37	$567.79	$438.75	$129.04	$95,597.40

EXHIBIT 22–3

(Continued)

Month	Payment	Interest	Principal	Unpaid Balance
38	$567.79	$438.15	$129.64	$95,467.76
39	$567.79	$437.56	$130.23	$95,337.53
40	$567.79	$436.96	$130.83	$95,206.71
41	$567.79	$436.36	$131.43	$95,075.28
42	$567.79	$435.76	$132.03	$94,943.25
43	$567.79	$435.16	$132.63	$94,810.62
44	$567.79	$434.55	$133.24	$94,677.38
45	$567.79	$433.94	$133.85	$94,543.53
46	$567.79	$433.32	$134.47	$94,409.06
47	$567.79	$432.71	$135.08	$94,273.98
48	$567.79	$432.09	$135.70	$94,138.28
49	$567.79	$431.47	$136.32	$94,001.96
50	$567.79	$430.84	$136.95	$93,865.01
51	$567.79	$430.21	$137.58	$93,727.43
52	$567.79	$429.58	$138.21	$93,589.23
53	$567.79	$428.95	$138.84	$93,450.39
54	$567.79	$428.31	$139.48	$93,310.91
55	$567.79	$427.68	$140.12	$93,170.80
56	$567.79	$427.03	$140.76	$93,030.04
57	$567.79	$426.39	$141.40	$92,888.64
58	$567.79	$425.74	$142.05	$92,746.59
59	$567.79	$425.09	$142.70	$92,603.88
60	$567.79	$424.43	$143.36	$92,460.53

For an ARM loan, the payment is calculated at the initial note rate for the full 360-month term. At the first reset and at every subsequent adjustment, the loan is "recast," and the monthly payment schedule is recalculated using the new note rate and the remaining term of the loan. For example, the payments on a three-year hybrid ARM with a 4.5% note rate initially would be calculated as a 4.5% loan with a 360-month term. If the loan resets to a 5.5% rate after three years, the payment is calculated using a 5.5% note rate and a 324-month term. The following year, the payment would be recalculated again using the prevailing rate (depending on the performance of the index referenced by the loan) and a 312-month term.

In general, mortgage loans can be prepaid at the option of the borrower. When a loan is prepaid, the holder of the loan (either in the form of a loan in portfolio or as part of a mortgage-backed security) receives the prepaid principal at face value. Prepayments take place either through the borrower "refinancing" the

EXHIBIT 22–4

Principal and Interest Payments for a $100,000 30-Year Fixed-Rate Loan with 5.5% Note Rate (Total Monthly Payment of $567.79)

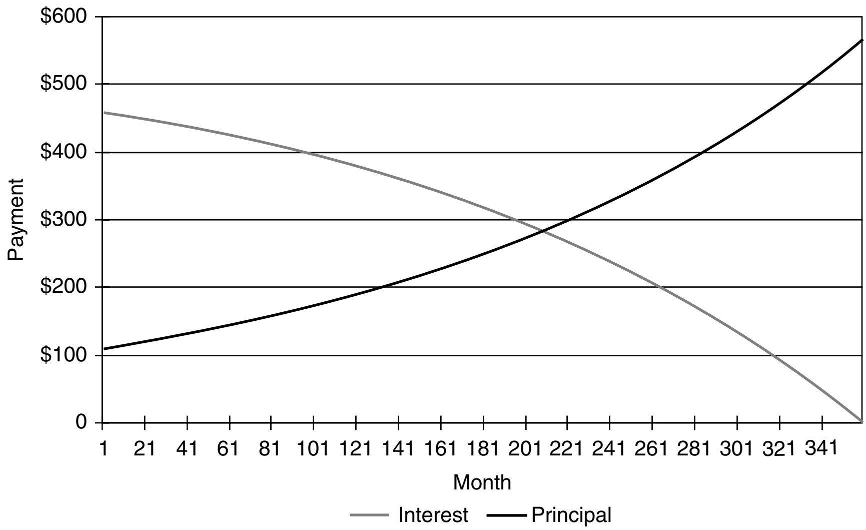
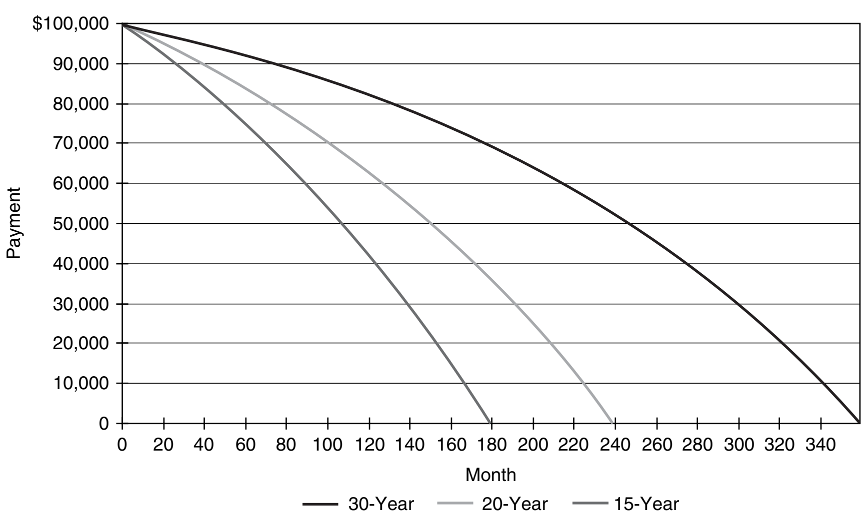


EXHIBIT 22–5

Unpaid Principal Balance for a $100,000 Fixed-Rate Loan at 5.5% for Different Loan Terms



loan (i.e., capitalizing on a decline in mortgage rates by taking a new loan with a lower rate), through the sale of the property, or through partial prepayments (referred to as "curtailments"), where the borrower reduces the outstanding balance of the loan. Some loans have prepayment penalties that extract a financial cost from borrowers seeking to refinance their loans. Such penalties generally allow partial prepayments of up to 20% of the loan's balance in any one year. However, for any prepayments involving the remaining balance, the penalty generally is calculated in terms of interest over a period (e.g., six months of interest). Prepayments (especially those due to refinancing) hurt the holder of the mortgage by calling away the asset and forcing the holder to reinvest the proceeds at lower interest rates. The implications of prepayments are discussed in more depth below.

THE MORTGAGE INDUSTRY

Within the mortgage market, there are a number of different types of financial institutions involved, either directly or indirectly, in the business of making mortgage loans. A number of different classification schemes can be used to distinguish businesses and functions.

Direct Lender versus Loan Broker

As indicated by the nomenclature, a direct lender actually underwrites and funds loans. Conversely, a mortgage broker represents clients and works with a number of different lenders in originating the loan. This involves taking the loan application and (in some cases) processing it through the GSEs' automated underwriting systems. The broker does not, however, make the loan but rather serves as an agent linking borrowers and lenders. Many large lenders classify operations in units that deal with brokers (generally called the *wholesale channel*) along with those that work directly with borrowers (the *retail channel*). These distinctions are necessary partly because the different channels have differing cost structures, necessitating alternative pricing.

Depository versus Nondepository

Depository institutions (which include banks, savings and loans, and credit unions) collect deposits from both wholesale and retail sources and use the deposits to fund their lending activities. Since depositories have portfolios (for both loans and securities), they have the option of either holding their loan production as a balance sheet asset or selling the securitized loans into the capital markets in the form of mortgage-backed securities (MBS). (In addition, there is a market for nonsecuritized mortgage portfolios among depositories because there are accounting advantages to holding loans on their books instead of securities.) Nondepository lenders (mainly so-called mortgage bankers) do not have loan portfolios; virtually all their loan production is sold to investors through the capital markets. Depositories that can hold mortgages or MBS in portfolio sometimes can be more aggressive in how they price different products, especially products they wish to accumulate in their loan or investment portfolios (most frequently short-duration assets such as adjustable-rate loans). By contrast, mortgage bankers must price all their production based on capital markets execution, which suggests that they might find it difficult at times to compete in some product sectors targeted aggressively by banks.

Originators versus Servicers

Loan *originators* underwrite and fund loan production. However, once the loan is closed, an infrastructure is required for collecting and accounting for principal and interest payments, remitting property taxes, and dealing with delinquent borrowers. Entities that provide this operational aspect of mortgage lending are called *servicers*. For providing these services, such entities receive a fee, which generally is part of the monthly interest payment. While many originators also act as servicers, servicing as a business is both labor- and data-intensive. As a result, large servicing operations reap the benefit of economies of scale and may explain the significant consolidation in this industry over the last decade. As a data point, the top 10 servicers comprised 48% of the market at the end of 2003 compared with 16% in 1993.

Servicing as an asset may be classified along several dimensions. Required, or "base," servicing is compensation for undertaking the activities described earlier, and is either dictated by the agencies or (in the case of nonagency securities or loans) conditional on the product. For example, as of this writing, the GSEs require 25 basis points of base servicing for fixed-rate loans, whereas Ginnie Mae requires either 19 or 44 basis points (depending on the securitization vehicle) for similar fixed-rate loans. The ownership of base servicing also provides the servicer with ancillary benefits, including interest float on insurance and tax escrow accounts and the ability to cross-sell other products using the database of borrower information. "Excess" servicing is any additional servicing over the base amount and is merely a strip of interest payments held by the servicer that allows the loan to be securitized with an "even" coupon, as demonstrated later in the section on execution dynamics. Excess servicing neither requires any activity on the part of the servicer nor does it convey any benefits; it is strictly a by-product of the securitization process.

The Loan Underwriting Process

After the application for a loan is filed, it is considered to be part of the "pipeline," which suggests that there is a planned sequence of activities that must be completed before the loan is funded. At application, the borrower can either lock the rate of the loan or let it float until some point before the closing. From the perspective of the lender, there is no interest-rate risk associated with the loan until it is locked. However, after the loan is locked, the lender is exposed to risk in the same fashion as any fixed-rate asset. Many lenders track locked loans and floating liabilities separately; they are referred to as the "committed" versus the "uncommitted" pipeline.

There are two essential and separate components of the underwriting process:

- Evaluation of the ability and willingness on the part of the borrower to repay the loan in a timely fashion
- Ensuring the integrity of the property and whether it can be sold in the event of a default to pay off the balance of the loan

There are several factors that are considered important in the evaluation of the creditworthiness of a potential borrower.

Credit Scores

Several firms collect data on the payment histories of individuals from lending institutions and use sophisticated models to evaluate and quantify individual creditworthiness. The process results in a *credit score,* which is essentially a numerical grade of the credit history of the borrower. There are three different credit reporting firms that calculate credit scores, namely Experian (which uses the Fair Isaac model), Transunion (which supports the Emperica model), and Equifax (which calls its model Beacon). While the credit scores have different underlying methodologies, the scores generically are referred to as "FICO scores." Lenders often get more than one score in order to minimize the impact of variations in credit scores across providers. In such cases, if the lender obtains all three scores, generally the middle score is used, whereas the convention is to use the lower value in the case of the availability of only two scores.

Credit scores are useful in quantifying the potential borrower's credit history. The general rule of thumb is that a borrower needs a credit score of 660 or higher to qualify as a "prime" credit. Borrowers with credit scores below that level can obtain loans through either the government programs (mainly the FHA) or through a subprime program, which involves higher rates or additional fees or both.

Loan-to-Value Ratio

The loan-to-value ratio (LTV) is an indicator of a borrower's leverage at the point when the loan application is filed. The LTV calculation compares the value of the desired loan to the market value of the property. By definition, a loan's LTV is a function of the down payment involved in the purchase transaction. In a refinancing, it depends on the requested balance of the new loan and the market value of the property.[2] LTV is important for a number of reasons. First, it is an indicator of the amount that can be recovered from a loan in the event of a default, especially if the value of the property declines. It also has an impact on the expected payment performance of the obligor because high LTVs may indicate a greater likelihood of default on the loan. While loans can be originated with very high LTVs, borrowers

2. If the new loan is larger than the original loan, the transaction is referred to as a "cash-out refinancing." Otherwise, the transaction is described as a "rate-and-term refinancing."

seeking a loan with an LTV greater than 80% generally must obtain insurance for the portion of the loan that exceeds 80%. As an example, if the borrower applies for a $90,000 loan in order to buy a property for $100,000, he must obtain so-called mortgage insurance (MI) on $10,000 of the balance. Mortgage insurance is a monthly premium that is added to the loan payment and can be eliminated if the borrower's home appreciates to the point where the loan has an LTV below 80%.

Another measure used by underwriters is the *combined LTV* (CLTV), which accounts for the existence of any second liens. A $100,000 property with an $80,000 first lien and a $10,000 second lien will have an LTV of 80% but a CLTV of 90%. In fact, it is fairly common to see these loans being originated together in a so-called piggyback transaction, where the borrower does not have to pay for mortgage insurance on the first lien. For the purposes of underwriting a loan, CLTVs are more indicative of the borrower's credit standing than LTVs and therefore a better gauge of the creditworthiness of the loan.[3]

Income Ratios

In order to ensure that borrowers' obligations are consistent with income, lenders calculate income ratios that compare the potential monthly payment on the loan to the borrower's monthly income. The most common measures are *front* and *back ratios*. The front ratio is calculated by dividing the total monthly payments on the home, including principal, interest, property taxes, and homeowners insurance, by the borrower's pretax monthly income. The back ratio is similar but adds other debt payments (including auto loan and credit card payments) to the total payments. Generally, the limits for front and back ratios are 28% and 36%, respectively.

Documentation

Lenders traditionally have required potential borrowers to provide data on their financial status and to support the data with documentation. Loan officers typically required applicants to report and document income, employment status, and financial resources (including the source of the down payment for the transaction). Part of the application process routinely involved compiling documents such as tax returns and bank statements for use in the underwriting process. However, over the last several years, there has been a relaxation in documentation standards with the development of newer programs that no longer demand the same degree of documentation.

This trend began in the mid-1990s, with increased lending to self-employed borrowers, who due to the nature of their employment had limited documentation and variable incomes. The tradeoff for this product, however, was to charge the borrower a higher rate to compensate the lender for the incremental risk associated with the loan. As a result, reduced- and no-documentation loans have become increasingly popular. Popular options include "stated income" loans

3. This, of course, assumes that the lender is aware of all loans made on the property; a loan made against a property carrying an unknown or "silent" second lien likely would result in an overly leveraged loan and a higher probability of ultimate principal loss.

(which require the borrower to supply an income figure but do not require it to be documented) and loans that require no disclosures on the part of applicants regarding income, assets, and/or employment. All these programs, as well as others developed using the same logic, are priced to reflect the incremental credit risk relative to standard "full documentation" loans.

The increased flexibility in documentation standards is part of a general trend toward *risk-based pricing*. In the risk-based pricing regime, borrowers with nonstandard characteristics are not denied credit but are charged a differential rate based on the perception of their incremental riskiness. The move toward risk-based pricing is responsible for the plethora of programs that have developed over the last decade to accommodate the borrowing needs of various nontraditional borrowers. This trend arguably also has created a fairer credit market because the standard borrower with stronger credit characteristics and full documentation is no longer required to subsidize the more marginal credits.

GENERATION OF MORTGAGE LENDING RATES

While it may appear simple on the surface, the determination of mortgage lending rates is a complex interplay between levels in the secondary market for loans (or, more typically, MBS), the value of servicing, the cost of credit enhancement, and the costs associated with generating the loan. In this process, the pricing of different MBS (quoted directly and through the mechanism of intercoupon spreads) is very important in determining the eventual disposition of loans because the MBS market serves to institutionalize the intermediation function by allowing providers of funds (investors) and users of funds (lenders) to interact at the national level. Using the MBS market, lenders make loans, package them into securities, sell them into the capital markets, and use the proceeds to make new loans. While certain lenders may hold some loans and products in loan portfolios (e.g., banks tend to hold short-duration products such as ARMs), the bulk of production is securitized and sold into the capital markets.

While a complete discussion of the MBS market is beyond the scope of this chapter, it is instructive to review the process involved in securitizing loans because of the importance of this process in the determination of lending rates. For the sake of simplicity, the following discussion focuses on fixed-rate conforming loans securitized under the aegis of the GSE programs. The coupons on such pools (or "pass-throughs" because they pass principal and interest through to the investor) generally are created in $^1/_2$ percentage point increments, e.g., 5.5%, 6.0%, etc. Loans, by contrast, generally are issued in $^1/_8$ percentage point increments. The creation of pools to be traded as MBS involves the aggregation of loans with similar characteristics, including note rates that are a minimum and maximum amount over the coupon rate depending on the agency and program. The weighted average of the note rates of the loans in the pool is referred to as the pool's "weighted average coupon" (WAC). The spread between the pool's WAC and its coupon rate (or pass-through rate) is allocated to three sources:

- Required or base servicing, which refers to a portion of the loan's note rate that is required to be held by the servicer of the loan. As noted previously, this entity collects payments from mortgagors, makes tax and insurance payments for the borrowers, and remits payments to investors. The amount of base servicing required differs depending on the agency and program
- Guaranty fees (or "g-fees") are fees paid to the agencies to insure the loan. Since these fees essentially represent the price of credit risk insurance, there is variation across loan types. In the conventional universe, loans that are perceived to be riskier typically require a higher g-fee for securitization. At the same time, lenders with higher volumes may be able to negotiate lower guaranty fees. For Ginnie Mae pools, the guaranty fee is almost always 6 basis points. Note that for Fannie Mae and Freddie Mac securities, g-fees can be capitalized and paid as an upfront fee in order to facilitate certain execution options
- Excess servicing is the remaining amount of the note rate that would reduce the interest rate of the loan to the desired coupon. This asset generally is capitalized and held by the servicer. Nonetheless, secondary markets exist for trading servicing in the form of either raw mortgage servicing rights or securities created from excess servicing.

A schematic showing how a typical pool issued by the GSEs allocates cash flows is shown in Exhibit 22–6.

The actual process of determining lending rates involves the calculation of discount points necessary for a range of rate levels and for rate levels associated with both positive and negative points. Negative points can be thought of as a rebate to the borrower in exchange for paying a higher rate. In this discussion we will assume that the loans in question will be securitized in fixed-rate pools issued by one of the GSEs. The process for other products is similar in concept, if not

EXHIBIT 22–6

Cashflow Allocation for a 5.5% GSE Pass-Through Pool

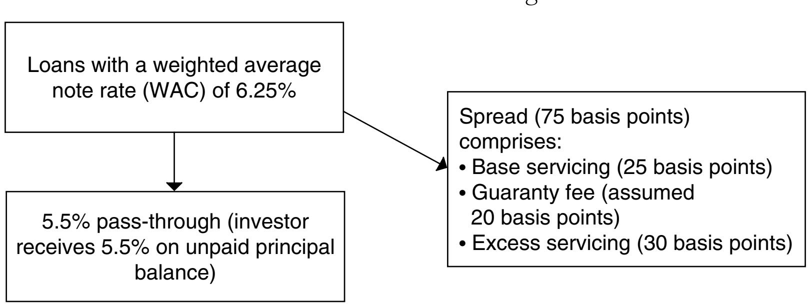


EXHIBIT 22–7

Hypothetical Rate/Point Matrix for 30-Year Conforming Fixed-Rate Loans

Rate	Points
4.750%	6.625
4.875%	5.750
5.000%	5.125
5.125%	4.625
5.250%	3.500
5.375%	2.750
5.500%	2.250
5.625%	1.750
5.750%	1.250
5.875%	0.500
6.000%	0.125
6.125%	–0.250
6.250%	–0.625
6.375%	–1.000
6.500%	–1.500
6.625%	–1.625
6.750%	–1.875
6.875%	–2.250
7.000%	–2.250
7.125%	–2.250
7.250%	–2.625
7.375%	–2.875
7.500%	–3.000

identical in process. Exhibit 22–7 shows a hypothetical matrix of rates and points for 30-year conforming fixed-rate loans.

Given existing market conditions, the process of generating points involves two steps:

- Determining the optimal execution for each note rate
- Calculating the appropriate amount of points for each note rate

Loans can be securitized in pools with a wide range of coupons (e.g., a conventional loan with a 7.5% note rate can be securitized in Fannie Mae or Freddie Mac pools with coupons ranging from 5.0% to 7.25%). To maximize their proceeds, the optimal execution is calculated regularly by the originator and is a function of the levels of pass-through prices, servicing valuations, and guaranty

EXHIBIT 22–8

Pooling Options for a 6.25% Note Rate Loan Using Hypothetical Prices and Levels

	6.0% MBS	5.5% MBS	Comments
MBS pass-through price	101	99	TBA prices for forward settlement
Base servicing	1.0	1.0	25 basis points in both cases—assumes 4× multiple*
Excess servicing:			
Amount in basis points	0	30	
Excess servicing value	0	1.2	4× multiple for 30 basis points for 5.5s*
Guarantee fee buyup/buydown:			
G-fee buyup/(down) in basis points†	20	0	
G-Fee buydown value	(0.60)	0.00	Assumes 3× multiple for buydown
Proceeds	**101.4**	**101.2**	
Total origination costs (includes allocation of G&A, hedging, and origination costs)	–1.65	–1.65	Assumed same in both cases
Net proceeds	**99.8**	**99.6**	

*For simplicity's sake, the multiples for base and excess servicing are assumed to be the same in this example. In addition, the value placed on servicing is a function of the different remittance styles used by Freddie Mac and Fannie Mae. As a result, the choice of remittance method may also affect the optimal pooling decision.

†The example assumes a 20 basis point g-fee. Note that the g-free buydown is paid to the GSE and therefore is treated as a negative value.

fee buydown proceeds.[4] Exhibit 22–8 shows two possible execution scenarios for a loan with a 6.25% note rate. Note that execution economics generally dictate that loans are pooled with coupons between 25 and 75 basis points lower than the note rates; creating a larger spread between note rate and coupon normally is not economical. In the example, securitizing the loan in the 6.0% pool is the best execution option because it provides the greatest proceeds to the lender.

Once the optimal execution is determined for each note rate strata, the associated points are then calculated. As with the execution calculation, the calculation of points is based on market prices for pass-throughs and prevailing valuations for servicing and g-fee buydowns. Exhibit 22–9 shows a hypothetical calculation of

4. Guaranty fee buydowns are the monetized value of the guaranty fee. They are paid by the originator as a fee at the time of funding.

EXHIBIT 22–9

Sample Calculation of Points Given a Lending Rate (All Levels Hypothetical)

	6.25	6.625	Comments
Optimal pass-through coupon*	6.0	6.0	
MBS pass-through price	101	101	
Servicing values:			
Base servicing†	1.0	1.0	25 basis points, assuming a 4× multiple
Excess servicing (net of guaranty fee)†	0.0	0.7	Assuming 20 basis points of guaranty fee, there is no excess servicing for the 6.25% note rate, and 17.5 basis points for the 6.625% note rate—example assumes 4× multiple.
Guaranty fee buydown	–0.6	0	For 6.25% note rate, 20 basis points of g-fee must be bought down. No buydown is required for 6.625% note rate, since 20 basis point g-fee can be paid out of the note rate after base servicing.
Total value of servicing and buydowns	0.4	1.7	
Gross value	**101.4000**	**102.7000**	MBS price plus servicing value plus origination income
Total costs			
(including origination, administrative, and hedging, costs, as well as an allocation for a targeted profit margin)	2.0	2.0	
Net value	99.4000	100.7000	Gross value less costs
Gross points	**0.6000**	**–0.7000**	100.00 less net value

*Determined by the methodology described in Exhibit 22–1.

†For this example, the assumed multiples are the same for both note rates. In practice, the multiples might be different due to different valuations placed on the servicing of the two note rates.

points for loans with 6.25% and 6.625% note rates, assuming that the best execution for both rates would be securitized as part of pools with a 6.0% coupon rate. The calculated points are shown at the bottom as the difference between the net value of the loan after pricing all components and its par value. While the example does not show it, points generally are rounded to the nearest one-eighth. In practice, points are calculated simultaneously for many rate levels and are subsequently posted in a rates/point matrix used to quote rates.

There are a few additional points to note with respect to Exhibit 22–9:

- As mentioned previously, the examples show the calculation for a loan that is eligible to be securitized in a pool issued by one of the GSEs. If a loan is ineligible for such securitization (or other options offer better execution), the cost of the guaranty fee is replaced in the calculation by the cost of alternative credit enhancement needed to securitize the loan.
- Included in the cost of the loan is the lender's targeted profit margin. Margins change in line with market conditions, specifically the levels of lending volumes and the price competitiveness of the industry at that time.

At this juncture it is useful to refer to the concept of risk-based pricing discussed earlier. As noted, the term describes the pricing of loans based on the specific attributes of the loan and its perceived incremental riskiness. The attributes include factors such as credit score, documentation style, loan size, LTV, and various combinations of these different characteristics. The paradigm suggests, for example, that a loan with reduced documentation becomes significantly riskier when the borrower also has a low credit score or that the incremental risk of a high-LTV loan increases when the loan's balance is significantly higher owing to limited liquidity in some higher-priced real estate markets.

Pricing the risk of individual attributes is accomplished through two primary methods. One methodology is based on creating multiple loan programs that reflect a variety of different attributes and prices the loans based on different guaranty fees or credit enhancement costs. This is reflected by the proliferation of lending programs that take into account credit histories, documentation, loan size, and LTV. The pricing of loans in such programs is not always intuitive. For example, some reduced-documentation programs would, on first blush, appear to be the type of program that requires a higher lending rate. However, since the credit quality of the borrowers in these programs typically tends to be extremely strong, the guaranty fee required by the GSEs is lower than that for standard programs, which in turn translates into a lower borrowing rate.

There are many cases, however, where it is not efficient to create separate loan programs. In this case, attributes are priced using "add-ons," or points added to the discount points calculated in the manner described previously. Add-ons are fees calculated to account for the incremental cost of credit enhancement for a loan. Similar to discount points, such fees are quoted as percentage points of the loan's face value. For example, a 30-year fixed-rate conforming-balance loan with a 5.875% note rate may be associated with 1/2 point. However, a borrower seeks a no income/no asset verification loan with an LTV higher than that specified by the program's guidelines. If the add-on in this case is 1 1/2 points, the loan then becomes a 5.875% loan with 2 points.

However, the disinclination of many borrowers to paying large amounts of money at closing necessitates a recalculation of the rate, given some targeted amount of points and the rate/point structure prevailing at that time. In the preceding example, suppose that the borrower only wishes to pay 1/2 point after the effect of the add-ons. Referring to Exhibit 22–7, note that a loan with 1/2 point is associated with a

5.875% note rate, whereas a loan with negative 1 point has a note rate of 6.375%. Therefore, the borrower in the example could obtain a loan with a rate of 6.375% with 1/2 point. This methodology explains, in large part, why loans with "alternative" characteristics carry higher rates than those associated with generic loans.

COMPONENT RISKS OF MORTGAGE PRODUCTS

Holders of fixed income investments ordinarily deal with interest-rate risk, which is the risk that changes in the level of market interest rates will cause fluctuations in the market value of such investments. Mortgages and associated mortgage-backed securities, however, have additional risks associated with them that are unique to the products and require additional analysis. (In the following discussions, mortgages and MBS are collectively referred to as *pools* for the sake of clarity.)

Prepayment Risk

In a previous section we noted that obligors generally have the ability to prepay their loans before they mature. For the holder of a mortgage asset, the borrower's prepayment option creates a unique form of risk. In cases where the obligor refinances the loan in order to capitalize on a drop in market rates, the investor has a high-yielding asset payoff, and it can be replaced only with an asset carrying a lower yield. Prepayment risk is analogous to "call risk" for corporate and municipal bonds in terms of its impact on returns, and it also creates uncertainty with respect to the timing of investors' cash flows. In addition, changing prepayment "speeds" owing to interest-rate moves cause variations in the cash flows of mortgage pools, strongly influencing their relative performance.

The importance of prepayments to the mortgage sector has created the need for the measurement and analysis of prepayment behavior. Prepayments occur for the following reasons:

- The sale of the property
- The destruction of the property by fire or other disaster
- A default on the part of the borrower (net of losses)
- Curtailments (i.e., partial prepayments)
- Refinancing

Prepayments attributable to reasons other than refinancings are referred to under the broad rubric of "turnover." Turnover rates tend to be fairly stable over time but are influenced by the health of the housing market, specifically the levels of real estate appreciation and home resale values. Refinancing activity, however, generally depends on being able to obtain a new loan at a lower rate, making this activity highly dependent on the level of interest and mortgage rates. In addition, the amount of refinancing activity can change greatly given a seemingly small change in rates. The paradigm in mortgages thus is fairly straightforward. Mortgages with low note rates (that are "out-of-the-money," to borrow a term from the option market) normally prepay fairly slowly and predictably, whereas loans carrying higher rates ("in-the-money") can see spikes in prepayments when rates drop, as well as significant volatility in prepayment speeds.

The measurement of prepayment rates is, on its face, fairly straightforward. A metric referred to as *single monthly mortality* (SMM) measures the monthly principal prepayments on a mortgage portfolio as a percentage of the balance at the beginning of the month in question. (Note that SMM does not include regular principal amortization.) The *conditional prepayment rate* (CPR) is simply the SMM annualized using the following formula:

$$\text{CPR} = 1 - (1 - \text{SMM})^{12}$$

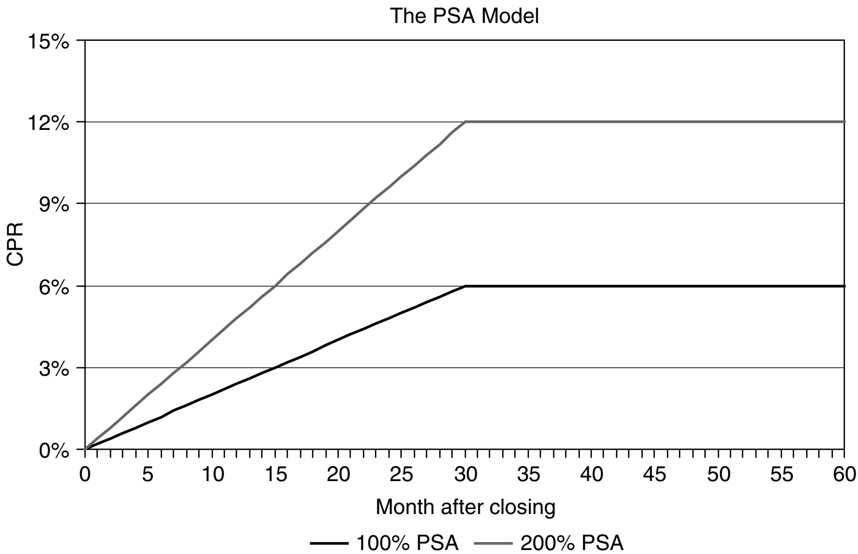
While CPR is the most common term used to describe prepayments, other conventions are also used. Logic suggests, for example, that prepayment behavior is not constant over the life of the loan. Immediately after the loan is funded, for example, a borrower is unlikely to prepay his mortgage; however, the propensity to prepay (for any reason) increases over time. This implies that prepayments adhere to some sort of "ramp," where the CPR increases at a constant and predictable rate. The most common ramp is the so-called PSA model, created by the Public Securities Association (now called the Bond Market Association). The base PSA model (100% of the model or 100% PSA, to use the market convention) assumes that prepayments begin at a rate of 0.2% in the first month and increase at a rate of 0.2% per month until they reach 6.0% CPR in month 30; at that point, prepayments remain at 6% CPR for the remaining term of the loan or security. Based on this convention, 200% PSA implies that speeds double that of the base model (i.e., 0.4% in the first month ramping to a terminal speed of 12% CPR in month 30.) Exhibit 22–10 shows a graphic representation of the PSA model.

The PSA model depends on the age of the loan (or, in a pool, the weighted-average loan age). For example, 4.0% CPR in month 20 equates to 100% PSA, whereas 4.0% CPR in month 6 represents 333% PSA. Conversely, the usefulness of the PSA model (or other ramps that are similar in nature) depends on how quickly prepayments move toward a terminal rate (or, to put it differently, how quickly they "ramp up"). It is generally understood that prepayment ramps have shortened over the last decade, reflecting the lowering of refinancing barriers and costs. In turn, this arguably has distorted the reported PSA speeds for loans that are 30 months old or less, making the PSA model less useful as a measure of prepayment speeds.

While a full discussion of prepayment behavior and risk is far beyond the scope of this chapter, it is important to understand how changes in prepayment rates affect the performance of mortgages and MBS. Since prepayments increase as bond prices rise and market yields are declining, mortgages shorten in average life and duration when the bond markets rally. As a result, the price performance of the mortgage portfolio or security tends to lag that of bonds without prepayment exposure when interest rates decline. Conversely, prepayments tend to slow when market yields are rising due to a bond market selloff, causing the average life and duration of the mortgages

EXHIBIT 22–10

The PSA Model



or MBS to increase. This phenomenon, generally described as *extension*, causes the price of the mortgage or MBS to decline more than comparable fixed-maturity instruments (such as Treasury notes) as the prevailing level of yields increases.

Owing to changes in prepayment rates, mortgages and MBS exhibit price performance that is generically referenced as "negative convexity." Since prepayments increase when rates decline, MBS shorten in average life and duration at precisely the time when they would benefit from extending. Conversely, when the bond market sells off, mortgage average lives and durations lengthen. This behavior causes the price changes in mortgages and MBS to be decidedly nonlinear in nature and to underperform those of assets that do not exhibit negatively convex behavior. Exhibit 22–11 shows a graphic representation of this behavior. Investors are generally compensated for the lagging price performance of MBS through higher base-case yields. However, the necessity of managing negative convexity and prepayment risk on the part of investors dictates active analysis and management of their MBS portfolios.

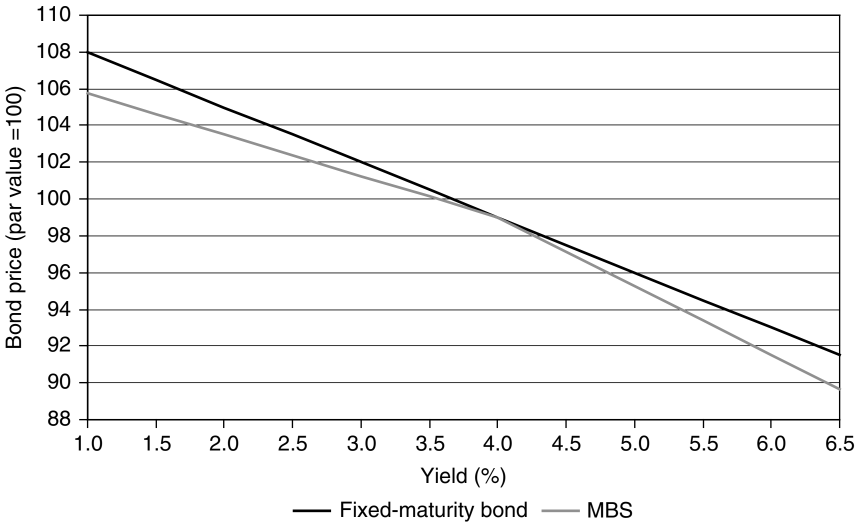
Credit and Default Risk

Analysis of the credit exposure in the mortgage sector is different from the assessment of credit risk in most other fixed income instruments because it requires

- Quantifying and stratifying the characteristics of the thousands of loans that underlie the mortgage investment

EXHIBIT 22–11

Performance Profile of Hypothetical Fixed-Maturity Bond versus MBS



- Estimating how these attributes will translate into performance based on standard metrics and the evaluation of reasonable best-, worst-, and likely-case performance
- Calculating returns based on these scenarios

In a prior section, some of the factors (credit scores, LTVs, etc.) that are used to gauge the creditworthiness of borrowers and the likelihood of a loan to result in a loss of principal were discussed. Many of the same measures are also used in evaluating the creditworthiness of a mortgage pool. For example, weighted-average credit scores and LTVs are calculated routinely, and stratifications of these characteristics (along with documentation styles and other attributes) are used in the credit evaluation of the pool. In addition to these characteristics of the loans, the following metrics are also relevant for the a posteriori evaluation of a mortgage pool.

Delinquencies

Delinquency measures are designed to gauge whether borrowers are current on their loan payments or, if they are late, stratifying them according to the seriousness of the delinquency. The most common convention for classifying delinquencies is one promulgated by the Office of Thrift Supervision (OTS); this OTS method classifies loans as follows:

- Payment due date to 30 days late: *Current*
- 30–60 days late: *30 days delinquent*

- 60–90 days late: *60 days delinquent*
- More than 90 days late: *90+ days delinquent*

Defaults

At some point in their existence, many loans that are associated with delinquencies become current because the condition leading to the delinquency (e.g., job loss, illness, etc.) resolves itself. However, some portion of the delinquent loan universe ends up in default. By definition, default is the point where the borrower loses title to the property in question. Default generally occurs for loans that are 90+ days delinquent, although loans where the borrower goes into bankruptcy may be classified as defaulted at an earlier point in time.

Defaults can be quantified in a number of ways. The *conditional default rate* (CDR) is the annualized value of the unpaid principal balance of newly defaulted loans over the course of a month as a percentage of the total unpaid balance of the pool at the beginning of the month. The *cumulative default rate* (sometimes referred to as the *CDX,* to avoid confusion) is the proportion of the total face value of loans in the pool that have gone into default to the total face value of the pool. Default rates are highly dependent on the type of loan in question; prime loans generally have cumulative default rates in the area of 1.0% to 1.5% after the first five years, whereas cumulative defaults on subprime loans can exceed 8.0% over the same period.

Severity

Since the lender has a lien on the borrower's property, much of the value of the loan can be recovered through the foreclosure process. Loss severity measures the face value of the loss on a loan after foreclosure is completed. Depending on the type of loan, loss severities can average in the area of 20% to 40% and can be heavily influenced by the loan's LTV (since a high LTV loan leaves less room for a decline in the value of the property in the event of a loss). However, in the event of a default, loans with relatively low LTVs also can result in losses, generally for two reasons:

- The appraised value of the property may be high relative to the property's actual market value.
- There are costs and lost income associated with the foreclosure process.

In light of these metrics, the process of evaluating the credit-adjusted performance of a pool involves first understanding the expected delinquencies, defaults, and loss severities of the pool based on its credit characteristics. Subsequently, loss-adjusted yields and returns can be generated. It should be noted that investors in some segments of the MBS market do not engage in detailed credit analysis; buyers of agency pools, for example, generally rely on the guaranty of the agency in question. Credit analysis is undertaken primarily by buyers of mortgages in whole-loan form, as well as investors in private-label deals (especially the so-called subordinate bonds or those parts of the deal that provide credit enhancement).

CONCLUSION

The basic mortgage instrument continues to develop and evolve along various dimensions. While the basic numeraire in the mortgage market is still the conforming loan limit as defined by the GSEs, the definition of "nonconforming" continues to expand along different dimensions. The rising rate of real estate appreciation has led to the increased creation of jumbo and superjumbo loans. At the same time, with the expansion of agency conforming limits, the distinction between conforming and jumbo loans continues to recede, with the latter category being heavily concentrated in high-cost real estate areas. In order to satisfy the demand for mortgage credit from homeowners who have varying incomes and challenges with respect to documentation, the industry has developed Alt-A loans, which continue to be a growth sector of the industry. Along an alternative dimension, the industry has further differentiated the basic conforming loan by engaging in the development of loans to impaired credits under the rubric of subprime lending. The growth of these various sectors also has created challenges with respect to pricing. While the basic pricing mechanism is still dependent on price discovery from the secondary market, mainly the market for securitized assets, the actual pricing engines rely heavily on specific loan attributes, a trend that is expected to be exacerbated as the lending paradigm continues to expand to include newer markets.

CHAPTER
TWENTY-THREE

AGENCY MORTGAGE-BACKED SECURITIES

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Agency mortgage-backed securities (MBS) are a unique asset class. They represent a core fixed income sector and have surpassed the size of the corporate debt market, as shown in Exhibit 23–1. They have essentially no credit risk and are preferred investments from the standpoint of capital requirements and other regulations. Yet, at the same time, they pose tremendous risk to investors owing to the uncertainty of prepayments on the underlying mortgages. The purpose of this chapter is to provide an overview of the distinguishing characteristics of *agency MBS,* securities issued by *government-sponsored enterprises* (GSEs), and to provide an analytical framework for evaluating the risk and relative value of these complex securities.

MORTGAGE LOANS

Mortgage loans are the building blocks of MBS. In order to develop an understanding of how MBS work, one first must become familiar with the structure and characteristics of mortgages. A mortgage is a loan that is secured by real property. A borrower or mortgagor is under legal obligation to repay the loan or risk forfeiture of the property backing the loan. A mortgage loan consists of two parts: the mortgage deed or deed of trust and the promissory note. The mortgage deed describes the real estate used as collateral against the repayment of the note. The promissory note represents the personal promise to repay the loan, which also stipulates the financial terms of the loan, including the rights of both the borrower and the lender.

Mortgages generally are categorized by interest-rate type and loan size. A fixed-rate mortgage, as the name implies, has a fixed rate of interest for the length of the loan. Loan terms can vary from 15 to 30 years, although other terms are

EXHIBIT 23–1

Size of U.S. Debt Markets, as of 3Q 2004

	Outstanding Volume ($trillion)	Percent of Total
Asset-backed securities	1.8	8%
Municipal securities	2.0	9%
Money market	2.7	12%
Federal Agency	2.8	12%
Treasury securities	3.8	16%
Corporate debt	4.6	20%
Mortgage-backed securities	5.4	23%
Total debt market	23.1	100%

Source: The Bond Market Association.

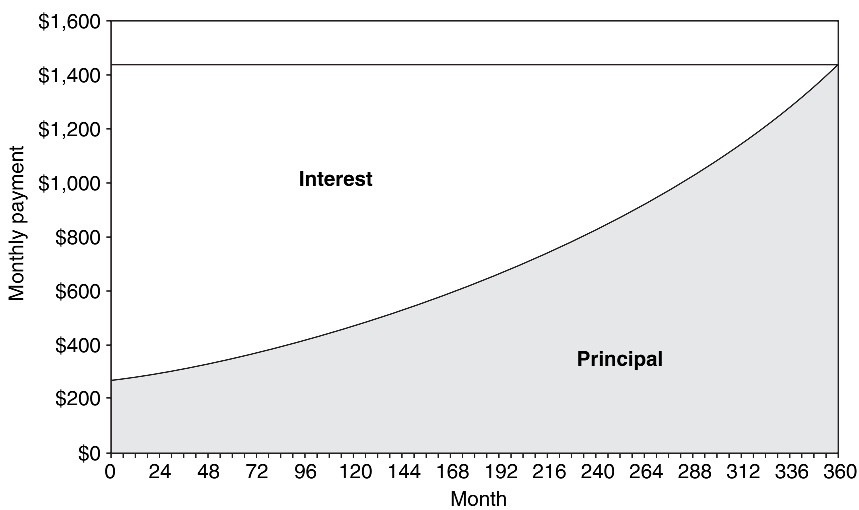
available as well. The most important attribute of fixed-rate programs is that the principal is fully amortized over the length of the loan. In other words, the principal is repaid gradually over the term of the loan compared with U.S. Treasury securities and other bonds, in which the principal generally is repaid in one lump sum at maturity. There are varying types of amortization for fixed-rate mortgages. The most common type of amortization is the *level-payment mortgage*, also known as a *constant-payment mortgage* (CPM). For a CPM, m onthly payments remain constant over the life of the loan, whereas the composition of principal and interest constantly changes, as shown in Exhibit 23–2. The exhibit shows that in the early years of the loan, the interest component of the monthly payment eclipses the principal component but eventually declines at an increasing rate over time. As the loan ages, the principal component becomes an increasingly larger portion of the monthly payment until the principal is completely repaid.

Adjustable-rate mortgages (ARMs) have variable rates of interest. Lenders typically offer ARMs at below-market "teaser" rates for an initial period of time. After the teaser rate period has expired, the coupon resets based on a specified index. Typically, the index is tied to a comparable-term U.S. Treasury bill or other market cost of funds, such as the London Interbank Offer Rate (LIBOR) or the 11th District Cost of Funds (COFI). An acceptable index from a regulator's point of view is one that is not susceptible to market manipulation by the lending institution and is driven by market conditions. Typically, the contract interest rate resets once a year subject to cap limitations. Periodic caps limit the rate increase at reset date, whereas lifetime caps limit the upper bounds of a coupon during the life of the loan. As a result, monthly payments adjust up or down as interest rates move.

Hybrid ARMs are a recent innovation in the ARM market. Hybrid ARMs blend the features of both fixed-rate and adjustable-rate mortgages. Hybrid ARMs

EXHIBIT 23–2

Constant-Payment Mortgage



initially are fixed-rate loans that convert into adjustable-rate loans after a predetermined period—typically 3, 5, 7, or 10 years—and then reset annually at a specified spread to an index over the remainder of a 30-year term. Other salient features of hybrid ARMs include cap structures and indexes. Hybrid ARMs are subject to initial, periodic, and lifetime caps. The initial cap limits the amount the contract rate of interest can rise at the first reset date. The periodic cap limits the increase in the contract rate at each subsequent reset date. The lifetime cap establishes a ceiling on the amount the contract rate can increase over the life of the loan. The most common cap structures for hybrid ARMs are presented in Exhibit 23–3. Hybrid ARMs have been issued with a variety of indexes, with the 1-year constant-maturity Treasury (CMT) as the most prevalent index prior to 2001. There has

EXHIBIT 23–3

Typical Hybrid ARM Cap Structures

Hybrid Type	Initial Cap	Periodic Cap	Lifetime Cap
3/1	2%	2%	6%
5/1	5%	2%	5%
5/1	2%	2%	5%
7/1	5%	2%	5%
10/1	5%	2%	5%

EXHIBIT 23–4

Mortgage Products and Rates Available on March 5, 2004

Program	Rate (%)	Points	APR (%)
30-year fixed	5.25	2	5.45
30-year fixed	5.75	0	5.77
20-year fixed	5.38	0	5.41
15-year fixed	4.50	2	4.84
15-year fixed	5.13	0	5.16
30-year fixed jumbo	5.75	0.25	5.79
15-year fixed jumbo	5.25	0	5.28
30-year adjustable	3.13	0	3.95
3/1 ARM	3.25	2	3.73
5/1 ARM	4.50	0.125	3.97
7/1 ARM	4.75	0	4.19
30-year fixed FHA/VA	4.75	0	6.54

APR = annual percentage rate.
Source: Countrywide Mortgage.

been a recent trend toward LIBOR-indexed hybrids, which reflects liquidity concerns with respect to the disappearance of the 1-year Treasury bill. In 2003, the Federal National Mortgage Association (Fannie Mae) introduced a LIBOR-indexed 5/1 hybrid program as a way to create more uniformity and liquidity in the market for LIBOR-based hybrid products.

The next distinguishing feature of a mortgage loan is the absolute size of the loan. For example, as of January 2005, a single-family mortgage less than or equal to $359,650 is considered a *conforming loan size*. A loan greater than the conforming loan size is called a *jumbo loan*.

Exhibit 23–4 provides a list of various mortgage products available as of March 2004. Notice that the first two products are both 30-year fixed-rate mortgages. However, the contracted rates of interest differ because the first product requires 2 percentage points of the loan amount paid upfront by the borrower at the time of loan origination. The second 30-year loan does not require a payment of points. Points (sometimes referred to as *discount points*) are paid to the lender to reduce the overall interest rate of the loan. Borrowers who plan to live in a dwelling for a long period of time tend to pay points up front to lower their interest rate and thus monthly mortgage payment. Analysts consider the choice of borrowers to pay points as often indicative or predictive of the length of expected tenure.

Further down Exhibit 23–4 you can see that the two fixed-rate jumbo mortgages (30 and 15 years) generally command higher interest rates than their conforming counterparts because jumbo loans are considered riskier owing to the larger loan amounts and because jumbo loans do not qualify for the agency loan programs. The ARM products listed have lower interest rates than fixed-rate products because these mortgages are fully adjustable after the initial fixed period has expired.

Exhibit 23–4 also quotes the *annual percentage rate* (APR), which is higher than the original contract rate and accounts for all costs, including interest, any origination fees, discount points, and private mortgage insurance, that may be part of the loan agreement.

HISTORY OF THE SECONDARY MORTGAGE MARKET

Approximately half of all mortgages are securitized and sold as MBS in the secondary mortgage market. The simplest MBS structure is a pass-through MBS, which entitles investors to a pro-rata share of principal and interest (less servicing costs and guarantee fees) from a pool of single-family-home mortgages.

The government-sponsored enterprises (GSEs) have been the main engine of growth of the secondary mortgage market. The Government National Mortgage Association (Ginnie Mae), a government agency under the supervision of the U.S. Department of Housing and Urban Development (HUD), securitizes primarily Federal Housing Authority (FHA)–insured or U.S. Department of Veterans Affairs (VA)–guaranteed mortgage loans. The Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) are private companies chartered by the U.S. government that securitize conventional mortgage loans that conform to specific loan size and underwriting guidelines. Mortgage loans that have been securitized by Ginnie Mae, Fannie Mae, and Freddie Mac are referred to as "agency MBS" and are the subject of this chapter.

The most important distinguishing characteristic of agency MBS is the implicit or explicit guarantee they carry. For example, Ginnie Mae guarantees the timely payment of principal and interest on all Ginnie Mae pass-through securities backed by the full faith credit of the United States government. Therefore, in the event that a borrower defaults on a mortgage in the underlying collateral pool, investors will continue to receive the timely payment of principal and interest.

In the case of Fannie Mae and Freddie Mac, MBS investors are also guaranteed the timely payment of principal and interest whether or not payments are made by mortgagors. However, the Fannie Mae and Freddie Mac guarantees constitute corporate guarantees and are not backed by the full faith and credit of the U.S. government. Yet, despite the lack of a formal government guarantee, Fannie Mae and Freddie Mac MBS are viewed by the financial markets as having credit status better than triple-A bonds. The source of this perception generally is attributed to the close ties between the government and the GSEs. The close ties include the history of the GSEs as government agencies, the unique regulatory structure of the GSEs, a largely symbolic line of credit to the Treasury, and the presence of presidential-appointed board members for the GSEs.

Fannie Mae was established in the 1930s to purchase and sell FHA-insured loans and eventually VA loans (1948). Prior to the 1950s, the secondary mortgage market consisted exclusively of the sale of whole loans to investors. Mortgage banks and thrift institutions would originate mortgages and sell them to life insurance companies, pension funds, and other financial institutions. The explicit government guarantee of FHA and VA loans facilitated the active trading of whole loans in the secondary mortgage market.

For much of its life, Fannie Mae operated as a national savings and loan in the sense that it gathered funds by issuing its own debt and buying mortgages that were held in its portfolio until 1968, when it was divided into two entities. A new GSE, which retained the same name, Fannie Mae, was created as a shareholder-owned GSE. Ginnie Mae also was created to continue to provide a secondary market for government-insured loans. In 1970, Ginnie Mae issued its first mortgage pass-through in which the timely payment of interest and principal was guaranteed to investors as well as the full repayment of principal even in the event of a default. At this point, Fannie Mae shifted its focus from government-guaranteed mortgages to non-FHA/VA mortgages known today as *conventional mortgages*.

In 1970, the U.S. government chartered Freddie Mac in response to credit shortages for single-family mortgages, which accounted for the largest share of the residential mortgage originations. The government's objective was to provide a secondary market for thrifts and other originators of conventional mortgages. Freddie Mac also was authorized to purchase FHA/VA loans. At the same time, Fannie Mae was given the authority to purchase conventional mortgage loans, which would allow both GSEs to compete for all residential mortgages.

As of this writing, Fannie Mae and Freddie Mac are competitors in the conventional mortgage market. There are constraints on their activities in that they cannot buy loans above the *conforming loan limit,* which is adjusted annually by an index of house prices. The conforming loan size limit was recently raised to $359,650 for 2005. Approximately 80% of mortgages in the United States fall below the conforming loan size limit.

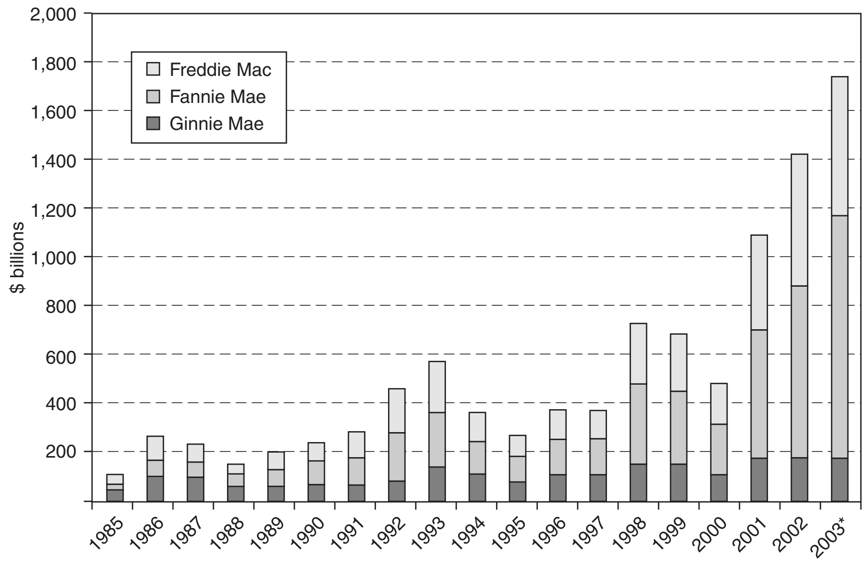
Exhibit 23–5 shows the growth pattern of the secondary MBS market since the mid-1980s. MBS issuance has remained relatively steady for Ginnie Mae since the mid-1980s, which is represented by the dark sections of the vertical bars. The volume of Fannie Mae and Freddie Mac issuance has grown steadily since the late 1980s through 1993. In recent years, the growth in issuance for Fannie Mae and Freddie Mac has been explosive. Since the last spike in issuance that occurred back in 1998, MBS issuance by Fannie Mae and Freddie Mac combined has almost tripled.

AGENCY POOL PROGRAMS

The GSEs rely on a network of lenders that originate loans in order to create mortgage pools backing their MBS. Lenders typically submit bundles of mortgage loans with similar loan characteristics to the GSEs. Once the loans pass the GSE credit quality guidelines, these loans are pooled together and eventually converted into MBS.

EXHIBIT 23–5

Annual Issuance of Agency Pass-Throughs,1985–2003



Source: Federal Reserve Bulletin and *2003 Mortgage Market Statistical Annual*.
Inside Mortagage Finance Publication Inc.

While loans in a pool may share broad similarities, differences do exist. For example, not all borrowers may be paying the same coupon. The loans may not be the same age when they were bundled. In recognition of these differences, aggregate pool characteristics or indicatives are calculated to provide investors with the starting point of their analysis. The standard terminology used to describe a typical agency pass-through can be found in Exhibit 23–6, which contains information about a specific Freddie Mac pool.

The *weighted-average coupon* (WAC) of the Freddie Mac pool in Exhibit 23–6 is 8.0%. The proceeds from a mortgage pass-through can be stated on a gross or net basis. *Gross WAC* refers to the actual weighted-average coupon of the mortgages in the underlying loan pool, whereas the *net WAC* represents the gross WAC less guaranty fees and servicing fees paid for processing the loan. The net WAC for this pool is equal to the net coupon of 7.5%. In this particular example, the servicing fee is 50 basis points, which is standard for Freddie Mac pass-throughs. *Servicing* refers to a third party who processes the homeowner's monthly mortgage payment, makes payments to local governments for property taxes, and pays the property insurance and mortgage insurance premiums if necessary. The servicer also ensures that timely payments are made by the borrower every month.

It is important to note that the dispersion of mortgage coupons within the pool is fairly small, with limits that depend on the specific agency pool program,

EXHIBIT 23–6

Freddie Mac Pool C00875, November 2004

Issue date	October 1, 1999
Collateral type	30-year fixed
Net coupon	7.5%
Current balance	$55,415,129
Original balance	$992,811,774
Factor	0.05581635
WAM (months)	287
WALA (months)	61
WAC	8.0%
Delay	44 days

which is discussed in further detail below. The WAC is important because it not only tells investors about the interest rates of the underlying mortgages but also reveals the sensitivity of the loan pool to prepayments. When current mortgage rates available to borrowers fall below 1.5% or 150 basis points of the current WAC of the loan pool, we would anticipate the pass-through to exhibit faster prepayment speeds. However, if current mortgage rates were to rise above the WAC of the pool, we would not expect prepayment rates to rise as long as this relationship between the WAC and current mortgage rates remained the same.

The *weighted-average maturity* (WAM) is another important measure because it gives investors an idea of how many payments are remaining before the principal of the pool is retired. Specifically, the WAM represents an average maturity weighted by the loan balances of the pool. In this particular example, the WAM of this Freddie Mac pool is 296 months. *The weighted-average loan age* (WALA) is just the converse of WAM and represents the average age of the underlying loans in the pool weighted by their balances. In this example, the WALA is 54 months.

The basic characteristics of loans within a mortgage pool generally have been standardized depending on the specific agency and program. The specific pooling requirements for each of the agency programs are summarized in Exhibit 23–7.

Each MBS pool carries a pass-through rate or coupon, which is the interest rate passed on to the investor, usually on the twenty-fifth day after the end of the accrual period. The pass-through rate is lower than the interest rate on the underlying mortgages in the pool. The interest differential covers the guarantee fee paid to the GSEs and the fee paid to the servicing institution for collecting payments from homeowners and other servicing functions.

Ginnie Mae offers several programs: Ginnie Mae I, Ginnie Mae II, and Ginnie Mae Platinum. Each of these programs offers full and timely payment of principal and interest backed by the full-faith-and-credit guarantee of the U.S. government.

EXHIBIT 23–7

Characteristics of Agency Pool Programs

	Ginnie Mae	Fannie Mae	Freddie Mac
Mortgage types	FHA/VA/RHS	Conventional/ some FHA/VA	Conventional/ some FHA/VA
Issuer	Ginnie I: Single issuers Ginnie II: Multiple issuers		
Guarantee	Timely payment of principal and interest	Timely payment of principal and interest	Timely payment of principal and interest
Guarantor	Full faith credit of U.S. government	Fannie Mae	Freddie Mac
Outstanding volume* ($billions)	457	1,879	1,190
Issuance in 2003* ($billions)	220	1,199	713
Minimum pool size	Ginnie I: $1,000,000 Ginnie II: $250,000		
Minimum no. of loans	Ginnie I: 3		
Servicing spread	Ginnie I: 50 bp		
	Ginnie II: 50–150 bp	Maximum of 250 bp	Maximum of 250 bp
Delay (days)			
Stated	45	55	45
Actual	14	24	14
Payment date	Ginnie I: 15th of the month Ginnie II: 20th of the month	25th of the month	15th of the month

*As of June 30, 2004.

Source: Bond Market Association.

The Ginnie Mae I program issues pass-through MBS where registered holders receive separate principal and interest payments on their certificates. This program requires all loans to be issued by a single lender. Each pool must consist of a minimum of three loans totaling a minimum dollar amount of $1,000,000. The underlying mortgages have roughly the same maturities and interest rates. Only fixed-rate mortgages can be submitted under this program. The single-family pools have a 50 basis point guaranty and servicing fee. Payments are made to the holders on the fifteenth day of each month.

The Ginnie Mae II program, which was introduced in 1983, allows registered holders to receive an aggregate principal and interest payment from a central paying agent on all their Ginnie Mae II MBS. The Ginnie Mae II program provides greater flexibility to issuers because it accommodates both multiple-issuer pools and single-issuer pools. Smaller issuers who do not meet the minimum dollar pool requirements of the Ginnie Mae I program are able to participate with pool sizes as small as $250,000. The Ginnie Mae II program also allows both fixed- and adjustable-rate mortgages. Coupon rates on underlying mortgages can vary between 50 and 150 basis points above the interest rate on the pool. Ginnie Mae II MBS pay on the twentieth day of each month.

Ginnie Mae Platinum securities are issued under the Ginnie Mae Multiclass Securities Program. A Ginnie Mae Platinum security is created by combining Ginnie Mae MBS pools with uniform coupons and original terms to maturity into a single certificate. An interesting feature of the Platinum program is that investors owning several MBS with relatively small remaining balances have the ability to aggregate the MBS. This provides critical liquidity to investors. Platinum pools also can be used by investors as collateral for repurchase agreements and structured financial products.

Fannie Mae offers a pass-through program that provides full and timely payment of principal and interest. However, Fannie Mae, not the full faith and credit of the U.S. government, guarantees the full and timely payment. Fannie Mae MBS pays interest on the twenty-fifth day of each month (after the accrual period). The pass-through rate is lower than the interest rate on the underlying mortgages; this interest differential covers the guaranty fee paid to Fannie Mae (as well as the servicing fee paid to the servicer). When the underlying loans are pooled together, Fannie Mae permits the interest rates on the loans to fall within a 250 basis point range.

Freddie Mac also offers a pass-through program that provides full and timely payment of interest and ultimate payment of principal guaranteed by Freddie Mac and not by the full faith and credit of the U.S. government. The Freddie Gold program, on the other hand, offers full and timely payment of interest and scheduled principal guaranteed by Freddie Mac. The Gold program is very competitive with the Fannie Mae MBS program; hence it is Freddie Mac's most popular MBS program. The Gold program pays interest on the fifteenth of every month. Freddie Mac also offers a Giant program that is similar in nature to the Ginnie Mae Platinum program, as described earlier.

TRADING CHARACTERISTICS

The timing and amount of cash that changes hands in a trade involving agency MBS are critical in determining the price and yield of the security. Therefore, understanding market trading conventions established for agency MBS is critical in analyzing the relative value and risk of these securities. The key issues are discussed below.

Settlement and TBA

Typically, pass-through MBS trade on a forward basis, where settlement occurs once per month. Each type of mortgage is assigned a particular day during the month for trade settlement. During any particular calendar month, the active month for which most trades will settle will be the next monthly settlement for that security. For example, during the month of June, the active trading month will be for July settlement. By the middle of July, traders generally will shift the active settlement month to August. Secondary collateralized mortgage obligations (CMOs), the subject of Chapter 24, trade mostly on a corporate (five business days) settlement basis.

The forward market facilitates the origination of mortgage loans because originating firms can sell MBS forward, prior to creating mortgage pools. In this way, the originators hedge the rates they have "locked in" for borrowers. Active trading in the one-month-forward market also stems from the importance of the CMO market. Among most Wall Street dealers, frequently the biggest trading counterparty of the MBS pass-through trader is the dealer's primary CMO desk. The pass-through trader will be responsible for purchasing the CMO collateral needed for any deal. Since most CMO deals settle one (or more) calendar month from the pricing date, trading for collateral is most active in the one-month-forward market. This does not preclude other settlement possibilities for investors. Until two days before the settlement within any particular month it is still possible for investors to purchase bonds for current-month settlement. Dealers still will make markets for current-month settlement but not always with the same liquidity as the most actively traded month.

However, there are times when attractive opportunities arise for investors as current settlement approaches. In cases where a dealer still needs collateral to settle a CMO, he may have an aggressive bid for current settlement collateral or be willing to create an attractive spread in the mortgage roll market. Investors who "roll" their mortgage pass-throughs enter into a repurchase agreement in which they sell their MBS today for repurchase at a later date. Exhibit 23–8 presents samples of to-be-announced (TBA) prices for various coupon FNMA 30s. In this example, rollers of FNMA 4.5s would sell at 98 20/32 and repurchase at a lower price of 98 11/32 in the next month. The difference of 9/32 is referred to as the *drop*.

The greater Wall Street's demand for mortgage pass-throughs settling in the nearby month, the greater is the drop. The demand for current production pass-throughs is driven by the need for collateral for CMO production. The choice of rolling bonds will depend on whether investors can reinvest the proceeds of the sale of their mortgage pass-throughs and earn a return greater than the yield of the bonds. The greater the drop, the lower the implied financing rate of the bonds.

There are also times when buyers and sellers arrange for immediate settlement. These trades occur more in unusual situations, subject to arrangements made between dealers and institutional investors.

EXHIBIT 23–8

TBA Analysis for Fannie Mae 30-Year Pass-Throughs, April 2004

Coupon	Price	May Drop (in 32nds)	May Roll Rate
4.5	98-20	–9	0.97%
5.0	101-01	–11	0.47%
5.5	102-26	–10	0.32%
6.0	104-06	–7	–0.20%
6.5	105-03	–4	1.11%
7.0	106-06	–5	0.44%
7.5	107-05	–4	–0.89%
8.0	108-00	–5	2.28%

Source: Bloomberg LP.

Settlement Cash Flows and Security Delivery

At the time of the trade, the two counterparties agree to the date, price, and quantity of securities. At the time of settlement, the purchaser will pay the price times the quantity of securities plus any accrued interest. The interest accrual period will include the number of days from the first of the month until the settlement date.

Most trades occur on a TBA basis. Mortgage lenders are allowed by the agencies to sell mortgages forward by securitizing the mortgages for purchase in the secondary market. In order to allow lenders to hedge (or fund) their origination pipelines, settlement dates are set between one and nine months from the date on which the transaction is negotiated. This permits lenders to lock in a price for the mortgages for which they are in the process of originating. An interesting feature of the TBA market is that the purchaser does not know what pools will be delivered until just prior to settlement. The number of pools that will be delivered (and the characteristics of the pools) are unknown. Generally, TBAs are analyzed using the *average characteristics of the given mortgage program.*

Trades also occur on a *specified pool basis*. These trades may reflect special inventory that a dealer holds or that a client needs. Trades on specific pools usually occur at prices above the current TBA quotes. In addition to specific pools, buyers and sellers may negotiate other types of characteristics, such as year of origination or number of pools to be delivered.

Specified pool trading occurs frequently for seasoned or WAM bonds. These are mortgage pools that contain older or seasoned loans. Given their prepayment characteristics relative to the average pools (faster for lower-coupon mortgages and slower for high-coupon mortgages), WAM bonds tend to have greater value than the generic pool and therefore sell at higher prices than the TBA price. Wall Street traders also use specified pool trading to obtain pools for structured transactions or to reduce back-office costs by restricting the number of pools to be delivered.

While pool-specific trading has existed throughout the life of the agency MBS market, the proportion of pool-specific trading has grown tremendously between 1995 and 2003, which has led to considerable fragmentation of the agency MBS market. The fragmentation is a result of the large range of loan sizes and dispersion of credit quality of borrowers within Fannie Mae and Freddie Mac conventional 30-year loan pools. The differences in agency pool composition can result in substantial differences in prepayment and, consequently, investment decisions.

In the past, Fannie and Freddie regularly provided information about loan coupons, remaining term, weighted-average loan age, weighted-average loan term, original WAM, original loan size, and issuer for each pool. Starting in 2003, Fannie Mae and Freddie Mac began to disclose additional pool characteristics that will have an impact on mortgage trading and prepayment modeling in the future. The additional disclosures include loan purpose, original loan-to-value (LTV) ratio, standardized credit scores of borrowers (FICO score), servicer, occupancy status, and property type. The availability of these additional pool characteristics likely will improve the current fragmentation of the TBA market and ultimately enhance liquidity.

Delay of Cash Flows

Nearly all borrowers make their mortgage payments in arrears on a monthly basis. Likewise, investors receive their cash just once a month. The time between the expected cash payment from the borrower and the ultimate cash flow received by the investor is called the *delay*. The effect of this delay must be treated by the yield calculations performed on MBS because it represents a true loss of economic opportunity. The delay varies slightly among the agencies and GSEs (see Exhibit 23–7).

While the delay factor is meant to cover many of the exigencies that occur when borrowers are late with their payments and the mechanical complications of processing the cash flows, it also provides an important source of income to the financial intermediaries. Both Fannie Mae and Freddie Mac derive significant income from the float earned between the time they collect cash flows and disburse them to investors.

Accrued Interest

The MBS begins to accrue interest on the first calendar day of the month. This corresponds to the same accrual period for the borrower. At the time of settlement, the investor must pay the previous holder the interest through the settlement date. After settlement, the investor is entitled to the entire month's interest.

MBS accrue interest on a 30/360-day basis. That is, accrued interest calculations assume that each month has 30 days and that each year has 360 days. Practically speaking, this means that each month the investor receives 1/12 of the annual coupon. As for calculating accrued interest, the investor receives 1/30 of the monthly interest payment for each day up until settlement. No additional interest is paid for settlement on the thirty-first of the month. Typically, most settlement occurs in the middle of the month, so the extra day is not an issue.

Delivery Standards: Variance and Pools per Million

In the nuts and bolts of trading MBS, some accommodations are made to smooth the settlement process. Many MBS pools are not originated in round dollars. However, trades between dealers and institutional investors usually take place in even lot sizes of $1 million or more. To accommodate the anomalies of pool size, the seller has some flexibility regarding the number of pools delivered and the principal amount settled.

In settling a trade, the seller can modify the amount of principal delivered. This deviation from the original trade amount is called *variance*. The variance permitted on TBA trades of Fannie Mae, Freddie Mac, and Ginnie Mae securities is ±0.01% of the dollar amount of the transaction agreed on by the parties. In the case of specified pool trades, no allowance for variance is permitted. If the variance is not within the 0.01% limit, the pools are not considered good delivery. In a declining market, sellers of MBS probably will deliver as much as possible in a trade, taking full advantage of the upper end of the variance limit. The opposite will occur in a rising market.

In order to keep someone from delivering a large number of low-principal dollar pools, the Bond Market Association, formerly the Public Securities Association (PSA), also limits the number of pools delivered in a trade. Restricting the number of pools to a small number has some operational benefits for the MBS purchaser. Tracking the monthly principal and interest payments can be labor-intensive and costly. Left unchecked, sellers would attempt to unload all of their small pools on someone else. Over time, the delivery requirements have been modified somewhat, allowing for more pools per trade for higher-coupon MBS. The increased number of pools reflects the high paydowns and the resulting low balances. The standard requirements for delivery and settlement of MBS are published in the *Bond Market Association Uniform Practices* manual, which is available online at www.bondmarkets.com.

PREPAYMENT AND CASH-FLOW BEHAVIOR

Prepayments are the primary distinguishing feature of MBS. Without prepayments, mortgages would be extremely easy to analyze. On the other hand, if MBS were so simple, the number and scope of investment opportunities would be severely limited. Prepayments are the double-edged sword of the MBS market. They create opportunity, but they also create risk.

The timing and amount of cash flows received by pass-through MBS are greatly affected by the prepayment behavior of underlying mortgages within the MBS pool. Borrowers generally have the right to prepay their loans at any time without penalty (with the exception of some subprime loans). Borrowers may pay off their loans in full or in part. For a full prepayment, the borrower pays off the remaining outstanding balance of the loan. Partial prepayments, often referred to as *curtailments,* reduce the balance of the loan but do not alter the scheduled monthly payments.

For individual loans, a partial prepayment shortens the life of the loan. However, for a pool of loans, a full prepayment of one or several loans does not have the same effect as a partial prepayment of an individual loan. Full prepayments of loans within a pool serve to reduce the outstanding balance but not reduce the average maturity of the underlying loan pool.

PREPAYMENT CONVENTIONS

Prepayments are defined as the difference between the actual balance of the MBS pool in any month and the balance expected owing to normal amortization. The market has developed several approaches to describing the prepayments for a pool of loans. Since MBS pools vary in size, prepayments measured in dollar terms would not make meaningful comparisons. Exhibit 23–9 summarizes three prepayment conventions, which are all expressed as a percentage or rate.

In order to develop a familiarity with the conventions, we will work through some numerical examples.[1] Using information about the scheduled balance, actual balance, and age presented in Exhibit 23–10, we can calculate the prepayment rates in SMM, CPR, and PSA formats.

SOURCES OF PREPAYMENTS

Prepayments arise when borrowers move, refinance, or default on their mortgage loans. Prepayments that result from changing residences constitute a base prepayment rate that is referred to as *turnover*. Job changes, marriage, divorce, and children are factors that directly affect housing turnover. Most conventional mortgages (non-FHA/VA loans) contain a *due-on-sale clause,* which stipulates that the mortgage must be paid in full when the house is sold. In contrast, FHA/VA loans are often *assumable,* which means they can be transferred to the new homeowner as long as the new borrower meets minimum credit requirements.

Mortgage refinancing represents the largest and most variable source of prepayments. There are several categories of refinancing that can occur. For example, there are high-quality borrowers who want to take advantage of lower-cost mortgages in a falling-interest-rate environment. There are also borrowers who refinance in order to borrow more money than the existing loan balance on their property, provided that there is sufficient equity in the home. This type of refinancing activity is called a *cash-out refinance*. Borrowers with previously tarnished credit histories are able to refinance at more favorable rates because of improvements in their credit ratings. This type of refinancing is referred to as *credit curing*.

Defaults are not technically prepayments, but they have the same effect as prepayments in that the principal balance of the defaulted loan is returned to the

1. Formulas for calculating SMM, CPR, and PSA can be found in the *Bond Market Association Uniform Practices* manual. Many other formulas for MBS valuation can be found there as well.

EXHIBIT 23–9

Prepayment Conventions

Single monthly mortality (SMM)	The SMM measures the percentage of dollars prepaid in any month, expressed as a percentage of the expected mortgage balance.	$\text{SMM} = 100 \times \dfrac{(\text{scheduled balance} - \text{actual balance})}{\text{schedule balance}}$
Conditional prepayment rate (CPR)	CPR reflects the percentage prepayment rate resulting from converting the SMM to an annual rate. The CPR is best understood as the percentage of non-amortized balance prepaid on an annual basis.	$\text{CPR} = 100 \times \left[1 - \left(1 - \dfrac{\text{SMM}}{100}\right)^{12}\right]$
Public Securities Association (PSA) model	An industry convention adopted by the Public Securities Association in which prepayment rates, expressed in CPR, are assumed to follow a standard path over time. This path assumes that the prepayment rate for a pool of loans increases gradually over the first 30 months and then levels out at a constant rate. Along the 100% PSA curve, the prepayment rate starts at 0.2% CPR in the first month and then rises 0.2% CPR per month until month 30, when the prepayment rate levels out at 6% CPR.	$\text{PSA} = 100 \times \dfrac{\text{CPR}}{\text{minimum (age,30)} \times 0.2}$

Note: The Public Securities Association is now the Bond Market Association, but the name PSA for the prepayment convention has not changed.

EXHIBIT 23–10

Sample Prepayment Rate Calculations

Scheduled balance	154,000
Actual balance	153,000
Age (months)	25
SMM	0.65%
CPR	7.52%
PSA	150.50%

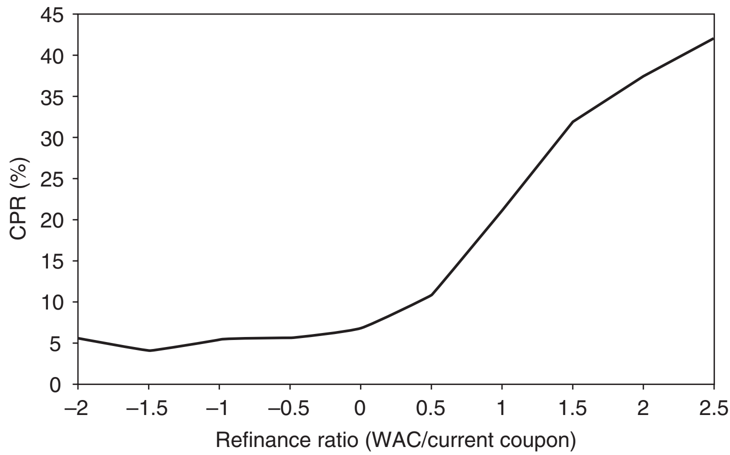
investor in the case of agency MBS. Because of the explicit and implicit guarantee provided by the GSEs, the investor is protected from the credit risk of individual borrowers that compose the pool. Defaults of agency MBS represent only a small fraction of monthly prepayments because of the high credit quality of the underlying mortgages and therefore can be forecast as part of prepayments. In some cases, particularly for nonagency subprime mortgages, it is critical to forecast defaults separately from prepayments because of the lower quality of the collateral.

The most important factors that affect the prepayment behavior of individuals include interest rates, aging, burnout, and seasonality. The primary factor influencing prepayment rates is the level of interest rates, which reflects a borrower's opportunity to refinance. The refinancing incentive is reflected by the difference between the interest rate of the borrower's loan versus the interest rate currently available in the market for new loans. For example, in the Andrew Davidson & Co. prepayment model, we use the current coupon yield (the yield on MBS trading near par) as a proxy for the rates currently available to borrowers. Loans where the difference between the loan coupon and the current coupon yield are greater than zero have a greater incentive to refinance. Exhibit 23–11 demonstrates the effect. As the refinance incentive ratio moves from negative to positive territory, prepayment speeds increase, as shown by CPR along the vertical axis. The relatively level prepayment speeds for refinancing incentive ratios less than zero reflect the base turnover phenomenon in the housing market. These loans where the coupon is less than the current coupon yield are called *discount loans* because they have prices less than par.

Aging is the second most important factor influencing prepayment behavior. Aging reflects the fact that new loans typically exhibit slower prepayment speeds compared with "seasoned" or older loans. The PSA benchmark aging curve was introduced in the mid-1980s to account for the aging pattern typically observed for agency MBS. The base PSA curve or 100% PSA is depicted in Exhibit 23–12 and starts at 0 CPR and rises linearly to 6 CPR by month 30. The PSA curve roughly depicts the prepayment pattern for discount loans but not for premium loans. Given the variation in aging patterns for different loan types, the

EXHIBIT 23–11

Interest-Rate Effect on Ginnie Mae 30-Year Prepayment Rates



PSA curve should be used with caution because it assumes the same aging pattern for all loan types and coupons.

Exhibit 23–13 shows the aging pattern of Ginnie Mae loans by coupon type. *Premium coupon loans* are defined as loans whose coupons are greater than the prevailing market rate and therefore have a positive refinancing incentive,

EXHIBIT 23–12

PSA Prepayment Convention

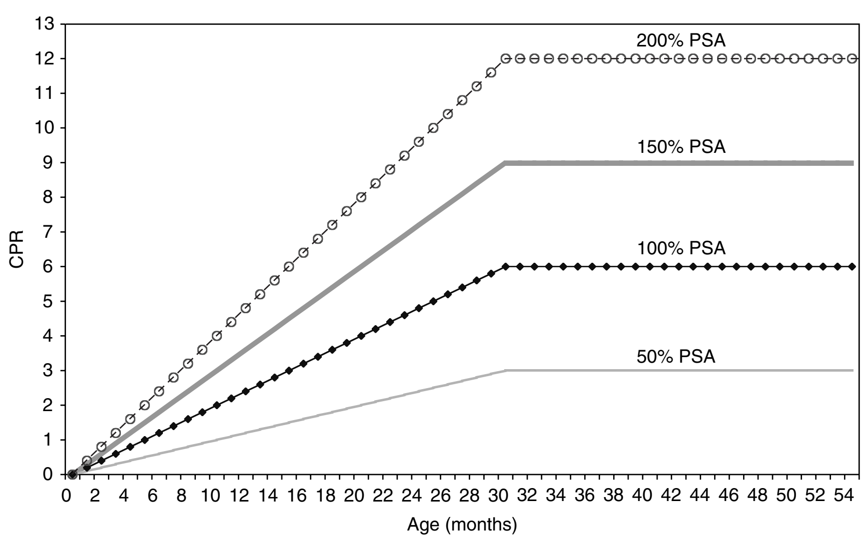
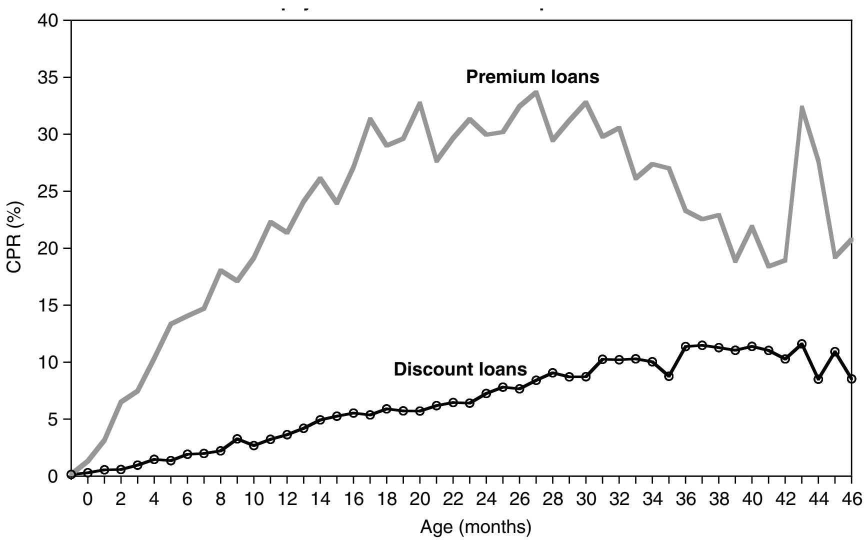


EXHIBIT 23–13

Prepayment Rates of Discount versus Premium Loans



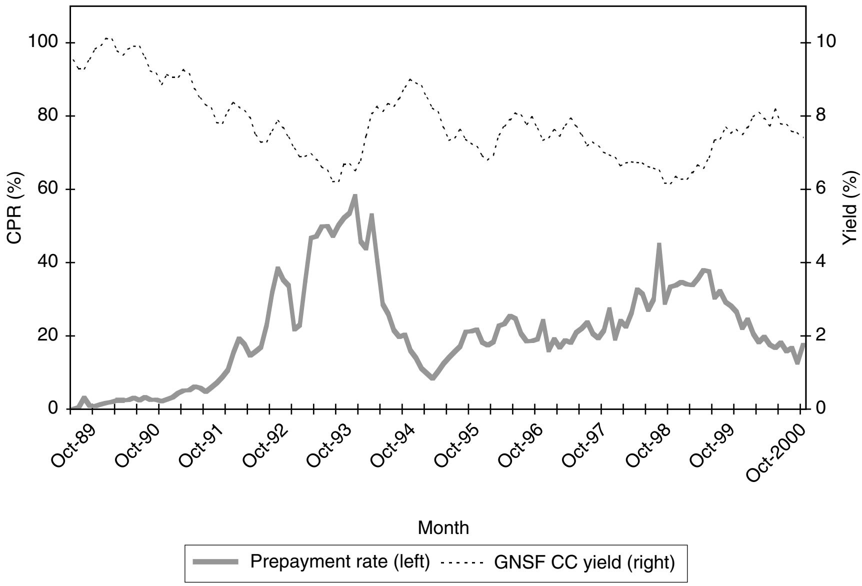
whereas *discount coupon loans* have coupons that are less than the current market rates. The exhibit illustrates that newer loans prepay more slowly regardless of whether they are premium or discount loans. Moreover, the exhibit also shows that not all loans age at the same rate. The premium loans experience higher prepayment speeds and peak sooner compared with the discount loan counterparts in the exhibit. In addition, the prepayment rates of discount loans tend to rise more slowly and peak farther out on the aging curve.

Burnout is the next most important factor determining the rate of prepayments and probably the most difficult to measure. The concept of burnout is based on empirical observation that refinancing activity within a loan pool declines over time regardless of whether interest rates continue to decline further. Exhibit 23–14 graphically illustrates the effect of burnout. The exhibit compares prepayment rates for Ginnie Mae 30-year 9.5s originated in the fourth quarter of 1989 with the Ginnie Mae 30-year current coupon yield, a proxy for the market prevailing rates. The exhibit shows that prepayments rose in conjunction with falling interest rates during the period 1989–1993. Prepayment speeds reached a peak CPR of 58% by the end of 1993 when interest rates had bottomed out at around 6%. As interest rates rose in 1994, prepayment speeds declined. However, even when interest rates fell back to 6% in 1998, prepayment speeds did not rise to original levels but generally remained below 40 CPR.

The burnout effect can best be understood by viewing an MBS pool as a collection of borrowers each with different propensities to refinance. Each borrower faces unique circumstances. Some have large families. Others are single. Each

EXHIBIT 23–14

Burnout Effect for Ginnie Mae 30-Year Pass-Throughs, 9.5 Coupon



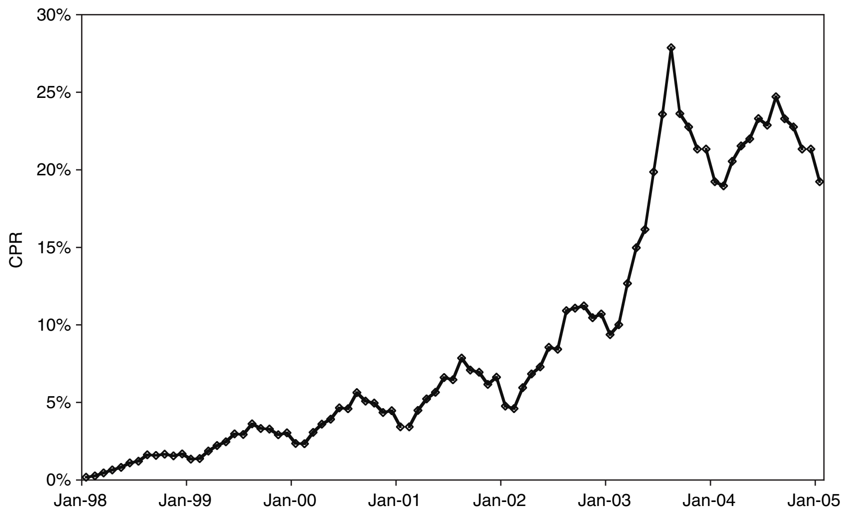
live in different geographic locations and have varying levels of education and financial resources. Given the diversity of borrowers, it is not surprising that they require different incentives to refinance. As rates fall, the borrowers with the greatest propensity do so. The borrowers remaining in the pool face higher refinancing costs, economic and noneconomic. These borrowers tend to repay at a slower rate compared with the first group of borrowers. Eventually, the only borrowers remaining in the pool are those with a very high refinancing threshold. At this point, the pool is considered burned out. It will continue to experience some prepayments but at a slower rate than for new pools.

Seasonality is another major determinant of prepayment rates. Seasonality reflects the close interaction of prepayments with housing market activity. Exhibit 23–15 shows that prepayments tend to be faster during the summer and slower during the winter months, reflecting increased home turnover during the summer months. Seasonality is more pronounced for discount loans compared with premium loans. Premium loans do not exhibit a large seasonal component because refinancing activity tends to eclipse the seasonality effect. The commonly observed features of seasonality are as follows: prepayments tend to be highest in May and July with an uptick in December, perhaps reflecting year-end tax strategies and moving during the holidays.

Housing markets and the *shape of the yield curve* also influence prepayments. Weak economic activity, declining housing prices, and unemployment all

EXHIBIT 23–15

Seasonality of Prepayments



tend to depress prepayments. These factors sometimes are regional in nature and can lead to large differences in prepayments across the United States. During the 1990s, home price appreciation strongly affected prepayments because rising home prices resulted in greater homeowner equity, thus increasing financial opportunities available to borrowers.

The shape of the yield curve also can affect prepayments. With the development of a variety of mortgage products such as ARMs, hybrid ARMs, and balloon loans, borrowers can choose products whose prices are derived from different parts of the yield curve. When the yield curve is steep, borrowers may refinance into shorter-maturity loans in order to reduce their borrowing costs. When the yield curve is flat, it may be advantageous for borrowers to lock in rates at the long end of the yield curve, particularly if they have a long time horizon.

PREPAYMENT MODELS

Evaluation of the investment characteristics of MBS requires estimates of prepayment rates. These estimates can take various forms, from a single assumption based on experience to complex models that rely on loan level details.

These forecasts, regardless of their source, are used to understand the performance characteristics of MBS and to determine appropriate valuation of different investments. Prepayment forecasters face a fundamental problem. They seek to estimate future events in a changing world. For example, new loan types are constantly being created, and the loan origination process is continually evolving. Still, the primary guide to future prepayments is past prepayments. Thus forecasters develop models that seek to explain prior prepayments. They hope that this information will provide valuable insights into future prepayments. Since the economic and social environment is changing constantly, and prepayments are affected by a host of factors, it is unlikely that any historically based analysis will completely reflect future prepayments. Investing based on prepayment models is a little like driving while looking through the rear view mirror. It may be hard to stay on the road, but it's better than driving with your eyes closed.

Good models are robust and parsimonious. Robust models provide good forecasts under a variety of conditions. That is, they do not need to be adjusted continually to reflect changing environments. Models that require constant adjustments probably will not provide accurate forecasts of future prepayments. *Parsimonious* means that the models are as simple as possible. Parsimonious models capture the major variables that affect prepayments using the fewest number of parameters. They have the advantage that they do not overfit the data compared with models with too many factors. The use of complex models with many parameters may result in an excellent fit to historical data but may not provide accurate projections. The added variables may reflect a spurious one-time correlation rather than real long-term relationships. Parsimonious models are also easier to incorporate into valuation tools.

Exhibit 23–16 shows the actual versus forecast (from an Andrew Davidson & Co. prepayment model) prepayment speeds for Fannie Mae 30-year MBS for 2003.

EXHIBIT 23–16

Performance by Coupon for Fannie Mae 30-Year Pass-Throughs

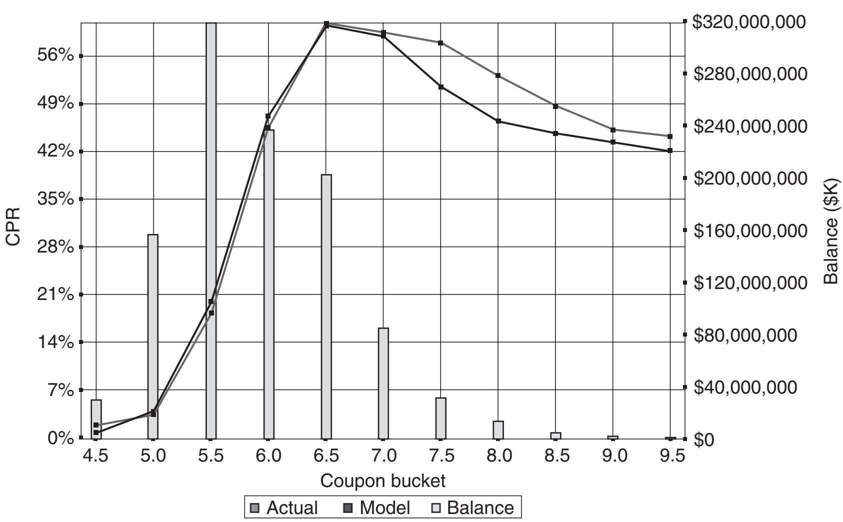


EXHIBIT 23–17

Median Prepayment Speeds for Wall Street Dealers

Page DG65 Govt **VMED**

B.Median **Mortgage Default Table** Mortgage Ticker: GNSF Age:TBA

3/17/04 LAST UPDATE

Bloomberg MEDIAN PREPAYMENTS Page 2 of 2

PAGE for Graph

		WAM			TRSRY	DIRECTED VALUES							
CPN	PSA	YR	MO	WAC	SPRD	-300	-200	-100	-50	+50	+100	+200	+300
4.000	127	29	7	4.500	10	1310	694	202	158	121	121	121	121
4.500	158	29	5	5.000	10	1427	1365	563	262	130	121	108	97
5.000	252	29	5	5.500	5	1513	1555	949	513	163	139	119	103
5.500	463	29	5	6.000	5	1452	1461	1210	865	246	169	135	117
6.000	703	28	11	6.500	2	1464	1402	1257	1024	419	249	157	129
6.500	744	28	3	7.000	2	958	970	968	920	563	354	187	150
7.000	737	27	9	7.500	2	910	920	908	861	598	457	219	170
7.500	685	26	10	8.000	2	831	808	739	729	639	527	296	201
8.000	671	26	7	8.500	2	800	769	769	729	641	576	371	229
8.500	681	26	4	9.000	2	765	761	752	756	647	618	452	264
9.000	854	26	4	9.500	2	927	911	889	892	793	713	525	311
9.500	595	19	6	10.000	2	932	837	719	663	557	553	526	358
10.000	578	17		10.500	2	869	783	683	637	508	446	333	248

Source: Used with permission from Bloomberg LP.

The major Wall Street firms also have prepayment models. Bloomberg LP computes the median prepayment speeds for dealers. A sample of the median results is shown for various coupon rates for Ginnie Mae securities as of March 17, 2004 in Exhibit 23–17.

VALUATION

A common measure of value quoted among investors is the spread between the MBS and a benchmark U.S. Treasury security. While spread measures are inadequate because they provide only a static view of relative value, they are a useful starting point for assessing relative value. Exhibit 23–18 presents various spread measures for Fannie Mae 30-year MBS with coupons ranging from 4.5% to 8%.

The first spread measure presented in the Exhibit 23–18 is the static yield, which is labeled "Spread/Benchmark." It is computed by subtracting the yield of a specific U.S. Treasury security from the yield of the MBS. For newly issued current coupon MBS, the benchmark Treasury is often the on-the-run 10-year Treasury note. Other MBS are compared with U.S. Treasuries with similar average lives. The first number represents the spread in basis points, and the second number represents the benchmark Treasury. For example, the spread of FNMA 5.0 is 190 basis points over the 5-year Treasury.

EXHIBIT 23–18

Spread Analysis for Fannie Mae 30-Year MBS, March 5, 2004

							Spread to		
Agency	Coupon	Maturity (years)	WAM	Price	Yield	WAL	Spread/ Benchmark*	WAL Treasury	Zero Curve
FNMA	4.5	30	353	97.58	4.86	7.2	97/10	161	102
FNMA	5.0	30	354	100.45	4.75	4.9	190/5	194	131
FNMA	5.5	30	350	102.39	4.38	3.2	153/5	242	127
FNMA	6.0	30	342	104.06	3.66	2.2	221/2	214	90
FNMA	6.5	30	338	105.08	3.35	2.0	229/2	194	82
FNMA	7.0	30	336	106.06	3.07	1.8	207/2	169	69
FNMA	7.5	30	338	107.03	3.12	1.9	107/2	173	72
FNMA	8.0	30	337	107.94	3.15	1.9	287/2	175	75

Source: Andrew Davidson & Co. Inc., prepayment and OAS models.
*Source: Bloomberg LP.

A more reliable measure of value than static yield is an interpolated weighted-average life spread, which is also shown in the same exhibit as "Spread to WAL Treasury." This measure uses a Treasury benchmark that more closely reflects the principal repayments of the MBS. For example, rather than compare the FNMA 4.5 with a 10-year Treasury, we would compare this MBS pass-through with a Treasury with the same WAL of 7.2 years. In order to do this, we interpolate the yield of a Treasury with an average life of 7.2 years. Notice that the interpolated weighted-average life spread for the FNMA 4.5 is greater than the static spread. The difference can be attributed to the divergence between the average lives of the MBS and the benchmark Treasury, which makes the WAL spread more reliable.

The spread to the zero curve or "zero spread" is also presented in Exhibit 23–18 and is a great improvement on static yield and interpolated WAL spread because it incorporates the shape of the yield curve and timing of cash flows. The cash flows of the MBS are discounted by the zero-coupon rate plus a constant spread that equates the net present value of cash flows to the current market price. In Exhibit 23–18, the zero spreads are lower compared with the WAL spreads. The reason for this is that lower yield spreads earned on longer-dated cash flows have a greater effect on value than the higher spreads earned on earlier cash flows. The flatter the yield curve, the less divergence will be observed between WAL and zero spread measures.

Option-adjusted spread (OAS) is the most important measure of risk and value because it takes into consideration the changing nature of underlying cash flows under a multitude of interest-rate scenarios. OAS represents the average expected spread to a benchmark yield curve over a large number of possible interest-rate scenarios. OAS captures the additional yield an investor is expected to earn from the prepayment option component of MBS cash flows.[2]

Additional measures such as *effective duration* and *effective convexity* also provide insight into the value of risk of the security. Effective duration measures the change in price for a 100 basis point change in interest rates, holding OAS constant. Convexity measures the change in duration for a 100 basis point change in rates. *Negative convexity* is a general feature of MBS due to prepayments, which limit the amount of upside price appreciation relative to the amount of downside price risk.

Exhibit 23–19 presents OAS results for various coupon Fannie Mae 30-year pass-throughs. The calculations were generated using the Andrew Davidson & Co. prepayment and OAS models. The OAS values on Fannie Mae pass-throughs on March 5, 2004 range between 30 and 70 basis points. The higher-premium coupons exhibit the highest OAS values. Notice that the lower-coupon pass-throughs have the highest effective durations, whereas the lower-premium coupons have the highest negative convexity. The high negative convexity for the 5.0s and 5.5s can be explained by the close proximity of these coupons to the refinancing threshold.

2. OAS is discussed in more detail in Chapter 38.

EXHIBIT 23–19

OAS Analysis for Fannie Mae 30-Year Pass-Throughs, March 5, 2004

Agency	Coupon	Price	Yield	OAS	Effective Duration	Effective Convexity
FNMA	4.5	97.58	4.86	31	5.02	–1.22
FNMA	5.0	100.45	4.75	21	3.89	–2.19
FNMA	5.5	102.39	4.38	20	2.49	–2.40
FNMA	6.0	104.08	3.66	22	1.77	–1.45
FNMA	6.5	105.08	3.35	42	1.76	0.58
FNMA	7.0	106.06	3.07	56	1.88	0.04
FNMA	7.5	107.03	3.12	63	1.92	–0.11
FNMA	8.0	107.94	3.15	69	1.87	–0.07

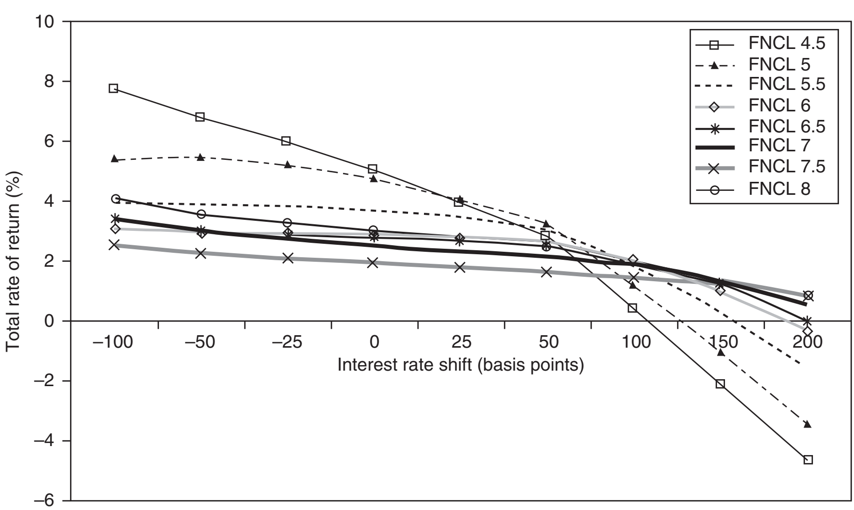
Source: Andrew Davidson & Co., Inc. prepayment and OAS models.

The 4.5s exhibit a much lower negative convexity because discount coupons have lower volatility of prepayments owing to lower refinancing incentives. Higher-premium coupons also exhibit lower negative convexity because of the burnout effect described earlier.

The impact of negative convexity is illustrated in the performance profiles of these Fannie Mae pass-throughs in Exhibit 23–20. The negative convexity

EXHIBIT 23–20

Total Return Analysis of 30-Year Fannie Mae Pass-Throughs



limits the upside in a falling-interest-rate environment and buffers the downside in a rising-rate environment. The effect of negative convexity is most pronounced for the 5.0 and 5.5 coupons. The exhibit shows that the total returns of the 5.0s and 5.5s are considerably dampened compared with the 4.5s as interest rates fall. In contrast, the total returns of 5.0s and 5.5s do not fall quite as steeply as the 4.5s in a falling-rate environment.

SUMMARY

Investors are attracted to agency MBS owing to the high credit quality, high yields, and tremendous liquidity of the market. However, investors must be careful to consider the impact of changing prepayment patterns on their investments. The large volume of MBS also has made agency MBS an attractive source of collateral for the CMO market.

CHAPTER

TWENTY-FOUR

COLLATERALIZED MORTGAGE OBLIGATIONS

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This chapter introduces the reader to the U.S. collateralized mortgage obligation (CMO) market. The first section of this chapter gives the background of the CMO market and explains the difference between agency and nonagency CMOs. The chapter then covers all of the major CMO tranche types in terms of structure and analysis, providing practical examples. It also covers information about option-adjusted spread (OAS) and prepayment models and how to use that information to hedge CMOs or determine relative value. While the chapter is aimed at the CMO novice or those who need a refresher, some of the analysis techniques covered are appropriate for investors already familiar with the CMO market.

THE CMO MARKET

The CMO market has existed since the mid-1980s. Its original purpose was to allow investors to more closely control when they receive principal from mortgage-backed securities (MBS). With pass-throughs, principal is received each month throughout the life of the security, often for a full 30 years. In a CMO, the principal is divided up into pieces, or *tranches,* creating some bonds that receive principal right away (and hence have shorter durations) and some bonds that do not, typically resulting in longer durations. The creation of so-called planned amortization class (PAC) bonds took the CMO a step further, attempting to create a corporate bond surrogate that investors could get comfortable with.

Now the CMO market has exploded into a myriad array of tranches using different types of collateral. The cash-flow priority of tranches can even jump around based on prepayments. The same financial technology used to create CMOs was used to create the domestic asset-backed securities (ABS) and collateralized debt obligations (CDO) markets and other securitized products markets overseas.

Why Do They Exist?

Like any security, CMOs exist because there is a market to buy and sell them. From the demand side, there are investors that still want to more closely control the cash flows they get from an MBS investment. In addition, the CMO market has grown to such an extent that many other things are possible using the CMO market than with the MBS pass-through market. From the supply side, CMO originators continue to operate as long as they can make a reasonable profit in the business. Often, all the CMO tranches are not sold right away, which forces the dealer to hold inventory and thus take risk.

Size of the CMO Market

The CMO market eclipsed its 1993 issuance record with a record-breaking $1 trillion-plus year in 2003. A booming housing market, low interest rates, a steep yield curve, and bank demand for CMOs have been the factors contributing to these record issuance numbers. Issuance of new CMOs dwarfs that in most other markets, including Treasuries and corporate bonds.

Liquidity

The raw size of the CMO market suggests that it should have enormous liquidity. However, liquidity is somewhat hampered by lack of homogeneity in the CMO market. Even the most common tranche types, PACs and sequentials, may have subtle differences that need to be examined and valued. (We will discuss this in detail later.) The liquidity of CMOs is typically less than pass-throughs but comparable with corporate bonds. Even specialized derivatives, such as interest only (IO) strips, often have relatively tight bid-ask spreads of around an eighth of a point.

Practical Details

In this section we cover practical details such as typical payment and settlement structure for CMOs. Rules generally are different for CMOs than for corporate bonds. In some cases, rules are different for certain types of CMO tranches than for pass-throughs.

Bond Settlement

CMOs usually settle in book entry via DTC (Depository Trust Co.). Primary market CMOs may have delayed settlement, similar to pass-throughs. For example, many new-issue CMOs settle in the month after the trade date. New-issue CMOs usually settle at the end of the month, to allow the dealer time to bring in collateral and finish structuring the deal.

Secondary-market CMO transactions are typically for corporate settlement, presently $T + 3$ business days. It is possible to trade CMOs for other settlements, such as cash, if necessary.

Monthly Interest and Principal Payments

CMOs pay interest monthly, similar to the underlying pass-throughs. Tranches eligible to receive principal payments will receive them at the same time as the interest payments. Most CMOs have the same number of delay days as the underlying collateral, for example, 55 stated delay days for FNMA pass-throughs. However, certain tranches such as CMO floaters may have reduced delay days to facilitate comparison with corporate bonds. The number of delay days for each tranche is available in the prospectus or from electronic sources. Of course, the number of delay days affects yield because interest and principal are returned later (and hence reinvestment interest on that interest and principal is forgone) the longer is the delay.

Deal Cleanup Calls

Some deals may contain cleanup calls triggered when only a small portion of the deal remains. The percentage trigger is typically set between 1% and 10%, inclusive. This feature is typically set up to avoid the burden of high fixed costs for the deal's trustee when a small amount of bonds remains outstanding. We discuss analyzing deal cleanup calls later in this chapter.

New-Issue versus Secondary Markets

The new-issue CMO market typically settles as much as one or two months in the future, allowing the issuer to gather the requisite collateral for the deal and complete structuring. This structuring period also affords the investor the opportunity to custom design CMO tranches that fit into her portfolio. Most secondary tranches trade for corporate settlement. While the investor cannot change existing tranches, more information about the tranche, such as historical prepayment speeds, can be valuable to the investor.

CMO TRANCHE TYPES

The crux of understanding the CMO market is understanding the different tranche types and how they are structured. Today, CMO deals are very complex, with multiple collateral sources, multiple tranche types, etc. in a complex array for each CMO deal. It is important to realize that each of these deals is made primarily from two basic flavors:

- A *planned amortization class (PAC) deal,* where the non-PAC (companion or support) tranches have highly variable cash flows and average lives, whereas the PAC enjoys relatively stable, prescheduled cash flows.
- A *sequential deal,* where standard sequential tranches have cash-flow priority (i.e., absorb most or all of the principal from the deal) in turn until they are all retired.

These types of deals can be altered or dressed up slightly (such as in a "PACquential" deal), but there are still two basic flavors. Once the PACs and sequentials are created, they can be divided even further (e.g., into a PAC floater and a PAC inverse floater). It is also possible to add other tranches with special features, such as a tranche where interest accrues back into the principal, called a *Z bond* (i.e., zero coupon). Nevertheless, to understand the structure of CMOs, one always must start with that first question of which deal type it is and then walk through how the individual tranche for analysis was created in order to analyze it correctly.

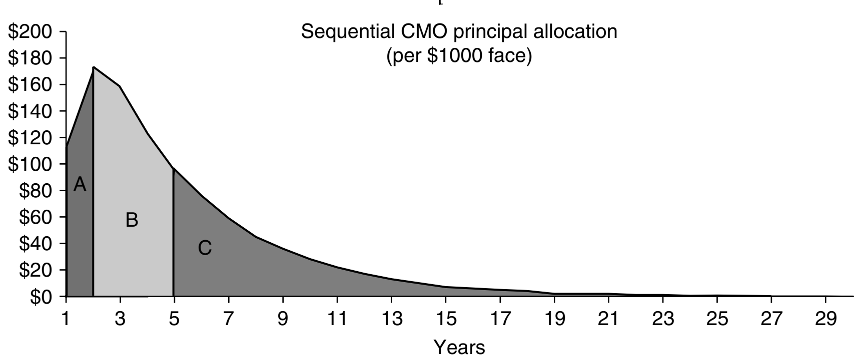
For each tranche type in this section we will provide the following: description, example, yield table, and methods of analysis. Note that while we have tried to be as realistic as possible in showing yield table and OAS analysis for CMO tranches, these numbers do not necessarily correspond to anything available in the market currently. These examples have been constructed mainly for learning purposes, not to illustrate relative value or hedging. We also do not identify deal names or CUSIPs on any of these bonds for those reasons.

Sequential

A *sequential CMO,* also referred to as a "vanilla bond," deal typically takes the collateral's principal and "time tranches" it. The first sequential tranche receives all the prepaid and scheduled principal from the deal until the tranche is retired, then the next sequential in line starts receiving principal. For example, in a simple three-tranche sequential example (Exhibit 24–1), the first sequential could be allocated 30% of the deal's principal. All principal cash flows would pay down the first sequential tranche to a zero balance. Then the second sequential would receive its principal and finally the third. The purpose of this structure is twofold. Investors may want a shorter or longer duration than the underlying collateral. In addition, the period of time before which the second sequential receives any principal is known as *lockout.* This lockout feature may be valuable to some investors who do not want to receive (and possibly reinvest) principal for some period of time.

EXHIBIT 24–1

Cash Flows from a Three-Tranche Sequential Deal



Source: DB Global Markets Research.

Example

Sequential bonds will have a different duration, average life, and projected cash flow for each prepayment assumption tested. In many respects, they perform like the underlying collateral of the CMO deal. Increase prepayments, and sequentials shorten their average life and duration. There are a few differences between sequentials and collateral:

- The window of time principal that is returned to the investor in a sequential is narrower than that for collateral.
- A sequential can be locked out from prepayments (i.e., the factor remains 1.0) for some period of time. Pass-throughs start to factor down from 1.0 as soon as they are created.
- The coupon on a sequential (or any other bond) can be different from the underlying collateral. Most commonly, the coupon on the sequential is "stripped down" lower than the collateral in order to create bonds that trade at or below par.

When a sequential coupon is stripped down, a portion of the interest from the collateral is diverted elsewhere in the deal.[1] The purpose of this maneuver is to lower the price of the sequential bond, although typically the yield of the bond also will fall. Nomenclature in the CMO world talks of the *tranche coupon* versus the *collateral coupon*. For example, a 5.0/5.5 sequential would be a bond with a 5% coupon in a deal using 5.5% pass-through collateral.

Exhibit 24–2 compares the yield tables of a full-coupon 5.5/5.5 sequential with a stripped-down 4.0/5.5 sequential. Note that the principal cash flows are essentially the same—the principal cash flows on these bonds react in the same way to changes in prepayment rates. However, market performance likely will be quite different owing to the longer duration of the 4.0/5.5 tranche. The 4.0/5.5 tranche has a 5.26 option-adjusted duration (OAD) versus a 3.11 OAD for the 5.5/5.5 full-coupon sequential in our example. When interest (IO) is removed from a tranche, the negative duration associated with the IO is also removed, extending the duration of the remaining bond.

An intuitive way to think about premium and discount CMO durations is callable corporate bonds. As the price of the bond goes over par, it becomes harder for the price to rise given a drop in interest rates because of the call feature (in the case of MBS, faster prepayments). The duration of a high-premium callable bond will be close to the call date because it is likely to be called. However, the duration of a deep-discount callable bond is longer, close to the maturity date of the bond, because the bond is unlikely to be called.

1. Note that the coupon income stripped off these tranches could become an "IO/IOette" tranche or could be added to a regular tranche with principal to create a premium tranche, for example, a 6% coupon off 5.5% collateral.

EXHIBIT 24–2

Comparing the Yield Tables of Full versus Stripped-Down Coupon Sequentials

Sequential, 4% on 5.5% Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	225	145	120
Price					
96.625	7.20%	6.03%	4.87%	4.67%	4.61%
97.625	6.20%	5.40%	4.61%	4.47%	4.43%
98.625	5.21%	4.78%	4.35%	4.27%	4.25%
Average life	1.09	1.76	4.5	6.2	7.05
LIBOR OAS	25				
OAD	5.26				
OAC	–1.36				

Sequential, 5.5% on 5.5% Scenario	–200	–100	0	100	200
Prepayment (PSA)	1596	823	223	146	121
Price					
101.9375	3.51%	4.23%	5.00%	5.13%	5.17%
102.9375	2.58%	3.63%	4.75%	4.93%	4.99%
103.9375	1.67%	3.04%	4.50%	4.73%	4.81%
Average Life	1.09	1.73	4.54	6.18	7.01
LIBOR OAS	35				
OAD	3.11				
OAC	–2.27				

Source: DB Global Markets Research.

Analysis

Analysis of sequentials falls into two broad categories:

- Analysis of short-duration sequentials that are currently paying, typically as short-duration bonds. They may be compared with short agencies, ABS, hybrid ARMs, other CMOs, etc.
- Longer-duration sequentials that often are compared with the underlying collateral. Many characteristics of the sequential and collateral typically are similar: prepayment speeds, duration profile, etc.

For short-duration bonds, investors typically are looking at yield and comparing it with similar-duration bonds. In addition, investors need to evaluate the extension risk of the sequential to make sure that it is not beyond their risk tolerance if interest rates rise, prepayment speeds slow, and the sequential extends.

For long-duration bonds, comparison with collateral can be made using OAS or yield analysis plus potentially a total-rate-of-return analysis that compares expected returns of different bonds under different interest-rate scenarios.

Planned Amortization Class

The second basic type of CMO deal is a PAC/companion structure. PAC stands for *planned amortization class* and is one of the most stable classes of CMO. It is given a preset schedule for its principal paydown. If prepayment speeds were to remain at a fixed speed in a specific prepayment band (the *PAC band*) for the life of the security, the PAC would adhere to its original schedule and behave similarly to a corporate bond with a pro-rata sinking-fund structure. Exhibit 24–3 shows the amortization schedule for a hypothetical PAC.

PAC Bands, Band Drift, and Broken PACs

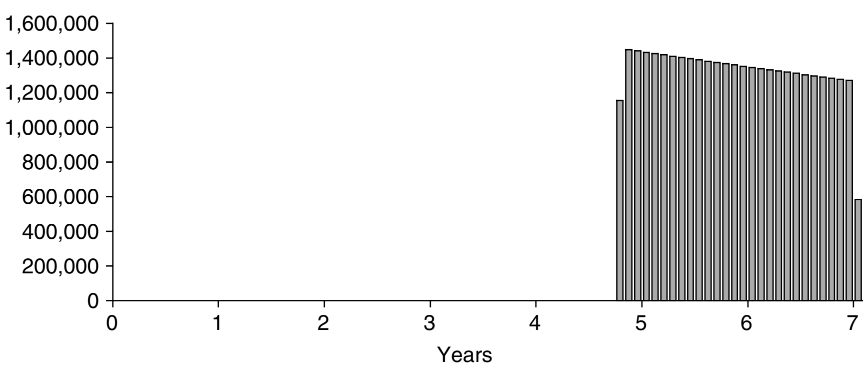
As mentioned earlier, each PAC has a band, expressed in PSA terms. If prepayments remained constantly at that level throughout the life of the PAC, it would adhere to its planned amortization schedule and have the expected average life.

Of course, prepayments do not remain constant for one month, let alone for the life of a security. Therefore, over time, especially in a fast-prepayment environment, the PAC bands on a PAC can drift, generally growing tighter over time (i.e., less advantageous for the investor).

One example of PAC band drift is in a fast-prepayment environment. If approximately one-third of a PAC CMO deal is companion bonds and prepayments

EXHIBIT 24–3

Amortization Schedule for a Hypothetical PAC



Source: DB Global Markets Research.

EXHIBIT 24–4

Example of a New PAC, Original PAC Band 100–250 PSA

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	220	143	120
Price					
101.1875	3.99%	4.39%	4.75%	4.75%	4.75%
102.1875	3.30%	3.96%	4.56%	4.56%	4.56%
103.1875	2.62%	3.54%	4.37%	4.37%	4.37%
Average life	1.5	2.47	5.95	5.95	5.95
LIBOR OAS	41				
OAD	3.65				
OAC	–1.26				
Vol. duration	0.05				

Source: DB Global Markets Research.

increase over the top end of the PAC band, at some point all the companion bonds will be paid off. When the companions are gone, the PACs behave like sequential bonds and are termed *broken PACs* in the marketplace. In reality, a broken PAC will behave like a sequential bond. However, given the stigma of being "broken," the broken PAC may trade more cheaply than a similar sequential.

Exhibit 24–4 shows an example of a new PAC with a band of 100–250 PSA. Note that as interest rates rise, its average life stays around 5.95 years. However, since all MBS are inherently callable in any given month, very fast prepayment speeds engendered by a rallying market cause the PAC to break out of its PAC band and shorten its duration significantly.

Exhibit 24–5, by contrast, shows a broken PAC originated a few years ago. All the companion bonds in this deal have paid off, so it effectively behaves like a sequential. Note also that its OAS happens to be higher than the sequential bond analyzed earlier in this section. This can occur in the market if there is a glut of broken PACs. This bond currently does not have a PAC band left but originally had a band of 100–255 PSA.

Analysis

The decision to buy PACs over sequentials or pass-throughs involves a couple of questions. First, is there a reason to buy cash-flow stability?

- Is cash-flow stability cheap via purchasing PACs?
- Is hedging pass-through or sequential cash flows using OTC derivatives expensive or cumbersome from an accounting (FAS 133) perspective?
- Does the investor think that the bond market is range-bound or could break out of a range?

EXHIBIT 24–5

Example of a Broken PAC, No PAC Band Left

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	225	145	120
Price					
102.9375	0.74%	2.97%	4.57%	4.84%	4.92%
103.9375	–0.74%	2.17%	4.26%	4.61%	4.72%
104.9375	–2.19%	1.38%	3.96%	4.39%	4.53%
Average life	0.66	1.26	3.52	5.02	5.79
LIBOR OAS	37				
OAD	1.98				
OAC	–4.07				
Vol. duration	0.03				

Source: DB Global Markets Research.

- What do implied and actual volatility in the market look like, and where are they going?

The answers to these questions can guide an investor toward whether to purchase PAC bonds.

Note that broken PAC analysis will be similar to sequential bond analysis. As mentioned earlier, broken PACs frequently trade at wider spreads than similar sequentials, creating relative value opportunities.[2]

Like sequentials, PACs can be compared using OAS analysis, yield, total-return analysis, etc. with other MBS or even with corporate bonds because of the PACs' stable nature.

PAC 2

In some structures, the effectiveness of PAC classes is enhanced by creating a structure similar to a PACs but with tighter PAC bands. In the priority of cash-flow waterfall, the PAC takes priority, followed by the PAC 2, and finally the companion bonds. If the companion bonds are retired and PACs remain, then the PAC 2s effectively become the new companion bonds.

In return for the higher cash-flow variability of the PAC 2, it will yield more than similar PACs in the same deal. At the same time, in extreme prepayment environments, the PAC 2 will suffer extension or call risk before the PAC. The PAC

2. Broken PACs tend to trade slightly cheaper than sequentials, whether because of the stigma of the "broken" deal or selling by investors who sell them to buy new PACs with intact bands.

EXHIBIT 24–6

Example of a PAC 2, No PAC Band Remaining

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	220	145	120
Price					
97.875	8.05%	7.06%	6.11%	5.97%	5.84%
98.875	6.63%	6.20%	5.80%	5.74%	5.68%
99.875	5.23%	5.36%	5.49%	5.51%	5.53%
Average life	0.75	1.27	3.81	5.54	8.78
LIBOR OAS	36				
OAD	5.37				
OAC	–2.19				

Source: DB Global Markets Research.

bond selected for Exhibit 24–6 has a relatively tight PAC band—so tight that we cannot observe cash-flow stability on this bond in the ±100 basis point scenarios.

Analysis

PAC 2 analysis needs to be very careful because bonds from this class exhibit much more variability of structure, cash flows, and value than the PAC 1 or sequential tranche types. OAS analysis can help an investor make a determination if a bond is attractive. Investors also need to focus on potential duration extension and shortening in radical-interest-rate scenarios to make sure that duration change is tolerable. In our example bond, duration extension if rates rise is worse than with our example sequential bond.

Companion

The companion or support tranche takes whatever principal is left over each month after the PAC bonds have been paid as closely to schedule as possible. If prepayment speeds are fast, excess principal will pay down support tranches once planned principal payments to the PACs have been made. On the other hand, if prepayment speeds are very slow, all the principal may go to the PAC bonds, with the support bonds receiving no principal for that month.

Example

The structuring of the companion bond, with approximately 30% of a deal being companions and the balance PACs, makes for highly variable cash flows and a wide variety of performance characteristics. Because of this, companion yields tend to be quite high. Exhibit 24–7 shows how the average life of the bond can vary widely.

EXHIBIT 24–7

Example of a Companion Bond

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	225	145	120
Price					
94.375	44.97%	25.96%	9.44%	6.00%	5.98%
95.375	36.95%	21.93%	8.70%	5.92%	5.90%
96.375	29.29%	18.03%	7.97%	5.83%	5.82%
Average life	0.16	0.3	1.57	23.95	25.66
LIBOR OAS	90				
OAD	11.00				
OAC	–16.04				

Source: DB Global Markets Research.

Analysis

Structures are very deal-specific, and OAS models can help to determine relative value among support bonds. Note, however, that OAS and hence relative value will be very sensitive to model assumptions. Discount companions are more popular because they can be sold to retail investors more easily. Exhibit 24–7 shows our example companion with high average life variability but a big OAS. Note also that the structure and price prevent the yield of the bond from falling much below 6%, even in a rising-interest-rate environment. The yield can exceed 40% in a dramatic interest-rate rally in our example bond.

Targeted Amortization Class

A targeted amortization class (TAC) is similar to a one-sided PAC. The bond has some call protection from adverse prepayment speeds. However, it can have a lot of extension risk if prepayments drop too low.

Example

In Exhibit 24–8, we see that our example TAC has a lot of extension risk. Even at reasonable, although slow, prepayment speeds, the bond extends out to 20 plus durations.

Analysis

TACs are not all created equal. Some behave more like PAC bonds or PAC 2s. Others look more like companion bonds. The defining characteristic of TACs is that they should have some call protection. A first cut of analysis should involve looking at the spread of average lives that can occur. In addition, OAS and perhaps total return analysis may be useful.

EXHIBIT 24–8

Example of a TAC

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	225	145	120
Price					
92.1875	32.71%	20.16%	8.90%	6.33%	6.22%
93.1875	28.78%	18.09%	8.44%	6.22%	6.13%
94.1875	24.97%	16.08%	7.98%	6.12%	6.04%
Average life	0.32	0.59	2.74	17.94	21.7
LIBOR OAS	44				
OAD	10.11				
OAC	–2.46				

Source: DB Global Markets Research.

While the TAC we have chosen does have a high OAS, it clearly has a large amount of risk if interest rates rise. The TAC is already at a discount dollar price, and its price could plunge further if prepayments slowed and extended the TAC out to a 20-year average life in a steep yield curve environment.

PACquential

A PACquential blends characteristics of a PAC and a sequential. While a type 1 PAC typically has a lower band of 100 PSA, a PACquential has more extension risk, with a lower band more typically around 150 PSA. Nevertheless, a PACquential does have a PAC band and is supported by its own companion bonds. This feature makes it more stable than a standard sequential tranche.

Example

Our example bond has a PAC band of 150 to 360 PSA, within which it has a 5.1 average life (see Exhibit 24–9). In this case, the extension risk of the bond down to 120 PSA is minimal. Therefore, the difference between this bond and a regular PAC is not that great.

Analysis

Note that since PACquentials are not that well standardized in the market, each bond must be examined carefully on its own merits. One factor to pay special attention to is extension risk of the PACquential below its PAC band down to as low as 100 PSA. Beyond that, all the standard analysis tools apply: OAS, average-life variability, and total return analysis.

EXHIBIT 24–9

Example of a PACquential

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	220	145	120
Price					
96.75	6.14%	5.26%	4.73%	4.72%	4.65%
97.75	5.42%	4.84%	4.49%	4.48%	4.44%
98.75	4.72%	4.43%	4.26%	4.26%	4.23%
Average life	1.53	2.7	5.1	5.23	5.85
LIBOR OAS	37				
OAD	4.48				
OAC	–1.38				

Source: DB Global Markets Research.

Z Bond

A bond can have different cash-flow characteristics (PAC, sequential, PACquential). Also, it can have different interest payment features. In the case of a Z bond, interest accrues and is added to principal initially. At some point, the Z starts to pay down interest and principal. The characteristic of suspension of interest for some period of time extends the duration of the Z bond. A Z bond can be created from any of the fundamental cash flows. Note that the accrued interest taken in from a Z bond can be used to pay down principal on another CMO tranche. This technique can be used to create bonds with a short legal final maturity, VADM bonds.

Example

The companion Z bond we have chosen for our example (Exhibit 24–10) has a deep discount dollar price, giving it PO-like characteristics, including convexity that is not that negative and pretty close to zero. Note the wide variation in average lives in different scenarios.

Analysis

There are a few main differences when analyzing a Z bond versus a regular tranche of the same variety.

- Is the Z bond currently a payer? If not, the audience of investors may be reduced.
- The OAD of the Z bond can swing extremely widely in different interest-rate scenarios because of its ability to accrete interest payments into principal.
- The OAD can be much longer than that for collateral.

EXHIBIT 24–10

Example of a Z Bond

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	223	145	120
Price					
84	12.58%	8.75%	6.64%	6.45%	6.39%
85	12.09%	8.36%	6.57%	6.39%	6.34%
86	11.61%	8.16%	6.49%	6.33%	6.28%
Average life	2.57	6.05	17.36	21.03	22.28
LIBOR OAS	53				
OAD	19.47				
OAC	–0.09				

Source: DB Global Markets Research.

Standard OAS or total rate of return (TRR) analysis should take these factors into account. On our example bond, the OAD is extremely long, almost 19.5. The fundamental question to ask is whether an investor would prefer to own this bond or a zero-coupon Treasury bond. The two can best be compared using TRR analysis.

Note also that these bonds will be extremely sensitive to small changes in model assumptions. Different models almost certainly will give a wide range of OAS valuations.

Very Accurately Determined Maturity

Very accurately determined maturity (VADM) bonds are structured to have short final maturities. They use accrued interest from Z bonds to pay off principal (see "Z Bond" above). In general, the average life of a VADM bond is more stable than a comparable-duration sequential bond. They are especially resistant to extension risk, because the short final maturity of the bonds is guaranteed even if prepayments drop to zero, a highly unlikely event.

Example

Exhibit 24–11 shows our example bond, 5.95-year average life even as prepayments drop to 0. Note, however, that the premium price exposes the bond to big issues if interest rates drop and prepayments speed up.

Analysis

Investors should purchase VADMs primarily if they absolutely need the guaranteed final maturity—such as in certain mutual funds or other investor situations. Check

EXHIBIT 24–11

Example of a VADM

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1595	800	225	145	120
Price					
103.5	3.44%	4.26%	4.81%	4.81%	4.81%
104.5	2.89%	3.92%	4.61%	4.61%	4.61%
105.5	2.34%	3.59%	4.41%	4.41%	4.41%
Average life	1.85	3.13	5.95	5.96	5.96
LIBOR OAS	56				
OAD	3.56				
OAC	–1.20				

Source: DB Global Markets Research.

that the VADM maturity does fit the requirements of the investor. In addition, check what the call risk of the bond looks like, which can vary widely among CMOs.

Floater

As well as the principal cash flows having different types, interest also may be paid in different ways. Most tranches have fixed-rate cash flows because most collateral for CMOs has a fixed interest rate. However, it is possible to construct tranches with a floating rate of interest, generally tied to LIBOR, but conceptually to any market interest rate. One possibility is to use an interest-rate swap to create a floating-rate bond. However, more likely is the division of a fixed-rate tranche into a "floater" and "inverse floater," whose interest rate moves down as the floater's moves up (see "Inverse Floater" below).

Key components for a floater include

- The index, such as LIBOR. Other indexes used are constant-maturity Treasury indexes such as a 10-year CMT.
- The margin, or spread, over the index paid to the investor.

Note that (1) all floaters (and inverse floaters) will have caps and floors on the interest rate for the bond and (2) these caps and floors are inclusive of the margin paid over the index.

Example

Our example bond shown in Exhibit 24–12 is a companion floater. The average life is highly variable. The major issuer with that for a bond buyer would be

EXHIBIT 24–12

Example of a Floater

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	220	145	120
Price					
98	6.84%	5.12%	2.74%	2.53%	2.52%
99	2.47%	2.47%	2.56%	3.64%	4.42%
100	2.04%	2.19%	2.39%	2.41%	2.41%
Average life	0.42	0.7	7.05	21.34	23.56
LIBOR OAS	19				
OAD	2.58				
OAC	–2.82				

Source: DB Global Markets Research.

difficulty in hedging the risk of the embedded cap. Thus higher cash-flow variability in general will push the OAS of a floater lower.

Analysis

Floating-rate bond analysis is similar to fixed-rate analysis in terms of examining cash flows and the bond's OAS. However, the floater has the additional complexity of having embedded caps and floors to value (even if the floor is 0%). It is especially important to make sure that the term structure model employed correctly values caps and floors at market values in this type of analysis. Additionally, an investor can price out an actual cap or floor for the expected average life of the security and see if the package of floater plus hedge makes sense.

Discount margin refers to the effective spread over the index once the bond's price and a prepayment assumption are factored in. An investor would look at discount margin as well as OAS to determine value in a floater.

Note that floater analysis (if uncapped) is effectively limited to the combination of index and index reset. Most of the duration of the floater would be due to the duration from the cap.

Inverse Floater

An inverse floater typically is created by dividing a fixed-rate tranche into a floating-rate portion and the inverse floater. The key understanding is that the sum of the parts (floater and inverse floater) must equal the whole (the underlying tranche) in terms of both interest and principal payments. (Also see the discussion later in chapter dealing with creation value.)

EXHIBIT 24–13

Example of an Inverse Floater

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	220	145	120
Price					
84.3125	60.38%	41.89%	19.84%	17.08%	17.04%
85.3125	56.69%	39.75%	19.41%	16.87%	16.83%
86.3125	53.09%	37.66%	18.98%	16.66%	16.63%
Average life	0.42	0.7	7.05	21.34	23.56
LIBOR OAS	696				
OAD	28.80				
OAC	–12.45				

Source: DB Global Markets Research.

Example

Our example is a discount companion inverse floater shown in Exhibit 24–13. These bonds have a lot of duration and are used often as substitutes for POs. Our example has a highly variable average life but high yields across interest-rate scenarios.

Analysis

Inverse floater duration is increased by the leverage of the inverse floater's coupon formula. In our example bond, the underlying tranche has an OAD of 9.57, and the inverse floater's leverage is 2.75. If the floater had a duration of 0, then the inverse floater's OAD is roughly equivalent to 1 plus leverage times the underlying tranche's OAD. In this case, the floater has significant duration (over 2) because of the extension risk, along with the relatively low coupon cap of the floater.

OAS analysis is important for analyzing inverse floaters, and as with floaters, inverse floaters have embedded caps and floors. Therefore, the term-structure model is important for evaluation. Also, the prepayment model used to evaluate the inverse floater is critical. As market rates fall, the inverse floater's coupon rises, but faster prepayments (and hence principal paydowns) may eat away the value of this to the bondholder. Effectively, the inverse floater buyer is leveraged to prepayments and thus must be careful to examine the effect of variations in prepayment assumptions on bond valuation.

Inverse Floater versus Leveraged Collateral

Does OAS analysis work? One way to check is to compare inverse floaters with leveraged collateral positions. While at first glance it may appear that one simply should buy the bond with the highest OAS, in reality, the duration (or OAD) of

EXHIBIT 24–14

Comparing Leveraged Collateral versus an Inverse Floater

Tranche Type	Security	Price	OAS	OAD
Inverse floater collateral	FNMA 5.5%	100.578125	5	4.7
Leveraged collateral stats	FNMA 5.5% leveraged	2.75 times lvg.	33	17.5
Inverse floater	*	85.31	696	28.8

*See Exhibit 24–13.
Source: Deutsche Bank.

the two assets being compared also matters significantly. To correctly compare inverse floaters with collateral, the collateral must be implicitly levered (by borrowing money) to the same duration as the inverse floater for the comparison to be fair. (The comparison is still not completely fair because leveraged collateral probably has more liquidity and easier funding than the inverse floater.)

In Exhibit 24–14, we can see that our prepayment model still prefers the inverse floater over a position of leveraged collateral. Levering the collateral involves investing a similar cash amount as for the inverse floater and then borrowing additional cash to buy more collateral until the investor has a similar duration and convexity exposure between the inverse floater and the leveraged collateral. In this example, we have borrowed money equivalent to the 2.75 times leverage of the inverse floater, assuming that we could borrow money at LIBOR flat.

Creation value is another method used to analyze inverse floaters. The value of floaters is relatively easy to determine because they are relatively liquid and easy to price. Likewise, the underlying tranche for the floater–inverse floater combination is typically easy to price. Given those two prices, the arbitrage-free creation value of the inverse floater can be determined (Exhibit 24–15). Investors prefer to purchase inverse floaters at or below creation value.

Trade against Forward Rates

Some investors buy inverse floaters as a trade against forward rates rising as fast as the market would suggest. For example, the yield of our inverse floater at unchanged rates and 220 PSA is 19.41%. The yield assuming this prepayment speed but forward rates is 18.4%. If rates rise more slowly than forward rates suggest, the true yield of the bond will be somewhere in between the two numbers.

Analyzing inverse floaters is complex and can be done in many different ways. They are not as liquid as regular tranches. The reward may be discovering some true value in the bonds or taking advantage of specific views on the market.

EXHIBIT 24–15

Floater + Inverse Floater = Underlying Companion Bond

	Floater	Inverse Floater	Underlying Companion
Collateral	FNCL 5.5 (354 WAM, 5.90 WAC)	FNCL 5.5 (354 WAM, 5.90 WAC)	FNCL 5.5 (354 WAM, 5.90 WAC)
Amount on issue (current and original)	25,626,350	9,318,674	34,945,024
Coupon	1 ML + 130 bp	17.05–2.75 × 1 ML	5.50
Cap	7.50%	17.05%	
Floor	1.30%	0%	
Yield	2.60%	19.41%	7.08%
Price	99.00	85.31	95.35
OAS	19	696	199
OAD	2.58	28.80	9.57
OAC	–2.82	–12.45	–5.39

Interest-Only and Principal-Only Tranches

Interest-only (IOs) tranches come in several forms. The primary one we will discuss is "trust IOs," where collateral is contributed to an IO/PO deal by dealers, a small fee is charged, and IO and PO tranches are returned to the dealers involved in proportion to their collateral contribution. This type of structure gets its own IO/PO trust number, hence the name. An IO also can be created by stripping interest off a CMO tranche or in other ways, which typically result in CMO tranches with IO characteristics. Trust IOs tend to have the most liquidity because they are large-size deals that trade on broker screens, whereas smaller deals have less price transparency.

IOs typically have negative duration. If rates rise, prepayment speeds tend to slow. Slower speeds benefit the IO holder, who wants the collateral factor to stay as high as possible for as long as possible. Once loans prepay, they stop paying interest beyond the month in which prepayment occurs. An IO investor wants prepayments to be as slow as possible. In the most extremely negative case, an investor could buy an IO and discover that the entire tranche has paid off in that month, reported in the following month.

The principal-only (PO) tranche is the complement of the IO. It returns only the principal portion of the pass-through. Thus a PO holder would prefer prepayments to be extremely fast. Under a dollar price of approximately $85 (which is typical), POs have positive convexity. This makes them useful for hedging purposes, for example, hedging mortgage servicing rights.

EXHIBIT 24–16

Example of an IO

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	325	150	125
Price					
24.53125	–104.60%	–59.38%	2.13%	12.50%	13.94%
25.53125	–106.20%	–60.62%	1.13%	11.52%	12.96%
26.53125	–107.70%	–61.78%	0.21%	10.61%	12.05%
Average life	1.12	1.55	4.93	8.71	9.69
LIBOR OAS	328				
OAD	–24.11				
OAC	–17.02				

Source: Deutsche Bank.

Example

Exhibit 24–16 shows an example of an IO. Since trust IO and PO pricing is relatively liquid, most of the analysis for IOs and POs will concern an investor's view of prepayments or interest rates versus the market's (as represented by IO/PO pricing). Nevertheless, IO/PO prices also can fluctuate owing to technicals, including short squeezes on certain tranches. Note how the IO in Exhibit 24–16 has a high negative duration.

Exhibit 24–17 shows an example PO from the same trust deal. Some investors buy POs for prepayment protection or positive convexity, but others buy

EXHIBIT 24–17

Example of a PO

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	1200	325	150	125
Price					
74.9375	28.69%	20.71%	6.58%	3.66%	3.27%
75.9375	27.23%	19.66%	6.24%	3.47%	3.10%
76.9375	25.81%	18.63%	5.91%	3.29%	2.94%
Average life	1.12	1.55	4.93	8.71	9.69
LIBOR OAS	–132				
OAD	14.71				
OAC	2.78				

Source: Deutsche Bank.

them simply to add duration to their mortgage portfolio. As interest rates drop, observe that the PO yield rises significantly owing to increased prepayments. Often, as in our hypothetical example, the PO will have a negative OAS in return for its positive convexity. Effectively, investors are paying a premium to buy options when they buy a PO.

Analysis

IO/PO analysis using OAS models or other techniques is notoriously complex, and even seasoned traders have lost money owing to technicals in the IO market. Since IOs and POs are notoriously sensitive to even small changes in prepayment assumptions, one must be very careful to examine the model used to calculate OASs. Variables such as seasoning and burnout are magnified many times in between analyzing the collateral and the IO/PO derivative.

Creation value also can be used to analyze IOs and POs, similar to the analysis of inverse floater–floater combinations. For trust IOs and POs, at first the combination (combo) typically trades at a small premium above collateral. The combination cannot trade significantly below the price of collateral, because the parts may be recombined into collateral for a small fee and sold. However, the combination may trade at a price significantly above TBA collateral for a number of reasons:

- The underlying collateral is valuable; for example, it has seasoning worth a payup to TBA collateral.
- There is a squeeze or scarcity of the IO or PO, which raises the price of the combination in turn. Sometimes POs get restructured in other deals, potentially leaving them dear.

Historical analysis of IO and PO OAS numbers may be somewhat useful but ends up being highly dependent on prepayment and the OAS model.

Premium tranche/IO arbitrage is another way to compare relative value of IOs versus regular classes of CMOs. For example, a PAC IO plus a stripped-down PAC should equal the value of the full-coupon PAC, or there is an arbitrage. This is similar to the recombination value of an inverse floater. In practice, since many investors are willing to accept tighter spreads for lower-dollar-price PAC bonds, we can see arbitrage opportunities occur during deal pricings that make the restructuring of a premium PAC tranche into a stripped-down coupon PAC and a PAC IO attractive.

For POs, some investors may be using them to hedge other assets, such as mortgage servicing rights (MSRs). In that case, all the preceding analysis may be performed, but the investor probably also wants to check how well correlated changes in price of the PO will match changes in the hedged item. Since the PO is an asset, not off balance sheet, FAS 133 does not apply to POs.

Unusual Features

Note that IOs can be stripped off of any CMO type, for example, PACs, creating PAC IOs. This class of bond will behave like a high-yielding PAC within the band but, if prepayments speed up, will pay off quickly, perhaps leaving a loss for the investor. Other nontrust IOs must be examined carefully as to the nature of their cash flows.

Exotics

We describe below a number of exotic CMOs for the sake of completeness but will not spend a lot of time looking at individual bonds.

Inverse IOs

Inverse IOs are created by stripping the premium portion off an inverse floater. In some respects, they behave as an interest-rate floor. At times, their pricing has been described in relation to floor prices. However, they are more like "knockout" floors because if interest rates fall enough, prepayment rates will speed up and pay down the notional principal of the tranche, reducing the remainder of the investment to zero. Because of their illiquidity, these bonds are even more difficult to hedge and value than trust IOs.

Inverse IOs are highly levered to one's interest-rate scenario and prepayment forecast. It is important to analyze how small variations in prepayment or interest-rate assumptions change the potential value of the bond.

Jump Zs

A jump Z reacts to fast prepayments by suddenly shifting from accrual to paying interest and principal (becoming a "payer"). This option can be of great value to the investor if the Z bond is at a discount price. Note also that some jump Zs are sticky, meaning that once the "payer" trigger has been pulled, they continue to pay even if prepayment rates subsequently drop.

Structured POs

POs themselves can be structured into TAC POs, super POs (companion POs), etc. Analysis is similar to that for regular POs, except that the bonds probably will be even more sensitive to slight changes in prepayment assumptions.

AGENCY VERSUS NONAGENCY CMOs

While most investors who can buy agency pass-throughs are allowed to buy agency CMOs, certain investors cannot participate in the nonagency CMO market. Here We will describe some of the differences between the two markets (see Exhibit 24–18 for a synopsis) and then address some specific nonagency CMO issues. Nonagency CMOs are discussed in more detail in Chapter 25.

Agency CMOs

Agency CMO analysis tends to be simpler because of established prepayment models and virtually no credit risk. Collateral information disclosure on nonagency CMOs tends to be slightly better, but in general, the information gap is marginal for new deals. On the other hand, older agency CMO deals may not have information such as FICO scores or owner-occupied status available.

EXHIBIT 24–18

Agency versus Nonagency CMO Differences

	Agency CMOs	Nonagency CMOs
Credit support	Agency guarantee, underlying mortgages, primary mortgage insurance	Credit enhancement (e.g., senior subordination), underlying mortgages, primary mortgage insurance
Actual delay days	Variable: 0,14, 24	Variable: 0, 24
BIS risk weighting	0% for GNMA; otherwise 20%	For AAA-rated tranches, 20%
Collateral types	Agency pass-throughs, conforming Alt-A loans	Jumbo or other nonconforming pass-throughs, reperforming loans, Alt-A loans
Prepayment model	Standard agency prepayment model	Specialized model based on collateral
Subject to interest shortfall	No, compensating interest paid by GSEs	On some deals

Source: DB Global Markets Research.

Agency CMOs generally are structured by dealers, who take all the risk on the deal. They will approach an agency to "wrap" the deal for a fee. Occasionally, the agency also will purchase some of the CMO tranches in a deal. Fannie Mae and Freddie Mac do exert some control over the new-issue CMO market because at times they hand out quotas for the amount of collateral that can be structured into CMOs according to coupon. This restriction is to prevent a squeeze or even a shortfall of collateral for deals pricing in the same month.

Nonagency CMOs

The analyst is required to do a significant amount of extra work for nonagency CMOs. Beyond the structure of the deals, the first point to make is that the whole loans backing these nonagency CMOs do not trade lockstep with agency collateral. In general, jumbo loans are perceived to have worse prepayment characteristics than agency pass-throughs, and the investor is also taking credit risk. Therefore, jumbo whole-loan packages typically trade behind similar agency collateral by \$0–24 to \$1–08 as compensation.

Nonagency CMO Credit Risk

The senior whole-loan CMO investor is taking direct mortgage credit risk, however marginal, whereas the agency CMO buyer has a negligible credit risk, similar to holding agency pass-throughs. Nonagency CMOs typically are created from collateral that is nonconforming for the GSEs. More often than not, this consists of so-called jumbo loans that are over the loan ceiling for the GSEs, for 2005 set at $359,650. Originators typically originate and pool these jumbo loans together and then work with Wall Street dealers to find a sale. Loans can be sold as "whole loans" without structuring, but more often that not the originator gets better execution by using a dealer to structure and sell them in CMO form. In this case, the deal is typically sold off an issuance shelf of the dealer or the originator, pursuant to Securities and Exchange Commission (SEC) Rule 415, and the GSEs do not wrap the deal.

Nonagency CMO Credit Enhancement

Typically, whole loans are not credit-enhanced. The buyer takes credit risk on the loans. Nonagency CMOs are usually structured into senior securities with an AAA rating using some form of credit support. This enhancement to AAA can take various forms.

- *Subordination.* In this case, losses are leveraged into a small subordinated tranche (or tranches) of the CMO deal. The structure takes losses and allocates them to subordinated tranches in a waterfall structure until they are gone, and the AAA tranche theoretically would have to take losses. Subordination may be combined with other methods of credit enhancement, most typically excess spread or reserve funds.

Other methods have been used in the past but typically are not seen in nonagency CMO deals in the United States today. One exception is lower- loan-quality deals, which still may use overcollateralization and/or excess spread.

- *Excess spread.* Some of the interest on the deal is captured and used to pay off losses before any other credit enhancement is used. Additional income may go to the reserve fund or back to the originator.
- *Reserve fund.* Cash is placed in an escrow account and is used to pay off losses. This is employed in coordination with excess spread.
- *Parent guarantee.* The issuer (dealer or originator of the loans) guarantees the investor against credit losses. This makes the CMO vulnerable to a corporate credit downgrade, which explains this structure's lack of popularity. (Note that this is effectively the method used for agency CMO deals, wrapped by an agency.)
- *Overcollateralization.* In this case, excess collateral backs the deal. Therefore, defaults and losses on the collateral must eat through the excess collateral before there is imminent risk to the bonds. Any excess collateral when the CMO is called or matures typically is returned to the originator.
- *Letter of credit.* A financial institution provides a guarantee on losses up to a certain dollar amount. This type of guarantee is vulnerable to a downgrade of the letter of credit, as well as collateral underperformance.

Subordination is the credit enhancement of choice as of this writing because it lets the issuer transfer credit risk on the collateral completely to the market in the form of subordinated tranche buyers. Although senior-subordinated enhanced CMO deals are at risk for downgrade, it is because the collateral or deal is performing poorly. There is minimal downgrade risk outside poor collateral performance.[3]

Subordinated Tranches

In this section we discuss subordinated tranches. While some of them are suitable only for sophisticated mortgage investors, others may offer better cash-flow stability than many other available MBS at the expense of a rating below AAA. While subordinated tranches can run the gamut from unrated tranches to AAA "mezzanine" tranches, there are a few rules of thumb.

For tranches rated single-A and higher, the cash-flow characteristics of the tranche tend to be more important than credit characteristics. Often a subordinated tranche has better convexity even than agency PAC bonds. Subordinates often are prohibited from receiving principal for some period of time for credit-enhancement purposes and also have relatively strict schedules for returning principal. These schedules are designed to prevent subordination levels from falling too low and risking a credit downgrade on the deal.

Subordinated bonds protect the senior bonds in a number of ways:

- Senior bonds are paid principal and interest before anything is paid to the subordinated bonds.
- Subordinated bonds take losses before senior bonds.
- The percentage of subordinate bonds in the deal is carefully managed over time through a set of formulas shifting the percentage of principal that gets paid to the senior and subordinated bonds. This is known as *shifting interest*.

For example, at first very little principal is allocated to the subordinated bonds because mortgage delinquencies and losses tend to mount in the first seven years of loans' lives. The overall percentage of subordinates thus is built up early in the life of the nonagency CMO. Later, after peak defaults have passed, more principal can be allocated to subordinated bonds.

Exhibit 24–19 shows an example of a shifting-interest subordinate. Note the very good call protection versus most MBS. Even at 800 PSA, the subordinate still has a 6.44 average life, relatively long for a CMO under that fast a prepayment speed.

For tranches rated BBB and lower, the credit characteristics of the collateral and deal tend to be more important than cash-flow characteristics. The risk of downgrades

3. One exception where a senior-subordinated CMO deal could be downgraded on an outside event is the bankruptcy of the originator/servicer of the loans. If loans were then found to be fraudulent, loan documentation was inadequate to service the loans, etc., then a CMO deal could get downgraded based on servicing risk. Note that the rating agencies do grade servicers.

EXHIBIT 24–19

Example of a Shifting-Interest Subordinate

Scenario	–200	–100	0	100	200
Prepayment (PSA)	1665	800	325	150	125
Price					
98.78125	5.94%	5.65%	5.61%	5.61%	5.62%
99.78125	5.40%	5.46%	5.48%	5.49%	5.49%
100.78125	4.87%	5.27%	5.33%	5.36%	5.33%
Average life	2.03	6.44	9.12	11.68	12.27
LIBOR OAS	62				
OAD	5.32				
OAC	–2.46				

Source: Deutsche Bank.

and losses if the housing market turns is relatively high in these tranche types, so care must be taken to examine the collateral carefully. Note also that these bonds have much smaller size and less liquidity than the higher-rated subordinated tranches.

Note that whether or not they are sold to the public, most nonagency CMO deals include an unrated first-loss tranche. The issuer often retains this unrated tranche as a sign of its faith in its loans and the CMO structure.

Special Collateral Types

There are a number of special collateral types we will discuss briefly in this section. In most cases, their prepayment characteristics are superior to typical jumbo whole loans. In turn, originators typically expect to be paid a premium over the price of typical whole loans for these collateral types.

- *Reperforming loans.* In general, these loans were first originated by a government agency. These loans can be culled from GNMA pools or sold by FHA/VA. In general, they are loans that were seriously delinquent that have been rehabilitated or modified. The underlying credit issues with the loans typically cause them to be less reactive to interest-rate moves and hence desirable to investors from a cash-flow-analysis standpoint.
- *VA vendee.* These loans typically are made at very high LTVs (up to 100%) to non-VA borrowers purchasing real estate owned by the VA (typically acquired through foreclosure). Since these homeowners have started with a below-market interest rate and a very high LTV, they are also less sensitive to an interest-rate rally in terms of refinancing.

- *Alt-A loans.* The Alt-A label has been applied to a broad swath of mortgage types. In general, we would characterize these loans as slightly below top-credit mortgages. These loans are primarily classified as "limited documentation," where the borrower is missing a standard credit history, documented source of income, or some other standard input used in credit scoring models. In general, Alt-A mortgage rates are higher than market, so they are also less sensitive to a rally in interest rates. Note that overall, Alt-A prepayments may be higher over time as the borrowers "cure" their problems at a reasonable pace. In most cases, the homeowner will find it advantageous to then refinance into a conforming loan at a lower rate. The important factor is that this credit curing is not necessarily correlated with interest rates; thus the collateral is considered more valuable than standard jumbo loans.

While lower-credit-quality loans have been securitized, in general, this is a very small market, primarily dominated by the home equity originators. Home equity loan–backed securities are discussed in Chapter 26.

Other Nonagency CMO Issues

Besides collateral credit, there are a few other issues with nonagency CMOs that differentiate them from agency CMOs. While CMO collateral is bankruptcy remote from the issuer and originator, there can be residual servicing risk if the servicer has financial problems. Jumbo mortgage prepayments tend to behave differently than agency mortgage prepayments. In addition, there are other details that the housing GSEs take care of that a nonagency CMO investor may need to worry about occasionally, such as compensating interest.

Compensating Interest. In a nonagency CMO deal, prepayments received before the end of the month result in an interest shortfall for the deal. The borrower is not obligated to pay interest for the balance of the month once the loan is paid off, yet the CMO deal is structured to pay interest on that balance through the end of the month. In agency deals, this shortfall is made up by the agencies themselves on the underlying pass-throughs. In nonagency deals, there are several ways that this problem can be solved.

- Compensating interest is paid by the servicer, originator, or deal sponsor to make up the interest-income shortfall owing to prepayments. Effectively, this structure resembles the agency CMO structure, with the exception that the credit rating of the compensating interest provider can become a factor in the deal's rating. Often the amount of interest in a single month is limited to fees taken in on the deal, effectively capping the risk to the compensating interest provider and raising a small risk to the investor.
- Create a regular CMO tranche or tranches that absorb the risk of the interest shortfall.

- Create a WAC IO, similar to a regular IO/IOette off a CMO deal, except that the coupon varies slightly to absorb interest shortfalls.

Building the coupon variability into the structure, such as via including a WAC IO, reduces the chance of a third-party credit downgrade of the structure.

Servicer and Bankruptcy Risk. While CMO collateral is bankruptcy remote from the issuer and originator, there can be residual servicing risk if the servicer has financial problems. As pointed out earlier, one of these parties may have a financial obligation to pay compensating interest, causing the rating agencies to scrutinize the credit of this third party.

In addition, there is risk in the transfer of servicing if the servicer on the underlying collateral of a nonagency CMO deal goes bankrupt. In the case of an agency deal, the agency would be responsible for solving this problem and, if necessary, paying for it. On a nonagency CMO deal, in general there is enough of a servicing fee available on the loans that they can be transferred without a direct charge to the investor. However, if the servicing fee is too small, the trustee may have to extract payment from bondholders in some fashion. Also, when the servicing is transferred, there is a risk of increased delinquencies as borrowers mail checks to the old address or deficiencies in the original servicer's procedures or documentation are discovered. Please note that actual losses to investors because of servicer bankruptcy are very rare. The servicing industry has consolidated into a smaller number of large, sophisticated servicers, and there is less risk that any one of them having problems would cause a widespread problem.

Jumbo Prepayments. Jumbo mortgage prepayments tend to behave differently than agency mortgage prepayments primarily because the larger loan size of the jumbos makes refinancing more economical even for smaller interest-rate incentives. The fixed costs of refinancing (filing fees, lawyer's fees, etc.) for a jumbo loan are balanced against a larger present value of interest-rate savings because of the larger loan amount. Large loan size thus tends to increase refinancing efficiency and hence option cost to the investor.

CMO ANALYSIS

This section looks at how investors analyze and use CMOs. We also cover term structure and prepayment models briefly.

Analysis for Regular CMO Tranches

CMO analysis depends on investor needs. While relative value may seem to be one answer, one rule does not necessarily hold for all investors. The definition of relative value can be different for different investors. Other investors have portfolio constraints. For example, an insurance company may need assets that closely match liabilities even if interest rates exhibit large moves.

Investor Goals and Constraints

Investors can have many goals and constraints when purchasing CMOs. For example,

- Insurance companies and banks sometimes have yield levels (bogies) below which they may not purchase bonds.
- Relative-value investors may require a certain OAS or OAS versus collateral.
- Hedge funds may require a certain amount of liquidity in purchases they make both for bonds and for potential hedges (such as cancelable swaps). If liquidity in the bond or the hedges in insufficient, they may decline to do an otherwise attractive trade.
- Funded investors may need to issue debt or raise equity before adding MBS. If the environment is not amenable to such issuance, then CMO purchases may be delayed.
- A bank may require CMOs to pass FFIEC, a test initially set up by U.S. bank regulators but no longer required to be followed.
- Individual or institutional investors may have a top-dollar price limit above which they will not purchase bonds.

Perhaps the variability of investors explains why there are so many different kinds of CMOs, some unique. Different requirements and views are what make a market.

Cash-Flow Analysis

For most regular tranche types, cash-flow analysis consists of testing various prepayment models and static prepayments to determine what the sensitivity of a bond is to changes in interest rates. This analysis would include a comparison of the negative convexity of different CMO bonds.

For some investors, cash-flow analysis becomes more detailed because they may be trying to hedge their own stream of liabilities, or perhaps they are hedging the CMO with an amortizing swap.

Finally, for nonstandard tranches, it pays to examine the cash-flow waterfall and test various interest-rate scenarios, examining the results in terms of cash-flow streams. It is important to check for bonds that have unusual cash flows. For example, anything that could cause a bond to have a longer-than-expected maturity or a gap when principal was not paid would be suspect.

OAS Analysis

For most regular CMO tranches, OAS analysis is relatively useful. For similar tranches off similar collateral, it is easy to use OAS to determine the relative value of the bonds. In addition, comparing OAS numbers for CMOs versus underlying collateral

EXHIBIT 24–20

Partial Durations of a 5-Year Wide-Window Sequential

Yield-curve point	2	5	10	30
Partial duration	0.685	1.56	2.795	0.17
OAD	4.7			

also is straightforward. The more difficult issue is how to compare OAS numbers of tranches of different durations. For example, often longer-dated tranches are at higher OAS numbers than similar shorter-dated tranches. This structural issue makes it difficult to evaluate relative value of longer- versus shorter-dated CMOs.

More issues in OAS analysis are presented later in this chapter and in Chapter 38.

Hedging

For normal CMO tranches, OADs are an acceptable way to calculate how to hedge. However, wide-window sequentials may require hedging on multiple points on the yield curve to avoid yield-curve risk, similar to hedging yield curve in the underlying collateral. Exhibit 24–20 shows how the bulk of duration risk may be in the 10-year area for a specific bond, but hedging in 2-year, 5-year, and 30-year areas would help reduce yield-curve risk.

Issues in OAS Analysis

There are a number of issues in OAS analysis to discuss in order to determine if the OAS received on a bond is truly what the investor seeks to find out: the spread of the MBS, ex-option cost, versus a benchmark such as swaps. While in the 1980s and early 1990s the primary variable differentiating OAS numbers was the prepayment model, at this point in the technology, the term-structure model has become equally important. We cover a number of other issues in this section, such as deal call risk and variations among prepayment models.

Term-Structure Model

As mortgages have linked more tightly over time with the OTC derivatives markets (swaps and swaptions), modeling the relationship between these two markets has become critical. To the extent that swaps and swaptions are used to hedge MBS (or vice versa), the two markets need to be evaluated using the same term-structure model and the same assumptions, or else different and perhaps erroneous results can be obtained.

While a one-factor interest-rate model was used in the past and may work reasonably for pass-throughs, it is clearly not enough if an investor is looking at

ARMs, floaters, or inverse floaters of any kind. More degrees of freedom for modeling the yield curve are needed. Therefore, in order to keep analysis consistent among different types of MBS tranches and derivatives, it appears critical to use the least common denominator of term-structure models that will accommodate all possible tranche types and analysis and not succumb to using different models for different types of bonds or situations.

Advances in term-structure modeling have placed the following features into the hands of mortgage analysts:

- Multiple knots on the yield curve
- Correct pricing of OTC derivatives using the model
- Pricing in a volatility "skew" (i.e., options not stuck at-the-money may be priced at a different volatility than standard at-the-money options)
- Sophisticated simulation of future mortgage interest rates based on the swaps curve and volatility

The point is that a term-structure model that does not do these things opens up arbitrage opportunities against an investor using it. In an extreme case, flaws in the term-structure model will misstate value and risk numbers associated with a CMO.

Forward Curve Bias

Despite all the care being put into term-structure models and their freedom from arbitrage, it is important also for investors to recognize the forward curve bias in these models, which creates a paradox.

- In order to remain arbitrage-free, the term-structure model must use the forward yield curve as its base case.
- In practice, the forward yield curve is usually wrong.

How can we reconcile these two facts?

The short answer is that we should use the forward yield curve because if we do not believe something that it is predicting, we can trade against it and make money if we are correct. At times, the second point becomes plainly obvious. For example, when the yield curve is extremely steep, forward rates predict massive flattening of the yield curve over a short period of time. If the Fed appears to be on hold during this time, are we likely to get the full amount of the yield-curve flattening? Probably not. However, it may be easier to trade on this view directly in the derivatives or futures market than trying to implement it in the mortgage market.

Prepayment Model

The prepayment model is still a very important component of mortgage analysis and OAS. Over time, prepayments have become more efficient. This trend appears to be continuing into the future, bolstered by competition among servicers. While most prepayment models address the standard issues of age, relative coupon, etc., there are now various subtleties that a model needs to account for.

- Does the model account for "credit impaired" mortgages issued at above-market rates?
- How does prepayment "burnout" work in the model, and can burnout be erased over time?

A prepayment model that is out of date or incorrect, even if only on a small segment of the market (high-premium mortgages), can have a large impact on an OAS because OAS models tend to generate some paths with very high and low interest rates—testing the boundaries of prepayment models and their ability to generate reasonable prepayment forecasts at out-of-sample interest rates.

Why $A + B$ Can Be Greater than C

One of the last topics we will cover in this section is why $A + B > C$ even if A and B are made up of the component cash flows of C. Here are some factors.

- A *and* B *are unique and more cannot be created.* For example, once a trust IO/PO deal is closed, additional collateral cannot be added later to increase the size of the deal. Thereafter, a squeeze in A or B will increase their price in relation to C, which is simply TBA collateral. $A + B$ can never be less than (C – transaction cost) for long because this would create a recombination arbitrage.[4]
- A *or* B *is getting squeezed.* One of the risks in the IO/PO market is that bonds can be resecuritized and hence lost to the possibility of recombination. For example, if virtually all the POs in a trust deal are resecuritized, the remaining POs will be in very high demand to hedge the remaining IO tranches. In addition, trust IO/PO sizes can be small enough that one dealer or investor potentially can squeeze the market in one of these bonds, making $A + B > C$.
- *The underlying collateral is valuable.* Sometimes $A + B$ may be compared with the wrong C. For example, comparing a trust IO and PO with TBA collateral may be appropriate most of the time. However, after the deal is seasoned for a while, the underlying collateral itself may be worth a payup to TBAs (seasoned collateral typically commands a premium price to TBAs).

4. Typically, an IO and a PO from the same trust can be recombined to form the underlying collateral for a 1/32nd fee and resold as collateral. While this typically never happens in practice, it creates an arbitrage floor for the IO and PO prices, which is important from a liquidity and pricing standpoint. This is much harder to do for floaters and inverse floaters because both sides of the combination in that case may be harder to find and less liquid, not trading on broker screens as trust IOs and POs do.

Examining Deal Call Risk

A feature in many CMO deals but not discussed often and sometimes not modeled is the embedded call. Originally conceived as a way to limit ongoing fixed expenses for deal trustees on CMOs that have shrunk to a very small size, the implications for investors can be significant. For example, the last cash-flow holder typically will be exposed to the call. A call that sounds small for an entire deal (say, 1%) actually may make up a large portion of the last tranche remaining in a CMO deal. For a tranche that was only 5% of the deal's original principal, a 1% cleanup call is exercised when 20% of the last tranche is remaining. The impact for investors of other tranches is *de minimis* but obviously can be large for the last cash-flow holder.

The good news is that this call is exercised most of the time because the fixed costs of the deal tend to be large enough that the trustee wants to exercise the call whenever possible. This assumption makes analysis easy. However, if the price of the collateral is significantly below par, calling the deal costs the trustee money. Analysis of the probability of call of deals in this situation is difficult. Therefore, the bondholder may want to run the bond with and without the call to assess the possible impact.

Investor Types and Behavior

In this section we examine different types of investors, such as commercial banks. We cover the following information for each:

- Types of CMOs typically purchased by these institutions
- Methods potentially used by these institutions for bond selection

GSEs (24%) and banks (44%) are the two largest holders of MBS as of year-end 2002. These investors also hold large amounts of CMOs.

Banks

Banks are large consumers of the CMO product. For many banks, the longer duration and possible duration extension of pass-throughs does not match their liabilities adequately. Additionally, with the addition of FAS 133 (accounting rules of derivatives), hedging pass-throughs with derivatives and acquiring hedge accounting are difficult. Therefore, it is easier for many banks to achieve a shorter-duration security or less extension risk by buying appropriately structured CMO bonds. Banks typically are buy-and-hold investors in CMOs, although some bonds may be placed in the trading account.

In general, banks focus on shorter-duration CMOs. A 10-year bond typically does not fit the liability structure of a bank. A two-year sequential CMO is a typical purchase for a bank. In general, banks will accept some prepayment and convexity risk in order to get a better spread. Therefore, banks tend to prefer sequentials over PAC bonds. Banks do very little hedging of their negative convexity using the options market, although they may delta hedge their mortgage position as its duration changes.

CMO selection at banks generally comes down to a few things: yield bogey, duration, OAS, and perhaps FFIEC eligibility. In general, a bank will have a target net interest margin over their cost of funds in order to purchase a security. This target may be translated into a yield or spread bogey over a market rate. Also, a bank may not want to take too much duration risk, so the duration of the security must fit the asset/liability framework of the bank, or it must be prepared to hedge the duration of the CMO. Some banks use OAS to determine relative value among tranches, but in general, asset/liability and liquidity concerns tend to dominate their CMO purchase decisions. Although regulators no longer require bonds to be FFIEC eligible, some bank boards or portfolio managers may restrict themselves to bonds that meet the FFIEC tests as a general test of "prudence."

Note also that banks are the largest consumer of mortgage "whole loans," or mortgages that are not securitized. These whole loans are mostly ineligible for agency securitization or are ARMs or hybrid ARMs.

Banks: The FFIEC Test. For a while in the 1990s, banks were restricted from buying MBS with significantly more convexity risk than MBS. This was enforced by applying the so-called FFIEC test to a CMO to see if it passes. This function is currently available on Bloomberg using the FMED <Go> command, as shown in Exhibit 24–21.

Essentially, the test restricted extension and call risk on a CMO's average life and also looked at potential price changes in ±300 basis point parallel interest-rate shocks, with the bond needing to change less than 17% of value. In addition, the starting average life could not be longer than ten years. Even though the test is no longer applied by the regulators, some investors feel that it still provides a suitable benchmark of whether a CMO is risky or not.

GSEs

There is no such thing as a bad bond, only a bad price. The housing GSEs (Fannie Mae and Freddie Mac) are sophisticated investors that will buy and hedge almost any CMO as long as it is cheap enough. They may use OAS or comparisons to collateral to determine cheapness. They may buy CMOs off certain collateral when the underlying collateral is hard to find. They can hedge using derivatives or issue debt (including callable debt) against CMOs that they purchase for their portfolios. They are, in general, buy-and-hold investors, although some CMOs may be placed in the available-for-sale account rather than the held-to-maturity account.

Because of the housing GSEs' relative-value framework, OAS is typically very important. On the other hand, some GSEs (such as the 12 FHLBs) have the ability to buy nonagency MBS. The FHLBs operate more like a bank in some cases, caring as much about yield, net interest margin, and average-life profile as they do about relative value in an OAS framework.

Insurance Companies

Insurance companies buy CMOs across the spectrum of "regular" tranches—PACs, sequentials, PACquentials. Property and casualty companies tend to buy

EXHIBIT 24–21

FFIEC Test

Regulatory packet: 1<go>. Download 22<go> DG65Msg:D. NEW YORK
Note: Projections start with 10/25/2003 payment.

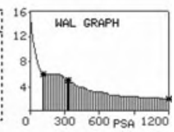
FFIEC HIGH RISK SECURITY TEST PG. 1 OF 14

CUSIP 31393EUU1 FNR 2003-90 MK 5% 10/25/26 CMO:EXCH,+

collateral: 100% FNCL 5.5 N WAC:5.9 WAM:353 AGE:5 (10/03)

ASSUMPTIONS | Source (for your records)

10/10/03
Bid/Ask P: 102-06 102-06 PRC CUSTOM
Prepay Base : 325 PSA B.Median 333
" 300BP : 1665down 112up D.TABLE 1667 112



detail? Y NCUA? N

Interpolate / Actual / Custom: I

PASS

				Test#1					Test #2		Test #3	
Tsy BP		Security		MAX	Trsy Sprd		Security		WAL Change		Prc Change	
Shift		PSA	WAL	WAL	Mty	BP	Yield	Price	actual	Max	actual	Max
-300	1665	1665	1.48		1.48	159	0.000	107-02	-3.44	-6.0	4.8%	17%
-200	1665	1665	1.48		1.48	137	0.779	105-28	-3.44	-6.0	3.6%	17%
-100	1410	1410	1.67		1.67	137	1.858	104-26	-3.26	-6.0	2.6%	17%
0	325	325	4.92	10	4.92	137	4.470	102-06	n/a		0.0%	
+100	155	155	5.88		5.88	137	5.694	96-17	0.95	+4.0	-5.5%	17%
+200	123	123	5.88		5.88	137	6.694	91-28	0.95	+4.0	-10.1%	17%
+300	112	112	5.88		5.88	137	7.694	87-16	0.95	+4.0	-14.4%	17%

Scan? N

10/ 7/03

BGN Tsy	Curve
.25	.91
.50	1.00
2	1.62
3	2.09
5	3.11
10	4.24
30	5.14

2-FBC	4-UBS	5-BS	6-BOA	7-ML	8-LB	9-SAL	10-GCM	11-MS	12-GS	13-JPS
332	267	235	393	333	196	414	358	189	408	405
980 107	1569 122	1667 108	1470 107	1690 115	1400 96	2080 124	2143 102	1448 112	2232 144	2340 113

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
G563-300-2 07-Oct-03 15:05:32

Source: Bloomberg LP.

shorter-maturity tranches, such as two-year sequentials. Life insurance companies are looking for more structure to match against their liabilities and are more likely to purchase longer-duration bonds, such as 10-year PACs. While MBS are a break from the credit risk that insurance companies typically take on the corporate bonds in their investment portfolios, they are well aware of the convexity risk that they are taking in MBS. In 1995, Standard & Poor's (S&P) devised a "convexity test" that penalized insurance companies for having negative convexity in their portfolios. This served primarily to reduce mortgage holdings at some particularly large "outlier" firms that held lots of MBS, but also has generally reduced MBS, holdings over time to smaller amounts at insurance companies.

In general, insurance companies may have restrictions on selling CMOs because of gain or loss constraints. Property and casualty companies may sell bonds against claims (after a hurricane, for example).

Money Managers

Money managers vary in sophistication. They generally are not subject to gain/loss constraints because they mark-to-market constantly, unless they are managing a separate account for a financial institution. Some money managers are active in the CMO derivatives market, but many are not. Most money managers are benchmarked against an index that contains pass-throughs. Therefore, any CMO is effectively an "out of index" bet for them. They typically will be comparing that CMO either with collateral or perhaps with Treasuries/agencies for certain types of CMOs. OAS analysis tends to be an important tool for them.

Liquidity tends to be a bigger issuer for money managers than for insurance companies. The money manager may need to be able to shift assets around quickly and thus is prepared to give up something in order to have better liquidity. Most money managers own many more pass-throughs than CMOs because of this fact. In addition, pass-throughs have the opportunity to finance at attractive levels (via the dollar roll market). Income from special financing can be a windfall for money managers because this income typically is not included in mortgage index returns the money managers are benchmarked against.

Money managers frequently take long-term views about strategy in mortgages. One type of view is to have a portfolio that has better (or worse) convexity than the benchmark index. A money manager typically can get better convexity by buying PAC bonds or give up convexity by buying companion bonds or certain types of sequentials or broken PACs.

Pension Funds

Pension funds in some ways operate similarly to money managers. However, ERISA (pension fund law) or investor considerations sometimes keep them from investing in mortgage derivatives. Similar to life insurance companies, they can be interested in longer-duration tranches at times.

Hedge Funds

Hedge funds can operate in a manner similar to money managers, but at times they enter into more complex trades involving OTC derivatives. For example, they might buy a CMO and try to hedge its cash flows over time using swaps and options, netting a positive spread that they hope to earn over time.

Certain hedge funds specialize in mortgage derivatives: inverse floaters, IOs, POs, inverse IOs, etc. They use sophisticated models to value these tranches, purchase them, and hedge them. One of the main issues for these funds will be pricing of their inventory (since individual bonds may not trade for months) and liquidity.

Retail Investors/Regional Dealers

Many CMOs, including CMO derivatives such as inverse floaters, end up in the hands of regional dealers. In turn, these regional dealers may sell those bonds to retail clients. In general, yield tends to be the focus of these buyers, and thus companion bonds are often sold via this channel.

Note that any broker that sells CMOs to retail investors must include a special series of disclaimers mandated by the National Association of Securities Dealers (NASD).

Lessons from the Past

Investors in MBS, and especially in derivative MBS, have gone out of business in the past. In a crisis, while the mortgage market may continue to trade via pass-throughs, the CMO market can lose liquidity, and the derivatives market can practically stop trading for some period of time. Investors should be prepared for all risks, including the risk of illiquidity and radical changes in pricing owing to such illiquidity. Dealers must make sure that they "know their customer" and that the customer is buying bonds appropriate for her goals.

APPENDIX 24

Using Bloomberg

PULLING UP A CMO

A CMO can be pulled up via a CUSIP or a ticker. The Bloomberg ticker is generally FNR or FHR (for Fannie Mae or Freddie Mac REMIC), followed by a space, the deal number, another space, and the tranche letter(s). This must be followed by the <Mtge> key and <Go> to pull the bond up. Please note that most CMO prices in Bloomberg are inaccurate. An alphabetical list of useful commands follows.

ALPHABETICAL LIST OF SOME USEFUL BLOOMBERG COMMANDS FOR CMOs

All the following commands can be executed after pulling up a CMO in Bloomberg. Simply type the command and hit the <Go> key. We do not recommend using OAS functions on Bloomberg because the term structure and prepayment models available are not state of the art. Bloomberg is more useful for examining tranche types, getting Bloomberg median prepayment forecasts, and calculating yield tables or pricing out a tranche for purchase or sale.

CAMP	new and outstanding CMOs, total
CAV	collateral availability
CMOR	displays recent CMO deals
DES	provides tranche description
DES2	provides CMO collateral description
FMED	run the FFIEC test on a tranche (user must input correct bond price)
ICMO	displays aggregated CMO issuance
VAC	view all classes—allows the user to look at all the tranches in a deal

VMED	view Bloomberg median prepayment speed
YT	yield table

CERTIFICATIONS

The views expressed in this chapter accurately reflect the personal views of the author's lead analyst(s) about the subject issuer and the securities of the issuer. In addition, the analyst has not and will not receive any compensation for providing a specific recommendation or view in this chapter.

CHAPTER

TWENTY-FIVE

NONAGENCY CMOs

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All the cash-flow structures found in agency collateralized mortgage obligations (CMOs) are also applicable to nonagency or whole-loan CMO structures. The major additional element in structuring nonagency CMOs is credit enhancement. The investor in a nonagency CMO is exposed to both prepayment risk and credit risk. Other elements include compensating interest payments, weighted-average coupon dispersions, and cleanup call provisions. In this chapter we will discuss various credit enhancement structures, compensating interest payments, cleanup call provisions, and the impact of coupon dispersions.

THE NONAGENCY MBS MARKET

The nonagency mortgage-backed securities (MBS) market is substantially smaller than the agency mortgage market. Nonagency or private-label MBS are collateralized by mortgage loans that do not meet government-sponsored enterprise (GSE) underwriting standards. These types of mortgages traditionally have been referred to as "nonconforming" because their loan size exceeds GSE limits. Another reason for a mortgage loan to be nonconforming is that it did not meet the credit-quality standards of the GSEs. Several different types of nonconforming loans are used as collateral for nonagency CMOs.

One of the most common types of collateral used to back nonagency MBS are jumbo mortgages. Jumbo mortgages have loan balances that exceed GSE guidelines ($359,650 in 2005) and are loans generally made to high-quality or "prime" borrowers.

Another common collateral type used to back nonagency MBS is home equity loans (HELs). The HEL market is quite heterogeneous because it includes second-lien mortgages, first-lien mortgages with high loan-to-value (LTV) ratios, home improvement loans (HIL), revolving home equity lines of credit (HELOC), and subprime mortgages. The HEL market was once considered to be only traditional prime "second mortgages," but this collateral type has evolved into a product area mainly focused on subprime or lower-credit-quality borrowers often labeled as B, C, or D grade. Only a small portion of HELs consists of true second-lien mortgages today.

Another large segment of the nonagency MBS market are Alt-A, or alternative-A, mortgage loans. Alt-A loans consist of loans to borrowers who have good credit but do not meet the standard criteria for determining creditworthiness. The reason that they do not meet the standards could be because the borrowers have incomes that are not easily verified, as in the case of the self-employed. These loans may be within or may exceed the conforming loan limits. Alt-A borrowers generally pay higher interest rates than prime borrowers. With the advent of automated underwriting, the distinction between prime and alt-A borrowers has been blurred. Fannie Mae and Freddie Mac also have increased their securitization of these types of loans so that many Alt-A loans are now contained in agency pass-throughs.

A major sector within the nonagency market are securities backed by hybrid adjustable-rate mortgages (ARMs). A hybrid ARM is a special type of ARM. With an ARM the coupon resets periodically based on changes in the reference rate. Coupon rate changes are subject to periodic and lifetime caps and floors. For most ARMs, following an initial fixed-rate period, the coupon rate resets annually. The initial fixed-rate period before the rate resets is one year or less. For a hybrid ARM, the initial fixed-rate period is greater than one year. Thus, the initial fixed-rate period distinguishes a hybrid ARM from an ARM as it is conventionally defined in the market today. For a hybrid ARM the initial fixed-rate period can range from 5 to 7 years, and in some cases up to 10 years. A relatively new product in the market is the interest-only hybrid ARM. By the middle of 2004, IO hybrid ARMs became the largest share of the nonagency market, surpassing that of fixed-rate nonagency products.

Issuers of nonagency MBS have been much more forthcoming with data, generally releasing loan-level data for the collateral backing their deals. In recent years, with the availability of data on borrower attributes for nonagency MBS and loan attributes, prepayment models have become more attribute sensitive rather than generic. More variables are now used to compute prepayments attributable to refinancing and housing turnover. For example, the model of Bear Stearns incorporates full property level information in order to capture the effects of

WAC and loan size dispersion on future prepayments.[1] To forecast prepayments attributable to refinancing and housing turnover, the model incorporates current housing prices and LTV data. The impact of secondary loan characteristics on prepayments is handled by loan characteristics such as loan purpose, occupancy status, documentation type, and rate premium.

CREDIT ENHANCEMENTS

Three nationally recognized statistical rating organizations rate whole-loan CMOs: Standard & Poor's Corporation, Moody's Investors Service, and Fitch IBCA. The primary factors these rating organizations consider in assigning a rating are the type of property (single-family residences, condominiums), the type of loan (fixed-rate level payment, adjustable rate, balloon), the term of the loans, the geographic dispersion of the loans, the loan size (conforming loans, jumbo loans), the amount of seasoning of the loan, and the purpose of the loan (purchase or refinancing). Typically, a double-A or triple-A rating is sought for the most senior tranche. The amount of credit enhancement necessary depends on rating agency requirements.

There are two general types of credit enhancement structures: external and internal. We will describe each type below.

External Credit Enhancements

External credit enhancements come in the form of third-party guarantees that provide for first loss protection against losses up to a specified level, for example, 10%. The most common forms of external enhancements are (1) a corporate guarantee, (2) a letter of credit, (3) pool insurance, and (4) bond insurance.

Pool insurance policies cover losses resulting from defaults and foreclosures. Policies typically are written for a dollar amount of coverage that continues in force throughout the life of the pool. However, some policies are written so that the dollar amount of coverage declines as the pool seasons as long as two conditions are met: (1) the credit performance is better than expected and (2) the rating agencies that rated the issue approve. Since only defaults and foreclosures are covered, additional insurance must be obtained to cover losses resulting from bankruptcy (i.e., court-mandated modification of mortgage debt), fraud arising in the origination process, and special hazards (i.e., losses resulting from events not covered by a standard homeowner's insurance policy).

Bond insurance provides the same function as in municipal bond structures. Typically, bond insurance is not used as primary protection but to supplement other forms of credit enhancement.

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1. Dale Westhoff and V.S. Srinivasan, "The New Generation of Prepayment Models to Value Nonagency MBS," Chapter 21 in Frank J. Fabozzi (ed.), *Handbook of Mortgage-Backed Securities: 5th Edition* (New York, NY: McGraw-Hill, 2001).

A CMO issue with external credit support is subject to the credit risk of the third-party guarantor. Should the third-party guarantor be downgraded, the CMO issue itself could be subject to downgrade depending on the performance of the collateral. This is the chief disadvantage of third-party guarantees. Therefore, it is imperative that investors perform credit analysis on both the collateral (the loans) and the third-party guarantor.

External credit enhancements do not materially alter the cash-flow characteristics of a CMO structure except in the form of prepayment. In case of a default resulting in net losses within the guarantee level, investors will receive the principal amount as if a prepayment has occurred. If the net losses exceed the guarantee level, investors will have a shortfall in the cash flow.

Internal Credit Enhancements

Internal credit enhancements come in more complicated forms than external credit enhancements and may alter the cash-flow characteristics of the loans even in the absence of default. The most common forms of internal credit enhancements are reserve funds and senior/subordinated structures.

Reserve Funds

Reserve funds come in two forms, cash reserve funds and excess spread accounts. Cash reserve funds are straight deposits of cash generated from issuance proceeds. In this case, part of the underwriting profits from the deal are deposited into a hypothecated fund that typically invests in money market instruments. Cash reserve funds typically are used in conjunction with letters of credit or other kinds of external credit enhancements. For example, a CMO may have 10% credit support, 9% of which is provided by a letter of credit and 1% from a cash reserve fund.

Excess spread accounts involve the allocation of excess spread or cash into a separate reserve account after paying out the net coupon, servicing fee, and all other expenses on a monthly basis. For example, suppose that the *gross weighted-average coupon* (gross WAC) is 7.75%, the servicing and other fees is 0.25%, and the *net weighted-average coupon* (net WAC) is 7.25%. This means that there is excess servicing of 0.25%. The amount in the reserve account will increase gradually and can be used to pay for possible future losses.

The excess spread is analogous to the guarantee fee paid to a GSE, except that this is a form of self-insurance. This form of credit enhancement relies on the assumption that defaults occur infrequently in the initial stages of the loans but increase gradually in the following two to five years. This assumption is consistent with the Bond Market Association's standard default assumption curve.

Senior/Subordinated Structure

The most widely used internal credit support structure is by far the senior/subordinated structure. The subordinated class is the first loss piece absorbing

EXHIBIT 25–1

Loss-Severity Table $100 Million Deal, 7.75% Subordination

Loss Amount (millions)	Senior Class	Subordinated Class
$5.00	0.00%	64.50%
$7.75	0.00%	100.00%
$10.00	2.40%	100.00%
$20.00	13.30%	100.00%

all losses on the underlying collateral, thus protecting the senior class. For example, a $100 million deal can be divided into two classes: a $92.25 million senior class and a $7.75 million subordinated class. The subordination level in this hypothetical structure is 7.75%. The subordinated class will absorb all losses up to $7.75 million, and the senior class will start to experience losses thereafter. Thus, if there are $5 million of losses, the subordinated class will realize this loss. Therefore, it would realize a 64.5% loss ($5/$7.75). If, instead, there is $10 million of losses, the subordinated class will experience $7.75 million of losses, or a 100% loss, and the senior class will experience a loss of $2.25 million ($10 million minus $7.75 million), or a 2.4% loss ($2.25/$92.25). Exhibit 25–1 is a loss-severity table showing various percentage losses in principal on both senior and subordinated classes at different loss levels.

The subordinated class holder obviously would require a yield premium to take on the greater default risk exposure relative to the senior class. This setup is another form of self-insurance wherein the senior class holder is giving up yield spread to the subordinated class holder. This form of credit enhancement does not affect cash-flow characteristics of the senior class except in the form of prepayment. To the extent that losses are within the subordination level, the senior class holder will receive principal as if a prepayment has occurred. Exhibit 25–2 shows the average life of both classes at 165 PSA before any default assumption for a hypothetical $100 million structure with a 7.75% subordination level.

Almost all existing senior/subordinated structures also incorporate a *shifting interest structure*. A shifting interest structure redirects prepayments disproportionally from the subordinated class to the senior class according to a specified schedule. An example of such a schedule appears in Exhibit 25–3.

The rationale for the shifting interest structure is to have enough insurance outstanding to cover future losses. Because of the shifting interest structure, the subordination amount actually may grow in time, especially in a low-default and fast-prepayment environment. This is sometimes referred to as “riding up the credit curve.”

Using the same example of our previous $100 million deal with 7.75% initial subordination and assuming a cumulative principal paydown of $16 million

EXHIBIT 25–2

Average Life for Senior/Subordinated Structure Assuming No Defaults and 165 PSA

Structure		
Gross WAC	8.13%	
New WAC	7.50%	
WAM (months)	357	
No shifting interest		
Senior class	92.25%	8.77
Subordinate class	7.75%	8.77
With shifting interest		
Senior class	92.25%	8.41
Subordinate class	7.75%	13.11
With shifting interest		
Senior class	84.50%	7.98
Subordinate class	15.50%	13.11

($6 million of regular repayments and $10 million of prepayments) by year five and no losses, the subordination actually will increase to 9.5%. The subordinated class principal balance will be reduced by the pro-rata share of regular repayments (7.75% of $6 million) and none of the prepayments to $7.29 million. The senior class principal balance will be reduced by the pro-rata share of regular repayments (92.25% of $6 million) and all the $10 million prepayments to $76.71. The new subordination level will increase to 9.5% ($7.29/$76.71). Exhibit 25–4 shows

EXHIBIT 25–3

Example of a Shifting Interest Structure

Months	Percentage of Prepayments Directed to Senior Class
1–60	100
61–72	70
73–84	60
85–96	40
97–108	20
109+	Pro rata

EXHIBIT 25–4

Subordination Level $100 Million Deal, 7.751% Subordination, 5 Years Out (in millions)

Regular Paydown	Prepayment	Loss	Size of Senior Class	Size of Subordinate Class	Subordination Level
$6	$10	$0	$76.71	$7.29	9.50%
$6	$20	$0	$66.71	$7.29	10.93%
$6	$40	$0	$46.71	$7.29	15.61%
$6	$10	$2	$76.71	$5.29	6.90%
$6	$20	$2	$66.71	$5.29	7.93%
$6	$40	$2	$46.71	$5.29	11.33%
$6	$10	$5	$76.71	$2.29	2.99%
$6	$20	$5	$66.71	$2.29	3.43%
$6	$40	$5	$46.71	$2.29	4.90%

the new subordination levels given various combinations of prepayments and losses. Holding net loss at zero, the faster the prepayments, the higher the subordination grows. Even in the case of losses, fast prepayments sometimes can offset the effect of principal losses to maintain the initial subordination.

While the shifting interest structure is beneficial to the senior class holder from a credit standpoint, it does alter the cash-flow characteristics of the senior class even in the absence of defaults. As Exhibit 25–2 indicates, a 7.75% subordination with the shifting interest structure will shorten the average life of the senior class to 8.41 years at the same 165 PSA, assuming no default. The size of the subordination also matters. A larger subordinated class redirects a higher proportion of prepayments to the senior class, thereby shortening the average life even further. A 15.5% subordination in the same example shortens the average life to 7.98 years.

It may be counterintuitive that the size of the subordination should affect the average life and cash flow of the senior class more than the credit quality. This is so because the size of the subordination is already factored into the rating. The rating agency typically requires more subordination for lower-credit-quality loans to obtain a triple-A rating and less subordination for better-credit-quality loans. From a credit standpoint, the investor may be indifferent between a 5% subordination on a package of good-quality loans and a 10% subordination on a package of lower-quality loans as long as the rating agency gives them the same rating. However, the quality of the underlying loans will determine the default rate and therefore the timing of the cash flow.

COMPENSATING INTEREST

An additional factor to consider that is unique to nonagency CMO structures is compensating interest. Mortgage pass-throughs and CMOs pay principal and interest on a monthly basis (with the exception of some early quarterly-pay CMOs), and principal paydown factors are also calculated only once a month. While homeowners may prepay their mortgage on any day throughout the month, the agencies guarantee and pay the investors a full month of interest as if all the prepayments occur on the last day of the month. Unfortunately, this guarantee does not apply to whole-loan mortgages and, consequently, not to nonagency CMOs. If a homeowner pays off a mortgage on the tenth day of the month, he will stop paying interest for the rest of the month. Because of the payment delay (e.g., 25 days) and the once-a-month calculation of principal paydown, the investor will receive full principal but only 10 days of interest on the twenty-fifth of the following month.

This phenomenon is known as *payment interest shortfall* or *compensating interest* and is handled differently by different issuers and services. Some issuers will only pay up to a specified amount, and some will not pay at all. The economic value of compensating interest depends on the level of prepayment and the types of CMO tranches. Generally, the faster the prepayment and the higher the coupon tranche, the higher is the economic value of compensating interest.

WEIGHTED-AVERAGE COUPON DISPERSION

The pooling standard on whole loans is looser than that on agency deals. Therefore, most nonagency CMOs have wider gross coupon and maturity dispersions given any WAC and WAM. While the agency would strip off variable amounts of servicing and guarantee fees to bring the net coupon of a pool down to 50 basis point increments, whole loans have fixed servicing fees, and the net coupons can vary. Using Exhibits 25–5 and 25–6 as examples, an agency CMO

EXHIBIT 25–5

Agency CMO

Pools	GWAC	Net Coupon (%)	IOette (bps)	Stripped-Down Coupon
1	8.70%	8.00%	100	7.00%
2	8.60%	8.00%	100	7.00%
3	8.50%	8.00%	100	7.00%
4	8.40%	8.00%	100	7.00%
Average	8.55%	8.00%	100	7.00%

EXHIBIT 25–6

Nonagency CMO

Pools	GWAC	Servicing (bps)	Net Coupon	WAC IO (bps)	Stripped-Down Coupon
1	8.70%	55	8.15%	115	7.00%
2	8.60%	55	8.05%	105	7.00%
3	8.50%	55	7.95%	95	7.00%
4	8.40%	55	7.85%	85	7.00%
Average	8.55%	55	8.00%	100	7.00%

may contain four pools with gross coupons of 8.7%, 8.6%, 8.5%, and 8.4% to yield a GWAC of 8.55%. Seventy basis points are stripped off the first pool to yield an 8% net coupon. Sixty basis points will be stripped off the second pool to also yield an 8% coupon. Fifty and forty basis points will be stripped off the third and fourth pools, respectively. Since all the pools have net coupons of 8%, the weighted-average net coupon is also 8%. Conversely, a nonagency CMO containing four pools with the exact GWACs will have a constant servicing fee of 55 basis points. The net coupons on these four pools then will be 8.15%, 8.05%, 7.95%, and 7.85% to yield the same weighted-average net coupon of 8%. To create fixed-rate (e.g., 7% coupon) tranches from the nonagency CMO regardless of which pool prepays, a WAC IO (weighted-average coupon interest-only) tranche must be created to absorb the variability of net coupons on the underlying pools. The WAC IO tranche will receive a weighted-average coupon of 100 basis points off the whole deal. The WAC IO is equivalent in structure to an IO strip or IOette in an agency deal. However, as soon as prepayments start to occur, the WAC IO strip may change. Hypothetically and intuitively, pools 1 and 2, with the higher WACs, prepay first. Exhibit 25–7 shows that this will leave the WAC IO strip with only 90 basis points of coupon, one-tenth less in cash flow going forward. This is

EXHIBIT 25–7

Nonagency CMO after Paydown

Pools	GWAC	Servicing (bps)	Net Coupon	WAC IO (bps)	Stripped-Down Coupon
3	8.50%	55	7.95%	95	7.00%
4	8.40%	55	7.85%	85	7.00%
Average	8.45%	55	7.90%	90	7.00%

extremely important in the analysis of WAC IOs because nonagency CMOs tend to have wider WAC dispersion.

CLEANUP CALL PROVISIONS

All nonagency CMO structures are issued with "cleanup" call provision. The cleanup call provides the services or the residual holders (typically the issuers) the right, but not the obligation, to call back all the outstanding tranches of the CMO structure when the CMO balance is paid down to a certain percentage of the original principal balance. The servicers typically find it more costly than the servicing fee to service the CMO when the balance is paid down to a small amount. For example, suppose that a $100 million CMO was issued originally with a 10% cleanup call. When the entire CMO balance is paid down to $10 million or less, the servicer can exercise the call to pay off all outstanding tranches like a balloon payment regardless of the percentage balance of the individual tranches.

The call provision, when exercised, shortens the principal payment window and the average life of the back-end tranches of a CMO. This provision is not unique to nonagency CMO structures. It is mandatory, however, for all nonagency CMO structures, whereas agency CMOs may or may not have cleanup calls.

CHAPTER
TWENTY-SIX

RESIDENTIAL ASSET-BACKED SECURITIES

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Mortgage securities fall into the following categories:

- *Conforming mortgages/collateralized mortgage obligations* (*CMOs*). Conforming on balance and underwriting criteria with respect to agency guidelines.
- *Private-label mortgages/CMOs.* Nonconforming due to balance or certain underwriting criteria.
- *Residential ABS*. First-lien mortgages, mainly to subprime borrowers; second-lien mortgages to prime and subprime borrowers; home equity lines of credit (HELOCs); high-loan-to-value mortgage loans.

In Chapters 23 and 24, conforming mortgage/CMOs are covered. In Chapter 25, private-label mortgages/CMOs (also referred to as *nonagency mortgage-backed securities*) are covered. The focus of this chapter is residential asset-backed securities (ABS).

The residential ABS sector grew rapidly during the 1990s. The development of nonconforming mortgage products such as home equity loans coincided with the coming of age of securitization, a dramatic growth in consumer credit, a secular decline in interest rates, and a period of strong house price appreciation—especially on the coasts. These nonconforming mortgage products supply much of the collateral backing the residential ABS market. New issue volume of public residential ABS has grown from just over $39 billion in 1996 to more than $383 billion in 2005. Residential ABS outstanding has increased from $52 billion in 1996 to more than $411 billion in 2004.

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EXHIBIT 26–1

Risk-Based Capital Matrix for U.S. Depository Institutions

Product/Security	Risk Weight
Treasuries GNMAs	0%
Federally related institutions (e.g., EX-IM Bank)	0%
GSE debt (FNMA, FHLMC, FHLB)	20%
GSE-backed MBS and CMOs (FNMA, FHLMC)	20%
AAA- and AA-rated securitizations (ABS, CMBS, whole-loan/private-label CMOs)	20%
A-rated securitizations (ABS, CMBS, whole-loan/private-label CMOs)	50%
BBB-rated securitizations (ABS, CMBS, whole-loan/private-lable CMOs)	100%
BB-rated securitizatinos	200%
B-rated or unrated securitizations	Dollar-for-dollar

Low absolute levels of interest rates in 2002 and 2004 and a desire to pick up some additional yield pushed more and more ABS investors into the residential ABS market. The growth of the sector, particularly in the mezzanine and subordinate tranches, improved liquidity. Various commercial analytical tools and greater dissemination of collateral pool credit data from servicer reports aided transparency. An additional factor drawing attention to residential ABS (and to structured finance products overall) is a change to capital regulations for depository institutions that went into effect on January 1, 2002. These risk-based capital rules give AAA and AA asset-backed securities a 20% risk weight (Exhibit 26–1). This risk weight is the same as that applied to agency debt, as well as agency mortgage-backed securities and CMOs. This regulatory change removes the capital advantage that securitized agency mortgages had over other structured finance products, including residential ABS. Thus commercial banks and thrifts subject to these regulations now have another, complementary mortgage product available to them. Indeed, there has been significant movement by depository institutions into the ABS market.

This chapter describes the major features of the residential, or home equity loan, ABS market. Its intent is to provide the reader with a foundation for understanding and analyzing residential ABS collateral and structures. Within the mortgage market, residential ABS offer the benefits of diversification for a mortgage portfolio and superior convexity attributes compared with agency mortgage securities.

MARKET DEVELOPMENT

The mortgage-related bond market is the largest segment of the U.S. fixed income markets. According to data from the Bond Market Association, approximately

$5.3 trillion of mortgage securities was outstanding at the end of 2003 compared with $4.5 trillion of corporates and $3.6 trillion of Treasuries. This market segment consists primarily of agency MBS and CMOs, as well as private-label MBS and CMOs. This is “the mortgage market” in the minds of many investors.

The origins of the residential ABS market lie in the development of the nonagency mortgage market beginning in the late 1970s and early 1980s. Many of the mortgages made by lenders fell outside the criteria developed by the agencies because of either the loan balance or underwriting criteria used. The nonagency mortgage market developed as a means to securitize this product. The structures used in the residential ABS sector today, especially the senior/subordinate structures used by most issuers, echo the senior/subordinate structures developed for nonagency MBS transactions of the middle to late 1980s.

Residential ABS are distinguished from the rest of the mortgage market by the purpose of the loans or the credit profile of the obligor base of the pool. Early residential ABS transactions were securitizations of second-lien mortgages with relatively low loan balances to prime borrowers. Thus the sector earned the name *home equity loan ABS*. During the latter half of the 1990s, the residential ABS market evolved toward first-lien loans as collateral. This trend toward first liens was driven by a falling interest-rate environment, consumers’ use of the equity in their homes to consolidate debt, growing competition in the mortgage lending market, and a proliferation of subprime borrower programs from major lenders. In addition, mortgage lenders preferred to take a first-lien position when refinancing subprime borrowers to limit their risk exposure.

The *home equity loan* (HEL) name of the sector stuck, but most transactions issued in the residential ABS market today are backed primarily by closed-end first-lien mortgages to subprime borrowers. The proportion of first liens is typically 90% or more of the original pool balance. The *home equity loan* designation still applies to this sector because most lenders are making funding decisions based on the equity available in the home. In most HEL pools, mortgages used to purchase a property are a relatively small proportion of the deal. Borrowers most often are refinancing existing mortgages to access the equity in their home (a cash-out refi), consolidate consumer debt, reduce their monthly payment (rate/term refi), finance home improvements, or pay for education or medical expenses. Home equity loans also may be used as a debt-management tool for borrowers to improve their household balance sheet by reducing their monthly payments.

The loans may be fixed-rate, adjustable-rate, or hybrid adjustable-rate mortgages (ARMs). In recent years, 2/28 and 3/27 ARMs have become the predominant products securitized. The borrowers often have impaired credit histories or debt-to-income ratios that exceed agency guidelines and also may be referred to as B and C borrowers. The subprime credit spectrum, however, extends from A– borrowers that are just below prime status to D quality borrowers.

During the past several years there have been significant changes to the structure of the subprime lending and home equity ABS markets. During the middle to late 1990s, most of the lenders were independent finance companies. These firms started out relatively small and used the developing securitization market as a means for asset growth and for producing earnings. The players in this market included names such as ContiFinancial, The Money Store, Green Tree, UCFC, and Advanta.

A severe liquidity crunch during late 1998 squeezed the financial positions of a number of lenders in the residential ABS sector. Intense competition for refinancings during the falling interest-rate environment of 1997 and 1998 led some issuers to weaken underwriting standards in order to maintain loan production and increase market share. In addition, unfettered access to the ABS market allowed certain originators a funding alternative that provided cash flow for additional growth. However, some of the firms that grew rapidly during this period were weakly capitalized and overly reliant on the securitization market for funding.

Access to the ABS market became more restricted during the latter half of 1998. Liquidity evaporated as a consequence of the events surrounding the demise of Long Term Capital Management. As a result, several of the firms in the sector were forced into bankruptcy or to merge with stronger firms. This shakeout left the sector with fewer but stronger subprime lenders.

Of the top 10 home equity ABS issuers in the market at year-end 1998, all but one, GMAC Mortgage, has exited the market through bankruptcy, merging with stronger players, or selling their subprime lending businesses (Exhibit 26–2). In most cases the servicing has been transferred to another mortgage servicer. The ABS issuers in the market today are a very different list than that seen just five years ago. They generally carry higher corporate credit ratings or belong to larger financial institutions that have the resources to provide support to the servicing of the subprime mortgage business. In addition, dealer shelves have become significant issuers of HEL bonds. Whole-loan sales by subprime mortgage originators to securities dealers, who in turn securitize the loans, have become an important channel for funding operations.

CHARACTERISTICS OF SUBPRIME BORROWERS

The agency mortgage securitization market developed well-established criteria based on loan balance and underwriting standards that transformed prime mortgages into something of a commodity. Credit performance is not a primary concern for investors because of the guarantee placed on the bonds by the agencies.

The borrowers represented in the residential ABS market have credit profiles that are below this prime segment serviced by the agency mortgage sector. A number of established mortgage lenders have developed lines of business that target subprime obligors who have limited options in the traditional home loan market, and new firms have entered the market over time.

But what does it mean to say a borrower is subprime? Exhibit 26–3 shows Standard & Poor's Rules-Based Credit Classifications for mortgage borrowers. This exhibit provides a generalized view of the underwriting criteria used by

E X H I B I T 26–2

Top 10 HEL ABS Issuers, 1998 and 2003

Top 10 Residential ABS Issuers—2003

Sponsor	Amount (billions)	Deals	Market Share
GMAC	$27.9	32	15.8%
Ameriquest	$16.4	15	9.3%
Countrywide	$13.8	18	7.8%
Lehman	$12.0	13	6.8%
CSFB	$9.9	17	5.6%
Option One	$9.3	8	5.3%
New Century	$8.9	14	5.0%
Long Beach	$7.3	6	4.1%
Argent Mortgage	$6.2	6	3.5%
Chase Mortgage	$5.1	6	2.9%

Top 10 Residential ABS Issuers—1998

Sponsor	Amount (billions)	Deals	Market Share
ContiFinancial	$6.5	4	3.7%
IMC	$5.1	7	2.9%
Green Tree	$4.7	10	2.7%
GMAC	$4.6	8	2.6%
Advanta	$4.1	6	2.3%
First Union/The Money Store	$3.8	6	2.2%
UCFC	$3.1	6	1.8%
AMRESCO	$3.0	4	1.7%
BankAmerica/EquiCredit	$2.9	4	1.6%
First Plus	$2.6	5	1.5%

EXHIBIT 26–3

Standard & Poor's Rules-Based Credit Classifications

	Credit Grade				
Characteristic	**A**	**A–**	**B**	**C**	**D**
Mortgage credit	0 × 30	2 × 30	3 × 30	4 × 30 1 × 60	5 × 30 2 × 60 1 × 90
Consumer credit		2 × 30 1 × 60	3 × 30 2 × 60	4 × 30 3 × 60 1 × 90	4 × 30 3 × 60 2 × 90
Revolving	2 × 30				
Installment	1 × 30				
Debt-income ratio	36%	45%	50%	55%	60%
Bankruptcy/notice of default	None in past 7 years	None in past 5 years	None in past 3 years	None in past 2 years	None in past year

Note: Each cell indicates number of times a consumer is *x* days past due.
Source: Standard & Poor's Structured Finance Ratings Group.

many subprime mortgage lenders. In this matrix, borrowers with credit characteristics below the A category would be considered subprime. Subprime borrowers have had some mortgage delinquencies, as well as some serious delinquencies on other consumer debt. Debt-service-to-income ratios are higher than those of prime borrowers. Furthermore, better-quality subprime borrowers would have no mortgage defaults or personal bankruptcies in the past few years.

Many subprime mortgage lenders also make greater use of FICO scores than they have in the past. FICO scores have become of particular interest to investors because one index number is used to encapsulate the credit profile of a borrower. Making strict cutoff points on the FICO scale is more an art than a science, but some rules of thumb can be applied. In general, FICO scores above 680 correspond to prime borrowers. Borrowers with FICOs from 680 to 620 are considered A– borrowers. FICO scores below 620 place borrowers squarely in the subprime category. According to statistics published by Fair, Isaac and Company, about 20% of the population would be considered subprime borrowers based on their FICO score. FICO scores compared with credit grade used by Fitch in rating subprime mortgage ABS are listed in Exhibit 26–4.

We offer a note of caution on the interpretation of FICO scores in the context of ABS. Originators use a number of factors beyond the FICO score when making the lending decision. In addition, the credit profile of the borrower is only

EXHIBIT 26–4

Fitch Ratings FICO Score Tolerance Bands

Fitch Credit Grade	A+	A	A–	B	B–
Low	720	680	620	590	575
High	900	720	680	620	590

Source: Fitch Ratings.

one of a number of factors used by the rating agencies when determining credit enhancement for a transaction. This is a statistic that should not be viewed in isolation or as a substitute for understanding the underwriting criteria of an issuer and its collateral performance over time.

PREPAYMENT SPEEDS

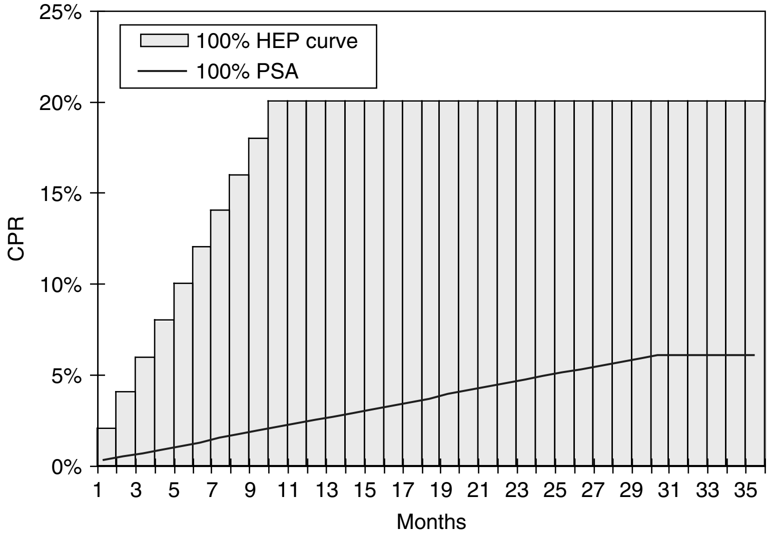
The prepayment profile of subprime mortgage collateral differs in important ways from conforming agency mortgages. These differences can provide a superior convexity profile compared with prime conforming mortgages. As a result, residential ABS provides a good opportunity for investors to add some diversification to their mortgage portfolios. Looking at baseline prepayment ramps, prepayment rates for subprime mortgage pools have a faster seasoning ramp and reach a higher steady-state level than the prepayment rates on conforming agency pools. These characteristics are similar for both fixed-rate and ARM collateral.

For example, a baseline fixed-rate home equity prepayment (HEP) curve ramps up to a steady-state prepayment rate of 20% CPR over 10 months. This prepayment ramp compares with the baseline for conforming agency mortgages of 6% CPR over 30 months, corresponding to a 100% PSA (Exhibit 26–5). The faster prepayment rates on subprime mortgage pools, all other things equal, translate into shorter average lives on the ABS compared with agency mortgages and CMOs.

Prepayment rates on ARM collateral show a similar seasoning pattern, usually peaking between 25% and 30% CPR after 12 months. Exhibit 26–6 shows prepayment curves for 2/28 and 3/27 hybrid ARMs. The prepayment spikes around 24 months for the 2/28 loans and around 36 months for the 3/27 loans coincide with the first reset dates for these mortgage products. When the fixed-rate period ends, the interest rate on the loan resets to a higher level. The higher rate increases the monthly payment for the borrower, providing an incentive to refinance. Most borrowers will refinance within a few months of their reset date, thus creating the pattern of a sharp increase in prepayments followed by a gradual return to the steady-state level as more borrowers seek out alternatives. The more muted effect of the prepayment spike on 3/27 hybrid ARMs is due to the longer

EXHIBIT 26–5

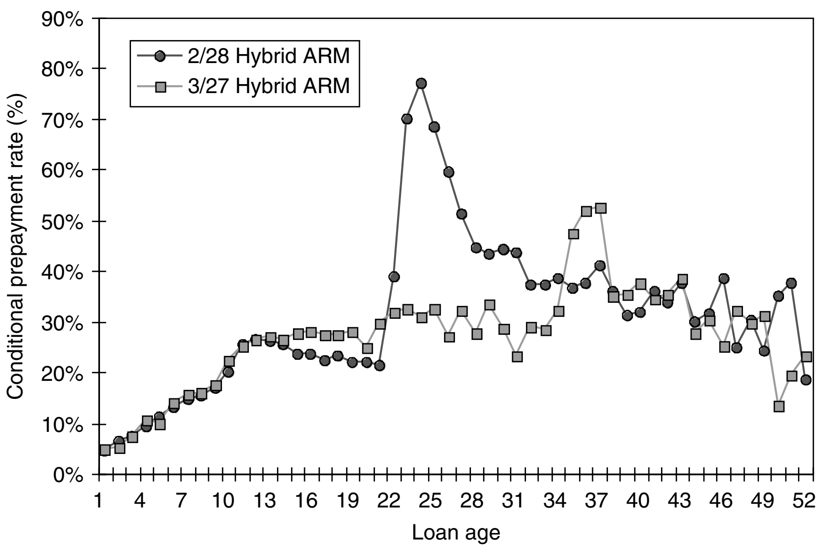
Baseline Prepayment Curves, Fixed-Rate Mortgages



Sources: Bloomberg, Bond Market Association.

EXHIBIT 26–6

Baseline Prepayment Curves, Adjustable-Rate Mortgages



seasoning period prior to the first reset date, which results in a greater "burnout" effect compared with the 2/28 product.

Lenders also may use prepayment penalties as a way to manage their prepayment risk. Lenders use prepayment penalties to make it more costly for the borrower to refinance until the penalty period expires, which can be anywhere from one to five years after origination. For example, the dollar amount of the penalty to the borrower may be calculated as 80% of six months' interest. The ability to levy a penalty and its amount may vary by state or local laws. Given the cash-flow position of most subprime consumers, this penalty amount can be significant. Prepayment penalties can reduce observed prepayment rates by as much as 8% to 10% of the baseline CPR while they are in effect. Loan pools with penalties will prepay more slowly than pools without penalties until the expiration of the penalties. At that point, pent-up demand for refinancing takes over, and prepayments will be higher, on average, for the loan pool that had penalties attached to them.

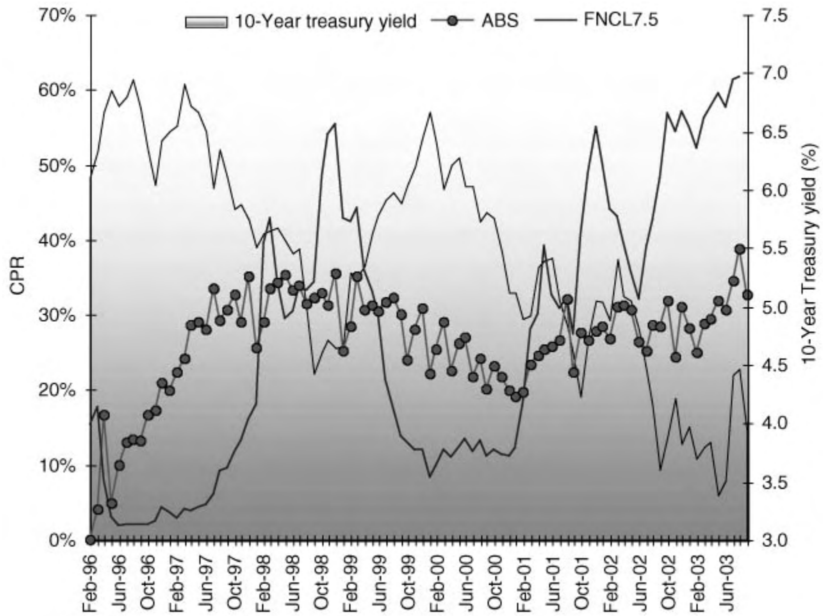
The major reason for faster average prepayment rates on subprime mortgage pools can be described as the "credit curing effect." Subprime borrowers may fall into this category because of past credit problems, such as delinquencies on mortgage or consumer debt, bankruptcy, a high debt-to-income ratio, or a lack of credit history. Over time, though, subprime borrowers have the opportunity to repair their household balance sheets and improve their credit quality. As their credit profile improves, they gain access to more refinancing options. A better credit profile translates into lower mortgage rates and the opportunity to reduce monthly mortgage payments significantly. Other major refinancing motivations include the consolidation of other consumer debt, term extension to reduce monthly payment amounts, and monetizing equity in the home to finance home improvements or to address temporary liquidity needs (such as for education or medical expenses).

Despite being faster on average, prepayment rates on pools of subprime mortgages generally are more stable than they are on conforming mortgage pools. Prepayments on subprime mortgages tend to be less sensitive to interest-rate swings, and thus provide superior convexity compared with agency mortgages. Exhibit 26–7 compares prepayment rates over the past several years for 1996 production loans for both FNMA pools and a group of subprime mortgage lenders. As expected, the subprime mortgages display the faster seasoning ramp typically seen on subprime loans. When interest rates fall, prepayments for both groups rise, but the conforming mortgages peak at a much higher level. When interest rates rise, prepayments for both groups slow, but they fall by less for the subprime group. Based on these data, conforming mortgage pools can have monthly prepayment rates that range from 10% to 60% CPR, whereas the subprime mortgages have prepayments that typically range between 15% and 40% CPR—a prepayment range that is only half as wide.

As a result, the average lives of the residential ABS are likely to be more stable for a given change in interest rates than the average lives of securities created from conforming loans. The main factor affecting prepayments on conforming mortgages is the prevailing mortgage rate for new loans compared with the

EXHIBIT 26–7

Comparing Prepayment Rates



rates on outstanding mortgages. However, the factors affecting prepayment rates on subprime mortgage pools are more varied, and movements in interest rates are only part of the story.

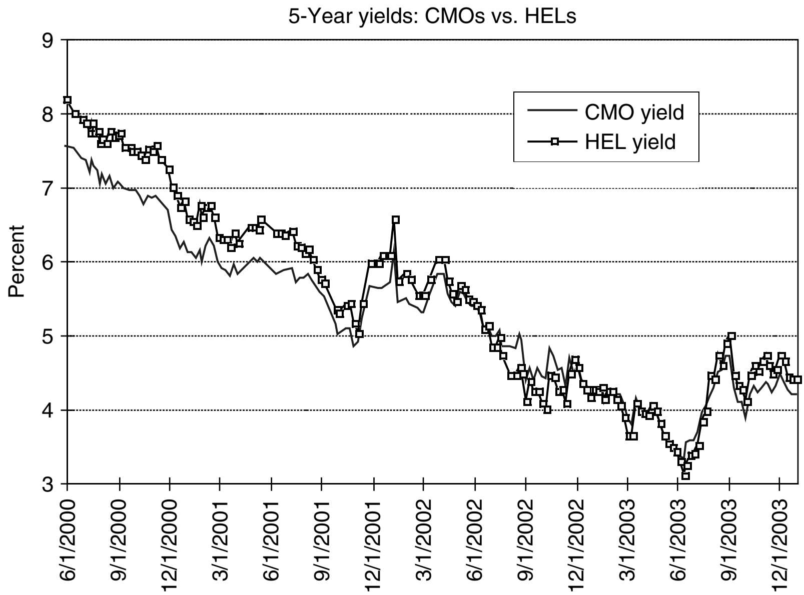
Subprime mortgage loans tend to have somewhat lower loan balances relative to conforming agency pools. With a lower total monthly payment, the incentive to refinance derived from falling mortgage rates is more muted than it would be for prime borrowers because there is less money at stake in any refinancing. Furthermore, subprime borrowers tend to have fewer refinancing alternatives owing to their credit history. This makes refinancing, even when interest rates are falling, that much more difficult than it is for prime borrowers.

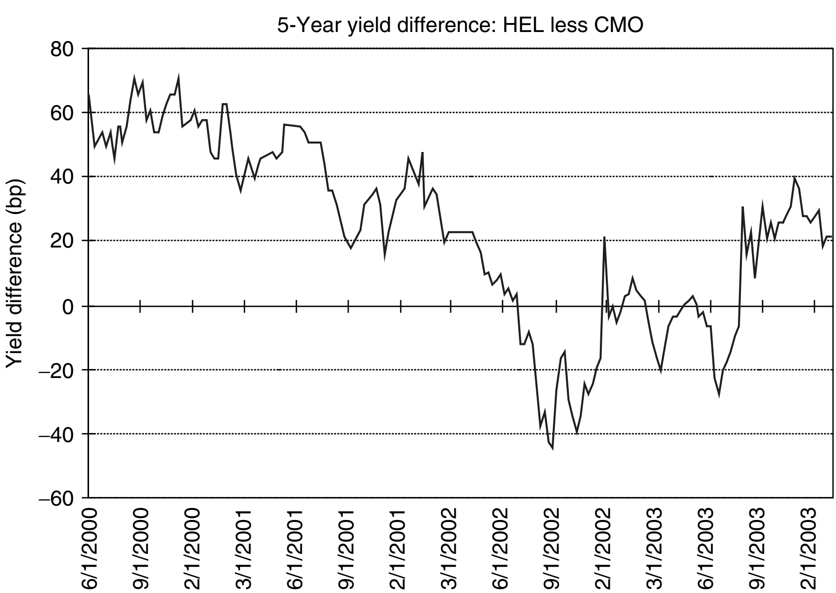
RELATIVE-VALUE CONSEQUENCES

The prepayment profile of subprime mortgages has consequences for their relative value compared with agency mortgage product (Exhibit 26–8). With less sensitivity to swings in interest rates, HELs should have superior convexity characteristics and more stable average lives. Relative yield movements between agency CMOs and HELs provide an example. As yields compressed from 2000 through 2003, the relative attractiveness of residential ABS can be seen in a comparison of the yields

EXHIBIT 26–8

Yields and Yield Difference, 5-Year HELs and Agency CMOs





on five-year sequential HELs and agency CMOs. Early in the period examined, HELs tracked agency CMOs and offered a higher yield of about 50 to 60 basis points. When interest rates continued to fall during 2001 and prepayment rates rose, the yield differential between HELs and agency CMOs narrowed to a range of 20 to 40 basis points.

During 2002 when interest rates were falling sharply and prepayment rates were accelerating, the yield on HELs moved inside the yield on the agency CMOs. The higher relative yield on the agency CMOs became necessary, in part, to compensate investors for the greater variability of conforming mortgage prepayment rates. The performance of the residential ABS product during this period suggests that many mortgage investors have come to recognize the superior convexity characteristics of subprime mortgage pools. Interest rates began to rise again during the second half of 2003 and returned to levels last seen during the fall of 2002. The yield concession of HELs widened out to the 20 to 30 basis point range over CMOs. A certain amount of concession for the ABS seems reasonable given the superior liquidity of the agency mortgage market. Nevertheless, mortgage investors can add diversification to their portfolios and improve their convexity profile by including the residential ABS product.

KEY ASPECTS OF CREDIT ANALYSIS

For investors in the agency mortgage market, credit analysis is largely unnecessary because of the agency guarantee on the underlying collateral. Agency mortgages and CMOs derive their credit support from that agency guaranty. Credit analysis is necessary in residential ABS, just as it is in other ABS sectors, because residential ABS derive their credit support from internal sources (overcollateralization, subordination, cash, or excess spread) or external sources (monoline bond insurance).

In order to determine credit enhancement, stress scenarios on mortgage defaults and recoveries are run by the credit rating agencies based on the historical experience of the mortgage market over the past 70 to 75 years. Several episodes of real estate market stress have been incorporated into the default and loss severity outlook of the rating agencies. These episodes include the Great Depression of the 1930s, the oil bust years of the middle and late 1980s in Texas, Louisiana, Oklahoma, and Alaska, and the recession of the early 1990s and its impact on real estate markets in New England and California.

Loss coverage requirements calculated by the rating agencies for subprime mortgage pools begin with a prime-borrower first-lien loan pool as a benchmark. They increase the stress factors and credit enhancement as necessary depending on the risk profile of each loan in the pool. The following list highlights the major risk factors reviewed by the rating agencies during the rating process.

- *Borrower credit quality.* Credit quality is measured based on the lender's underwriting criteria or FICO/credit score of the borrowers in the pool. Over the past few years, mortgage lenders have increasingly used FICO or credit scores in their underwriting of new loans as a supplement to their traditional underwriting guidelines. Weighted-average FICO scores for subprime pools tend to be around 600, although it is not unusual to find weighted-average scores for the pools that can be higher.

- *LTV ratio*. The loan-to-value (LTV) ratio is a key indicator of default risk and loss severity. Loans with higher LTVs have greater default risk because the borrower has less equity in the property. This factor can affect the willingness of the borrower to pay. However, as a loan seasons, equity tends to grow because the loan amortizes and the underlying property tends to appreciate. As equity builds, the borrower's willingness to pay increases because there is more to lose in the event of a default. It should be noted, though, that the beneficial effect of seasoning is measured in years, not in months, because there is little in the way of principal that amortizes in the early years of a mortgage loan. Weighted-average LTVs on subprime mortgage pools are typically around 80%. It is not unusual, however, for LTVs to be skewed toward the higher end. In many cases, typical LTVs on subprime mortgage pools have a significant proportion in a range between 80% and 100%.
- *Dwelling type*. Single-family detached homes are the predominant type of property in most residential ABS pools. They present the lowest risk of default and offer the best recovery values. They are the largest part of the residential real estate market and are the preferred property type for most homebuyers. As a result, their market value tends to be more stable than that of other dwelling types. High-rise condominiums, co-ops, and multifamily homes tend to be riskier properties because they have narrower appeal to buyers and have the potential for greater price volatility. Property maintenance becomes an important issue in multifamily dwellings, but such properties tend to be a relatively small portion of most residential ABS transactions. Residential ABS pools sometimes include small portions of manufactured housing (MH), perhaps 1% or less of the original pool balance. In any case, the rating agencies apply a higher loss severity to MH loans to incorporate the weaknesses that currently exist in that market segment. The exposure to MH in subprime pools will be explicitly accounted for in the sizing of credit enhancement by the rating agencies.
- *Occupancy status*. Subprime mortgage pools are composed primarily of owner-occupied homes, usually exceeding 90% of the original balance. Second homes, vacation homes, and investment properties make up the remainder. Owner-occupied homes tend to carry lower default risk because a homeowner is less likely to forfeit her primary residence than a second home or investment property. Rental income from the investment property, which may be needed by the borrower to make the mortgage payments, can be volatile, making investment property a more risky asset type.

- *Lien status.* Subprime mortgage pools are composed primarily of first-lien mortgages. To the extent that second-lien loans are included in the collateral pool, a combined LTV (CLTV) of the first and second mortgages would be used to determine the amount of equity each borrower has in the home. It is this CLTV that will determine the risk of default applied to that loan.
- *Geographic concentrations.* Real estate markets can vary greatly in different parts of the country. Indeed, house price trends on the coasts have experienced much more volatility over past housing cycles than markets in the Midwest. In addition, the cost of an average house tends to be higher. As a result, the rating agencies take account of geographic concentrations in subprime mortgage pools. For example, it is not unusual to have geographic concentrations that may be relatively high in California or various northeastern states compared with other types of ABS. Unusually high geographic concentrations often will require extra credit enhancement to mitigate any additional risks.
- *Loan purpose.* Newly originated mortgage loans are used to purchase a home or to refinance an existing mortgage. Purchase loans may be viewed as a less risky loan because a market-determined purchase price and a more recent appraisal of the property customarily support them. Refinancings come in two types: a rate/term refinance or a cash-out refinance. A rate/term refinance replaces the current mortgage with a new mortgage that has a lower interest rate or a shorter maturity. The purpose of this loan is to reduce the monthly payment or to decrease the term of the loan. Cash-out refinancing replaces the current mortgage with a new mortgage loan in which the borrower is monetizing a portion of the equity built up in the property. In general terms, cash-out refinancing is more risky than a purchase mortgage or rate/term refinancing because there is no sale by which to independently measure of the market value of the home. In recent years, cash-out refinancings have been the predominant loan purpose in residential mortgage ABS pools.
- *Mortgage seasoning.* As noted earlier under the section on LTVs, seasoning of the collateral is beneficial, and more seasoning on the mortgage pool is preferred to less. The amount of seasoning in a subprime mortgage pool can be a significant mitigating factor for other risks present in the collateral pool. For example, significant amounts of seasoning may reduce current LTV ratios compared with their original values, which reduces the risk of default in the pool. In addition, a more seasoned pool already may have experienced some early defaults, leaving a better-quality pool in terms of the underlying borrower credit profile.
- *Loan size.* Loan size can be another important credit quality factor. Jumbo loans, which are greater than the $359,650 loan balance (for the calendar year 2005) currently established by the agencies as a conforming

single-family loan may be riskier because the underlying properties can suffer greater market value volatility owing to a more limited universe of buyers.

- *Loan documentation.* Full documentation of borrower income, debt levels, and property valuation is required for prime conforming mortgage pools sold to the agencies. Subprime mortgage pools are composed primarily of fully documented loans. Reduced- or limited-documentation programs may be offered by mortgage lenders to condense the amount of paperwork required of the borrower. For example, these programs may require more limited documentation of borrower income used to calculate debt-to-income ratios. The risk is that less qualified borrowers will be granted too much credit under limited documentation programs. However, lenders may adjust their decision criteria for limited- or low-documentation loans with respect to the required LTV. This means that borrowers using limited-documentation programs might be required to have a lower LTV or more equity in their home than a borrower underwritten to full-documentation standards. The rating agencies also make adjustments to their default frequencies (and credit enhancement) to compensate for lower documentation thresholds.
- *Loan type.* Subprime mortgage pools may include a number of different loan types. Fixed-rate loans, for example, may have terms of 15, 20, or 30 years. Furthermore, fixed-rate mortgages may be offered with a balloon feature, where the mortgage has fixed payments of principal and interest based on a 30-year amortization schedule. After an amortization period (5, 7, 10, or 15 years, for example), the unpaid principal balance becomes due in a lump-sum payment. At this point, borrowers will repay the loan or need to refinance the remaining principal balance. The risk is that the borrower will not be able to refinance at an affordable rate or that property values will not be adequate to support the desired loan balance. The rating agencies tend to require higher levels of credit enhancement for pools with higher levels of balloon loans.

  Adjustable-rate mortgages (ARMs) come in a number of different varieties. Typically, ARMs have a low initial (or “teaser”) rate that adjusts periodically, for example, every six months. Any rate adjustment is usually subject to periodic and lifetime caps. Periodic and lifetime caps may be 2% and 6%, respectively. Borrowers like ARMs because the low initial interest rate may allow them to qualify for a larger mortgage than they would under a 30-year fixed-rate loan. However, the interest-rate reset introduces the risk of higher future payments for the borrower. As a result, the rating agencies usually will require more credit enhancement to mitigate the interest-rate risk inherent in adjustable-rate loans. Another product offered by many lenders is a hybrid ARM. Hybrid ARMs offer a fixed-rate period before the loan becomes fully adjustable. Fixed periods typically are for 2, 3, 5, 7, or

10 years. These loans also carry periodic and lifetime caps to any interest-rate adjustments. The most common hybrid ARM terms found in residential ABS pools are 2/28 and 3/27 ARM collateral.

STRUCTURAL CONSIDERATIONS

The collateral pools backing residential ABS transactions may include all fixed-rate mortgages, all ARMs or hybrid ARMs, separate pools of fixed and ARM collateral backing separate groups of fixed- and floating-rate securities, or a combination of fixed and ARM collateral backing the ABS bonds.

Like most new asset types in the ABS market, early residential ABS transactions started out carrying bond insurance as credit enhancement. In 1997, the first senior/subordinate structures were introduced to the residential ABS market. Over time, more issuers moved to senior/subordinate structures as the market for AAA bonds became more liquid, more data on collateral performance for issuers became available, and a market developed for the subordinate bonds.

Residential ABS transactions that use a senior/subordinate structure typically are tranched down to the BBB rating level. In many cases, transactions have been structured to include classes that carry ratings with pluses or minuses on them (e.g., BBB+ or BBB–). The issuer's decision as to which type of credit enhancement to use will be based on the relative costs of executing each structure. From time to time, market dislocations will cause issuers to make greater use of bond insurance structures because of a lack of liquidity or demand in the subordinate bond sector. When demand for subordinate bonds is strong, more senior/subordinate transactions will be issued relative to wrapped deals.

Over the past few years, Fannie Mae and Freddie Mac have become more active in the ABS market by wrapping pools of loans with conforming balances, which may be purchased by the agencies or sold to ABS investors. These securities may be structured as part of a larger transaction. ABS investors also may be sold securities backed by a pool of nonconforming loans that are not wrapped by the agency and are structured with their own credit enhancement.

Bond Insurance Structures

Bond insurance structures use internal credit enhancement in the form of overcollateralization and excess spread to support the bonds being issued at an investment grade rating level (BBB– equivalent or better). The bond insurer then guarantees timely payment of interest and ultimate payment of principal at maturity to achieve a credit rating of AAA.

In residential ABS transactions using bond insurance, principal usually is allocated sequentially to the AAA-rated senior classes. This form of credit enhancement may be most economical when an issuer is new to the ABS market or the market has limited information on past credit performance. Alternatively, the market from time to time may demonstrate weaker demand for subordinate ABS.

This condition will manifest through relatively wide spread differentials because the relative value outlook of investors may have shifted, or some sort of market dislocation may have occurred. In those situations, a wrapped transaction may provide the most reliable execution.

Senior/Subordinate Structures

The ratings on the residential ABS in senior/subordinate structures rely on a combination of the subordination of lower-rated classes, overcollateralization, and excess spread. In addition, most transactions incorporate credit performance triggers based on the level of delinquencies or net losses that can redirect cash flow to support the senior bonds if credit performance of the collateral is weaker than expected.

Like most other ABS transactions, the first line of defense to protect investors from credit losses is excess spread. In the case of residential ABS, there is usually a substantial amount of excess spread available because the weighted-average coupon (WAC) on the mortgage loans is well in excess of the WAC of the bonds issued. In many transactions, excess spread may be used to accelerate the amortization of the AAA bonds in order to build up overcollateralization to a required target amount. The target amount is usually reached within the first several months of the transaction's life. If overcollateralization is funded at the outset by the issuer, then excess spread can be used to maintain that target amount. The target overcollateralization amount generally is established as a percentage of the initial principal balance of the collateral pool.

Subordination and Shifting Interest

Like other nonagency mortgage securities, residential ABS transactions use a "shifting interest" structure that increases the level of credit enhancement available to the senior bondholders. During the early stages of a transaction, all principal collections (and, as noted earlier, some excess interest collections) are paid to the senior bonds, and the subordinate bonds are locked out from receiving principal during this period.

For example, consider a simple two-class transaction in which the AAA-rated class A is 88% of the bonds issued and the BBB-rated class B is 12% of the bonds issued. In a shifting interest structure, all principal collections would be paid to the class A bonds at the outset, and the class B bonds would be locked out. Over time, the class A bonds amortize, and their percentage interest in the underlying collateral pool would decrease. At the same time, the percentage interest in the collateral pool of the class B bonds would increase.

In the most common cases, the subordinate bonds are locked out from receiving principal collections for the first 36 months of the transaction or until the credit enhancement level for the senior notes has doubled, whichever is later. A doubling of the initial credit enhancement level is equivalent to saying that the principal balance of the collateral pool has been reduced by 50% (a pool factor of 0.50). In our example earlier, when the percentage interest for class B reaches 24% (alternatively, credit enhancement for class A has doubled) and the transaction is at least 36 months old, then the class B bonds start to receive principal payments.

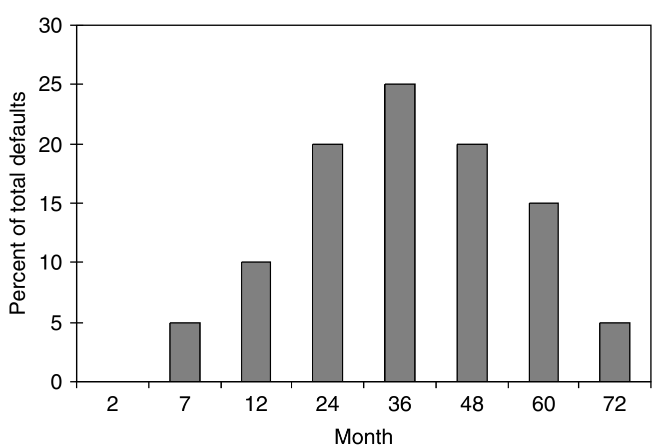
This point in the life of a residential ABS transaction is called the *stepdown date,* which refers to the reduction, or step down, of the dollar amount of subordination as credit enhancement from its then-current levels. For transactions with multiple classes carrying different ratings, the mezzanine and subordinate classes would receive their pro-rata share of principal collections and begin to amortize.

Why a 36-Month Lockout?

Based on observed default experience, a pool of subprime mortgage loans will experience about 60% of its total expected cumulative defaults by the thirty-sixth month of the transaction, with the majority of expected defaults occurring in years 2, 3, and 4 (Exhibit 26–9). Less than 20% of the total amount of expected defaults occurs within the first 12 months of a transaction. Therefore, the early lockout for the subordinate bonds increases the amount of credit enhancement during the period when the transaction needs it most. If the collateral pool performs as expected, then the subordinate bonds would receive principal payments as scheduled. If credit performance is below expectations, then sufficient credit enhancement should be available to withstand the additional stress.

EXHIBIT 26–9

Expected Defaults on Residential ABS Pools



Source: Standard & Poor's.

Delinquency and Net-Loss Triggers

A reduction in the dollar amount of credit enhancement may occur on the stepdown date as long as the collateral pool is performing as expected. Two tests, a delinquency test and a cumulative net-loss test, have been designed to measure collateral performance and are employed commonly in residential ABS deals. One or both of these tests may be used in a particular transaction. However, all the relevant trigger events must be passed for the stepdown of credit enhancement to occur.

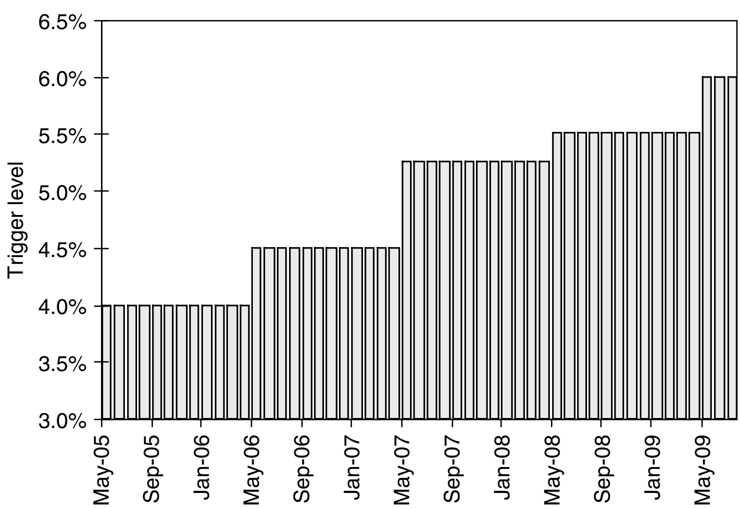
Actual trigger levels vary from one issuer to another depending on the actual credit performance of its mortgage loans. An issuer's trigger levels may vary over time and across different transactions as well. Delinquency tests typically are based on the three-month average of 60+ day delinquencies (including bankruptcy, foreclosure, and REO) being less than some threshold percentage of the outstanding credit enhancement.

For example, the delinquency trigger event in Option One 2002 was set at 60+ day delinquencies exceeding 80% of the current credit enhancement percentage. For example, if current credit enhancement stands at 22%, then 60+ day delinquencies would have to be less than 17% after the stepdown date for the subordinate bonds to receive principal payments.

The cumulative net-loss trigger is based on a percentage that steps up over time. As long as cumulative net losses are below the current threshold level, principal would be paid to the subordinate bonds after the stepdown date. For example, Exhibit 26–10 shows the cumulative net-loss threshold levels for

EXHIBIT 26–10

Cumulative Net-Loss Trigger, Option One 2002



Note: Stepdown date is May 2005.
Source: Transaction Prospectus.

Option One 2002. The dates for measuring this trigger begin with the stepdown date, and the threshold for cumulative net losses increases in various increments over the next four years from 4% to 6%.

The trigger tests are reviewed each month after the stepdown date. If the triggers are passed in that month, then principal may be passed through to the subordinate classes in a transaction. If the triggers are breached, then principal cash flow is diverted from the subordinate classes and paid to the senior bonds. If a transaction is past its stepdown date, depending on whether or not the triggers are breached, the subordinate bonds may switch back and forth between receiving principal and being locked out. Because the breach of a trigger will lock out a subordinate bond and extend its average life, subordinate bonds in the secondary market often will be traded "to fail"—that is, to the average life implied by the transaction failing its triggers continuously after the stepdown date.

Deep Mortgage Insurance

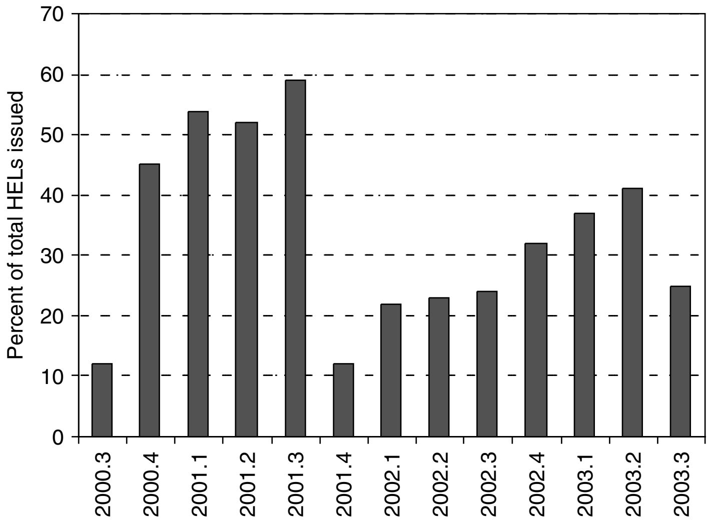
Since its introduction to the subprime market in late 2000, mortgage insurance purchased by the issuer at the time of securitization of the loans has become a regular feature in the residential ABS market. This type of mortgage insurance is also referred to as "deep" mortgage insurance, or "deep MI." The issuer pays an annual premium, which comes out of the cash flows of the securitization, for a policy that will cover losses on a portion of the mortgage loans in the pool. The proportion of loans covered by deep MI as credit enhancement is generally about 60% to 65% of the original pool. On average, since the second half of 2000, deep MI has been used in about 34% of all residential ABS deals, according to data compiled by Standard & Poor's (Exhibit 26–11). Usage has settled into a range of 20% to 40% of all deals after an initial burst of interest when deep MI was introduced.

This loan-level mortgage insurance differs from a monoline wrap in important ways. A wrap from one of the bond insurance companies is an unconditional guarantee of timely interest payments and ultimate repayment of principal on the bonds. The investor's credit exposure is directly to the bond guarantor. In a structure using deep MI, the loans must meet the insurer's criteria. The insurance company's policy specifies the characteristics of the loans to be covered, such as a maximum LTV, minimum borrower credit profile, or various property types. When a default occurs, the issuer files a claim against the insurance. The insurance company reviews the claim. All, or only a portion, of the claim may be covered by the insurance, or it may be rejected altogether if the insurer's underwriting guidelines have been violated by the lender. Anecdotal evidence to date from the rating agencies suggests that rejection rates of claims have been relatively low.

The three most active mortgage insurance companies in the subprime market are PMI Mortgage Insurance Co., Radian Guaranty, Inc., and Mortgage Guaranty Insurance Corporation (MGIC). Nevertheless, certain investors may pass

EXHIBIT 26–11

Residential ABS Using Deep MI



Source: Standard & Poor's "Trends in Residential Mortgage Products."

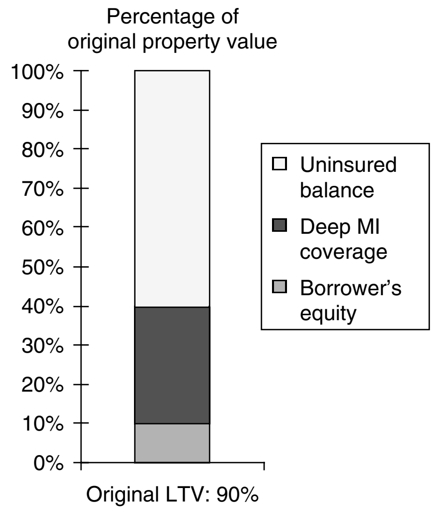
on transactions using deep MI because it introduces some additional corporate credit risk to the ABS that does not exist in a straight senior/subordinate structure.

Mortgage insurance covers a portion of the principal balance of a loan to a prespecified LTV level, for example, down to a 60% to 65% LTV. It also covers accrued interest and expenses incurred during the foreclosure and liquidation process. Deep MI makes a loan look like it has a lower LTV because the insurance takes a second-loss position in the loan after the borrowers equity. The presence of the insurance has the effect of reducing realized losses on the loans covered and in turn supports the bondholders in the deal. The rating agencies have come to accept deep MI as a significant source of credit support that reduces the amount of upfront enhancement necessary to support the desired ratings on the bonds compared to a straight senior/subordinate structure.

Exhibit 26–12 offers a simple example of a loan at origination covered by deep MI. The original LTV of the loan on this property is 90%. In this example, the deep MI is written down to an LTV of 60%. The mortgage insurance covers one-third of the outstanding loan balance and has a second-loss position in the loan. From the outside, this loan now looks like it has an LTV of 60%. In practice, loans with different LTVs and levels of coverage will have different mortgage insurance coverage ratios. Over time, this loan will amortize, and the amount of equity in the property will increase, assuming no change in market value. The mortgage insurance policy is designed to still cover one-third of the outstanding loan balance as the loan amortizes.

EXHIBIT 26–12

Example Loan Covered by Deep MI



Available Funds Cap

One of the key structural features found in floating-rate residential ABS transactions is an available funds cap (AFC). Conceptually, the AFC says that investors will be paid interest on their bonds up to the amount of interest that can be generated by the mortgage pool after transaction fees and expenses. The deal can only pay out what it collects.

Floating-rate residential ABS usually are indexed to one-month LIBOR and reset monthly. ARMs included in these transactions may use several different indexes, such as six-month LIBOR or the one-year constant-maturity Treasury. The loans may be offered to borrowers at a below-market teaser rate for an initial period. The loans reset less often than the bonds, so a timing mismatch is present. Furthermore, hybrid ARM loans, such as 2/28 or 3/27 loans that have a two- or three-year fixed-rate period before adjusting, may be included in the pool. The presence of these types of loans creates additional interest-rate mismatch. ARMs also have periodic and lifetime caps that constrain the amount of adjustment of the mortgage rate each period or over the life of the loan. Such constraints are accounted for in the AFC.

To calculate the initial level of the AFC, transaction expenses (servicing fee, trustee fee, I/O strip, surety fee, etc.) are subtracted from the original weighted-average coupon on the underlying mortgage loans. After the coupon on the bonds is accounted for, the available excess spread generated by the mortgage pool can be calculated (Exhibit 26–13).

EXHIBIT 26–13

Calculating an Available Funds Cap and Life Cap Percentage

Initial Available Funds Cap		Life Cap	
WA gross coupon	9.00%	WA life cap	15.00%
Less servicing fee	0.50%	Less servicing fee	0.50%
Less trustee fee	0.01%	Less trustee fee	0.01%
Less I/O strip	0.38%	Less I/O strip	0.38%
Less mortgage insurance	0.25%	Less mortgage insurance	0.25%
Net available funds cap	7.86%	Net available funds cap	13.86%
WA bond coupon	2.26%	WA bond spread	0.43%
Initial excess spread available	5.60%	Maximum 1 m rate to cap	13.43%
		Current 1m LIBOR	1.84%
		Maximum LIBOR increase	11.59%

Over time, adjustable-rate loans reach their reset dates, and the AFC cap will increase from its initial level as the mortgage loans reset and the available WAC on the collateral increases. The maximum rate of the AFC also can be estimated (Exhibit 26–13). Using the weighted-average spread on the bonds, the maximum increase in LIBOR before hitting the life cap can be estimated on the fully adjusted collateral pool.

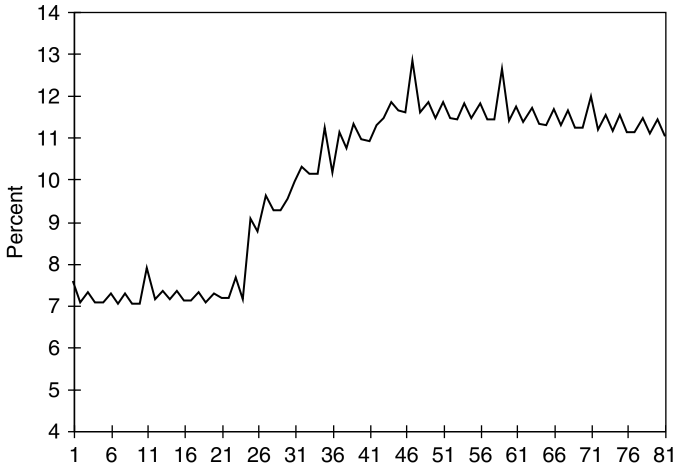
This adjustment process can be seen in the example AFC estimated for the Option One Series 2002-3 in Exhibit 26–14. The level of the cap is estimated assuming that LIBOR rates increase beyond the maximum rate obtainable on the mortgage loans and that the collateral prepays at the pricing prepayment speed. The impact of the resets on 2/28 and 3/27 hybrid ARMs becomes clear in this representation. The cap increases sharply between 24 and 48 months as the hybrid ARM loans reset.

The AFC is likely to be a more significant component of the analysis for subordinate bonds than for senior bonds. Subordinate bonds tend to have longer average lives, which means that there is more time for the cap to become binding. The potential for failing triggers means the subordinate bonds could extend their average lives. Furthermore, the wider spread margin on subordinate bonds makes them more sensitive to changes in interest rates and the AFC. It is important to remember that the AFC calculations typically found in a term sheet or prospectus usually are based on an assumption of zero losses and delinquencies. Stress scenarios may be run at the pricing speed with one-month LIBOR rates rising to 20%. Investors may want to see additional stress cases under more realistic scenarios, especially if they are considering buying subordinate bonds.

The introduction of credit risk complicates the analysis of what to expect from the AFC. Losses reduce available excess spread in the period when they are realized, which reduces the AFC. Losses and delinquencies also

EXHIBIT 26–14

Available Funds Cap Calculation, Option One Series 2002–2003



Source: Transaction Term Sheet.

may trigger the failure of stepdown tests, which can change the cash-flow waterfall. For example, passing a stepdown test after the stepdown date releases overcollateralization that has been built up over the first three years of a transaction. This overcollateralization release is available, if needed, to meet interest payments on the bonds and raises the level of the AFC. A failure of the stepdown tests traps overcollateralization in the deal to increase credit enhancement and reduces the expected level of the AFC. A failure of the stepdown triggers directs more principal to the senior bonds, shortens their average lives, and reduces their cap costs. Conversely, the average lives of the subordinate bonds extend, and their cap costs increase.

During the most recent refinancing wave of 2002 and 2003, mortgage rates reached very low levels, especially for subprime mortgages. WACs on subprime pools reached all-time lows. Many transactions brought to market during this period included cap contracts to help mitigate the effect of low-WAC mortgages in an environment where rates are expected to rise again in the near future. The notional amount of the cap typically amortizes over time based on some schedule, in many cases based on the pricing speed assumptions of the transaction.

The collateral composition is an important determinant of the risks in an AFC. For example, the proportion of fixed-rate collateral-backing floating-rate bonds will have an important impact on the AFC. More fixed-rate loans relative to ARM loans will raise the AFC in the early periods of the deal prior to the reset date for the ARM loans. However, the presence of fixed-rate loans will reduce the AFC in later periods after the reset date of the ARM loans. There are two main reasons for this relationship. First, fixed-rate loans tend to have higher upfront rates compared with ARMs, and that difference is reduced once the ARMs enter their adjustment period. The record low short-term interest rates of 2002 and 2003 compound the impact on the AFC. Second, ARM loans tend to prepay faster than fixed-rate loans. In a rising interest-rate environment, fixed-rate prepayments are likely to slow down more than ARMs. This would leave relatively more fixed-rate loans and fewer adjustable rate loans, and it would cause the AFC to become more restrictive and in the extreme approach the net WAC on the fixed-rate loans.

Available Funds Cap Carryforward

A carryforward mechanism may be established in a floating-rate residential ABS transaction to mitigate the cap risk under the AFC. The difference between the coupon payable on the bonds and the AFC is carried forward to future periods. The carryforward amount is capitalized and accrues interest at the coupon on the bonds. These amounts will be repaid to investors with future excess spread when available. However, if excess cash is not available during the life of the transaction, then investors are still at risk to lose these payments at the cleanup call or at maturity. The placement of these carryforward payments in the cash-flow waterfall also should be taken account of. These provisions may be at the bottom of the waterfall, where there would be greater risk of not receiving them. Some transactions do not provide for a carryforward at all, so investors should read the offering documents closely to verify the presence and effectiveness of any carryforward mechanism.

Step-Up Coupon

Residential ABS transactions also may include a step-up in coupon on bonds with longer average lives. On fixed-rate securities, the coupon may step up by 50 basis points. In floating-rate transactions, the margin over the index may be increased by some multiple, for example 1.5 or 2× the original margin. Such an increase in coupon comes directly out of the excess spread that would normally flow back to the seller. The step-up coupon provides a powerful incentive for the seller/servicer to exercise its cleanup call option on the mortgage collateral. This structural enhancement helps to mitigate the risk of extension at the tail end of a residential ABS transaction.

CONCLUSION

Residential ABS offer significant benefits from greater diversification for a mortgage portfolio, including superior convexity attributes compared with conforming agency mortgage pools. These traits translate into good relative value for the investor. In addition, changes to risk-based capital regulations for depository institutions have removed the capital advantage held by agency mortgage product. Over time, the residential ABS sector has grown to be one of the largest and most liquid segments of the MBS market because transparency has improved and the number of investors active in the segment has increased. Our expectation is that this sector will continue to evolve, making this one of the most dynamic parts of the market.

CHAPTER
TWENTY-SEVEN

COMMERCIAL MORTGAGE-BACKED SECURITIES

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Commercial mortgage-backed securities (CMBS) represent an interesting departure from residential MBS. With residential MBS, the underlying collateral is loans on residential properties (one to four units). With CMBS, the underlying collateral is loans on retail properties, office properties, industrial properties, multifamily housing, and hotels. Unlike residential mortgage loans, commercial loans tend to be "locked out" from prepayment for 10 years. Counterbalancing the reduction of prepayment risk for CMBS is the increase in default risk.

Both CMBS and real estate investment trusts (REITs) have grown tremendously over the past six years as investors' tastes for new real estate–related products have increased. Investment banks were able to apply what they have learned from residential MBS (with some interesting twists) to the commercial real estate loan market. Not only is the U.S. market continuing to expand, but also CMBS are growing at an ever-increasing rate in Europe (albeit at a much smaller scale). This chapter focuses on the interesting twists that make CMBS such a fascinating product.

THE CMBS DEAL

A CMBS is formed when an issuer deposits commercial loans into a trust. The issuer then creates securities in the form of classes of bonds backed by the commercial loans. As payments on the commercial loans (and any lump-sum repayment of principal) are received, they are distributed (passed through) to the bondholders according to the rules governing the distribution of proceeds.

Bond Pass-Through Rates

An example of a recent CMBS deal can be used to highlight the distribution of cash flows to the bondholders and the rules governing the distribution. The

EXHIBIT 27–1

Bonds for GMAC 1999-C3 Deal

Bond	Moody Rating	Fitch Rating	Original Amount	Subor-dination Original	Coupon	Coupon Type
A-1-a	Aaa	AAA	$50,000,000	0.2700	0.0697	Fixed
A-1-b	Aaa	AAA	$190,976,000	0.2700	0.0727	Fixed
A-2	Aaa	AAA	$600,000,000	0.2700	0.0718	Fixed
B	Aa2	AA	$51,840,000	0.2250	0.0754	Fixed
C	A2	A	$57,601,000	0.1750	0.0779	Fixed
D	A3	A–	$20,160,000	0.1575	0.0779	WAC-0b
E	Baa2	BBB	$37,440,000	0.1250	0.0779	WAC-0b
F	Baa3	BBB–	$23,040,000	0.1050	0.0779	WAC-0b
G	NA	NA	$57,601,000	0.0550	0.0697	Fixed
H	NA	NA	$8,640,000	0.0475	0.0697	Fixed
J	NA	NA	$11,520,000	0.0375	0.0697	Fixed
K	NA	NA	$14,400,000	0.0250	0.0697	Fixed
L	NA	NA	$11,520,000	0.0150	0.0697	Fixed
M	NA	NA	$5,760,000	0.0100	0.0697	Fixed
N	NA	NA	$11,524,048	0.0000	0.0697	Fixed
X	NA	NA	$1,152,022,048n	NA	0.0053	WAC/IO
R	NA	NA	$0r	NA	0	

Source: S&P Conquest.

GMAC 1999-C3 deal, underwritten jointly by Deutsche Bank and Goldman Sachs, is summarized in Exhibit 27–1. The balance of the bonds as of the cutoff date (9/10/99) is $1,152,022,048. The gross weighted-average coupon (WACg) is 7.90%, and the net weighted-average coupon (WACn) is 7.79%. The weighted-average maturity (WAM) is 117 months.

The bonds are sequential-pay. The pass-through rate for class A-1-a is 6.97% and fixed. The pass-through rates for classes A-1-b, A-2, B, C, G, H, J, K, L, M, and N are equal to the lesser of the fixed pass-through rate and the WACn of the mortgage pool. For example, the A-1-b bondholders will receive the lesser of the fixed pass-through rate (7.27%) and the WACn (7.79%). Pass-through rates for classes D, E and F are equal to the WAC of the mortgage pool.

Class X is an interest-only class. Class X receives the excess of the WACn received from the pool over the weighted-average pass-through rate paid to the sequential-pay bonds. Class X's notional balance equals the outstanding balance of the sequential-pay bonds.

CMBS Ratings and Subordination Levels

The rating agencies play a critical role in the CMBS market. The role of the rating agency is to provide a third-party opinion on the quality of each bond in the structure (as well as the necessary level of credit enhancement to achieve a desired rating level). The rating agency examines critical characteristics of the underlying pool of loans such as the debt service coverage ratio (DSCR) and the loan-to-value (LTV) ratio. If the target ratios at the asset level are below a certain level, the credit rating of the bond is reduced. Subordination can be used at the structure level to improve the rating of the bond. For example, suppose that a certain class of property requires a DSCR of 1.50× to qualify for an A rating; if the actual DSCR is only 1.25×, additional subordination can be added at the deal level to bring the rating to an A rating.

The credit ratings for the bonds in the GMAC 1999-C3 deals are presented in Exhibit 27–1. Fitch rated the first three bonds (classes A-1-a, A-1-b, and A-2) as AAA. Moody's rates the same bond classes as Aaa. The B through F bonds have progressively lower ratings. The subordination level decline with the bond ratings: 27% subordination for the AAA bond down to 10.5% for the BBB− bond. The subordination levels continue to drop for the C bond (17.5%) through the N bond (0%).

Prioritization of Payments

The highest-rated bonds are paid off first in the CMBS structure. Any return of principal caused by amortization, prepayment, or default is used to repay the highest-rated tranche first and then the lower-rated bonds. Any interest received on outstanding principal is paid to all tranches. However, it is important to note that many deals vary from this simplistic prioritization assumption.

For example, consider the GMAC 1999-C3 deal. The bonds that are rated AAA by Fitch (classes A-1-a, A-1-b, A-2, and X) are the Senior Certificates. Classes B through M are organized in a simple sequential structure. Principal and interest are distributed first to the class B and last to the class N bonds. Unfortunately, the Senior Certificates are not as simple in their prioritization.

The loans underlying the GMAC 1999-C3 are divided into two groups. Group 2 consists of the multifamily loans, and group 1 consists of the remaining loans (retail, office, warehouse, etc.). In terms of making distributions to the Senior Certificates, 61% of group 1's distribution amount is transferred to group 2's distribution amount. Group 1's distribution amount is used to pay

1. Interest on bond classes A-1-a and A-1-b, and the portion of interest on the class X on components A-1-a and A-1-b pro rata
2. Principal to classes A-1-a and A-1-b in that order

Loan group 2's distribution amount is used to pay

1. Interest on class A-2 and the portion of interest on the class X components from A-2 to N pro rata
2. Principal to the class A-2

In the event where the balances of all the subordinated classes (class B through class M) have been reduced to zero because of the allocation of losses, the principal and interest will be distributed on a pro-rata basis to classes A-1-a, A-1-b, and A-2.

Loan default adds an additional twist to the structuring. Any losses that arise from loan defaults will be charged against the principal balance of the lowest-rated CMBS bond tranche that is outstanding (also known as the *first-loss piece*). For the GMAC 1999-C3 deal, losses are allocated in reverse sequential order from class N through class B. After class B is retired, classes A-1-a, A-1-b, and A-2 bear losses on a pro-rata basis. As a consequence, a localized market decline (such as a rapid decline in the Boston real estate market) can lead to the sudden termination of a bond tranche. Hence issuers seek strategies that will minimize the likelihood of a microburst of defaults.

As long as there is no delinquency, the CMBS are well behaved. Unfortunately, delinquency triggers intervention by the servicer (whose role will be discussed later in this chapter). In the event of a delinquency, there may be insufficient cash to make all scheduled payments. In this case, the servicer is supposed to advance both principal and interest. The principal and interest continue to be advanced by the servicer as long as these amounts are recoverable.

Call Protection

In the residential MBS market, the vast majority of mortgages have no prepayment penalties. In the CMBS market, the vast majority of mortgages have some form of prepayment penalty that can affect the longevity and yield of a bond. Call protection can be made at both the loan level and in the CMBS structure. At the loan level, there exist several forms of call protection: prepayment lockout, yield maintenance, defeasance, and prepayment penalties.

Prepayment lockout is where the borrower is contractually prohibited from prepaying the loan during the lockout period. The lockout is the most stringent form of call protection because it removes the option for the borrower to prepay before the end of the lockout period. The prepayment lockout is used commonly in newer CMBS deals.

Under *yield maintenance,* the borrower is required to pay a "make whole" penalty to the lender if the loan is prepaid. The penalty is calculated as the difference between the present value of the loan's remaining cash flows at the time of prepayment and principal prepayment. Yield maintenance was a common form of call protection in older CMBS deals, but it is less common in newer deals.

Defeasance is calculated in the same manner as yield maintenance. However, instead of passing the loan repayment and any penalty through to the investor, the borrower invests that cash in U.S. Treasury securities (strips/bills) to fulfill the remaining cash-flow structure of the loan. The Treasuries replace the building as collateral for the loan. The expected cash flows for that loan remain intact through to the final maturity date. Like yield maintenance, it was more popular with older CMBS deals and is less common in newer deals.

With *prepayment penalties,* the borrower must pay a fixed percentage of the unpaid balance of the loan as a prepayment penalty if the borrower wishes to refinance. The penalty usually declines as the loan ages (e.g., starting with 5% of the outstanding principal in the first year, 4% in the second year, etc. until the penalty evaporates).

Exhibit 27–2 and 27–3 examine the largest 20 loans underlying the GMAC 1999-C3 deal. In terms of call protection, each of the loans is locked out. The

EXHIBIT 27–2

The 20 Largest Loans Underlying the GMAC 1999-C3 Deal

	Name	Location, MSA	Category	Loan Amount
1	Biltmore Fashion	Phoenix, Arizona	Retail	$80,000,000
2	Prime Outlets	Niagara Falls, New York	Retail	$62,835,426
3	Equity Inns	Various	Hotel	$46,511,317
4	One Colorado	Pasadena, California	Retail	$42,628,093
5	Comerica Bank	San Jose, California	Office	$33,640,510
6	120 Monument	Indianapolis, Indiana	Office	$28,955,362
7	125 Maiden	New York, New York	Office	$28,500,000
8	Texas Development	Houston, Texas	Apartment	$26,926,701
9	Sherman Plaza	Van Nuys, California	Office	$25,984,904
10	Alliance TP	Various	Apartment	$24,888,157
11	Bush Tower	New York, New York	Office	$23,000,000
12	County Line	Jackson, Mississippi	Retail	$20,990,264
13	Sherwood Lakes	Schererville, Indiana	Apartment	$20,162,442
14	Laurel Portfolio	Various	Apartment	$17,950,331
15	Sweet Paper	Various	Warehouse	$17,420,000
16	Sheraton Portsmouth	Portsmouth, New Hampshire	Hotel	$15,949,087
17	Trinity Commons	Fort Worth, Texas	Retail	$15,242,981
18	Village Square	Indianapolis, Indiana	Apartment	$14,993,950
19	Golden Books	Fayetteville, North Carolina	Warehouse	$14,493,350
20	Air Touch	Dublin, Ohio	Office	$13,992,523

Source: S&P Conquest.

EXHIBIT 27–3

Loan Characteristics for the 20 Largest Loans Underlying the GMAC 1999-C3 Deal

	Name	Coupon	Maturity	Current Occupancy	DSCR	LTV	Prepay Lockout
1	Biltmore Fashion	7.68%	07/01/09	96.00%	1.43	60.40%	114
2	Prime Outlets	7.60%	05/01/09	96.00%	1.36	72.70%	109
3	Equity Inns	8.37%	07/01/09	NA	1.90	49.50%	114
4	One Colorado	8.29%	07/01/09	91.00%	1.25	72.30%	114
5	Comerica Bank	7.55%	05/01/08	99.00%	1.43	65.20%	32
6	120 Monument	8.09%	06/01/09	100.00%	1.23	74.40%	113
7	125 Maiden	8.12%	09/01/09	97.00%	1.31	73.80%	116
8	Texas Development	7.44%	05/01/09	NA	1.34	72.00%	114
9	Sherman Plaza	7.68%	08/01/09	95.00%	1.24	68.40%	115
10	Alliance TP	7.32%	08/01/09	NA	1.19	86.40%	112
11	Bush Tower	7.99%	08/01/09	97.00%	1.27	46.00%	115
12	County Line	7.91%	08/01/09	98.00%	1.39	84.00%	115
13	Sherwood Lakes	6.99%	02/01/08	94.00%	1.32	76.70%	94
14	Laurel Portfolio	7.37%	05/01/09	NA	1.22	73.60%	112
15	Sweet Paper	8.26%	06/01/09	NA	1.25	71.40%	113
16	Sheraton Portsmouth	8.53%	05/01/09	71.00%	1.28	72.50%	116
17	Trinity Commons	7.93%	08/01/09	97.00%	1.44	68.80%	115
18	Village Square	7.80%	10/01/07	97.00%	1.28	79.30%	93
19	Golden Books	8.50%	08/01/09	100.00%	1.69	67.40%	119
20	Air Touch	7.98%	08/01/09	100.00%	1.20	77.70%	117

Source: S&P Conquest.

average lockout has about 114 months remaining. Hence the loans underling this CMBS deal have just less than 10 years of prepayment protection.

In addition to call protection at the loan level, call protection is available in structural form as well. Since CMBS bond structures are sequential-pay, lower-rated tranches cannot pay down until the higher-rated tranches are retired. This is the exact opposite of default, where principal losses hit the lowest-rated tranches first.

Timing of Principal Repayment

Unlike residential mortgages that are fully amortized over a long time period (say, 30 years), commercial loans underlying CMBS deals are often *balloon loans*. Balloon loans require substantial principal payment on the final maturity date, although the loan is fully amortized over a longer period of time. For example, a loan can be fully amortized over 30 years but require a full repayment of outstanding principal after the tenth year. The purpose of a balloon loan is to keep the periodic loan payment of interest and principal as low as possible.

Balloon loans pose potential problems for investors owing to the large lump-sum payment that must be refinanced. If there is a change in the quality of the underlying asset (e.g., a decline in the real estate market, increased competition leading to a decline in lease rates, etc.), there is a danger that the loan will not be refinanced; this can result in default. In order to prevent this type of loan failure at the balloon date from occurring, there are two types of loan provisions: the internal tail and the external tail.

The *internal tail* requires the borrower to provide evidence that an effort is underway to refinance the loan prior to the balloon date (say, one year prior to the balloon date). The lender would require that the borrower obtain a refinancing commitment before the balloon date (say, six months prior to the balloon date). With an *external tail,* the maturity date of the CMBS deal is set to be longer than that of the underlying loans. This allows the borrower more time to arrange refinancing while avoiding default on the bond obligations. The servicer advances any missing interest and scheduled principal in this buffer period.

THE UNDERLYING LOAN PORTFOLIO

There are two sources of risk relating to the underlying loan portfolio. The first risk is prepayment risk, and the second risk is default/delinquency risk.

Diversification

A factor that is often considered when analyzing the risk of a CMBS deal is the diversification of the underlying loans across space. The reasoning for what is termed *spatial diversification* is that the default risk of the underlying pool of loans is lessened if the loans are made on properties in different regions of the

EXHIBIT 27–4

Aggregate Loan Amounts by State for GMAC 1999-C3 Deal

State	Loan Amount	No. of Loans	% of Pool
California	$257,522,410	33	22.35%
Texas	$162,355,125	26	14.09%
New York	$130,070,471	7	11.29%
Arizona	$99,942,794	5	8.68%
Indiana	$68,623,516	5	5.96%
Ohio	$44,982,528	5	3.90%
Mississippi	$23,067,864	2	2.00%
New Jersey	$22,983,973	5	2.00%
Other	$342,473,371	50	29.73%
TOTAL	$1,152,022,052	138	100.00%

Source: S&P Conquest.

country. Rather than have the entire portfolio of loans being subject to an idiosyncratic risk factor (e.g., the decline in oil prices and the collapse of the Houston real estate market), the portfolio can spread its risks across numerous economies. Thus the collapse of the Houston real estate market (which may lead to higher defaults on commercial loans) will be less of a concern if the commercial property markets in Chicago, Kansas City, New York, and Seattle remain strong.

The strategy of spatial diversification can be seen in Exhibit 27–4. Approximately 22% of the loans underlying the GMAC 1999-C3 are on properties in California, 14% on properties in Texas, and 11% on properties in New York. The remaining loans are spread out among other states, such as New Hampshire, Missouri, Illinois, and Mississippi. Thus the GMAC 1999-C3 deal has achieved a significant degree of spatial diversification. Although a 22% concentration factor for California is still quite large, it is considerably less than a 100% concentration factor (which is often referred to as a "pure play" strategy). Furthermore, California, Texas, and New York represent the states where most of the commercial loans are being originated.

In addition to spatial diversification, CMBS pools can be diversified across property types. Rating agencies tend to give lower levels of credit enhancement to deals that contain diversification across property types because a pool that is diversified across residential, office, industrial, and retail properties likely will avoid the potential of a national glut in one of the sectors (such as the retail market).

The degree of property type diversification can be seen in Exhibit 27–5. Approximately 90% of the loans are on retail, apartment, and office properties, with retail having the largest percentage (30.44%). As a consequence, the GMAC

EXHIBIT 27–5

Aggregate Loan Amounts by Property Type for GMAC 1999-C3 Deal

Property Type	Loan Amount	No. of Loans	% of Pool
Apartment	$259,779,802	39	22.55%
Office	$322,053,844	36	27.96%
Retail	$350,683,062	34	30.44%
Warehouse	$99,126,075	15	8.60%
Hotel	$105,832,139	8	9.19%
Other	$14,547,130	6	1.26%
TOTAL	$1,152,022,052	138	100.00%

Source: S&P Conquest.

1999-C3 deals has reduced the risk of default by not being heavily concentrated in only one of the property groups.

The loan characteristics of the pool underlying the GMAC 1999-C3 pools are presented in Exhibit 27–6. The hotel properties are viewed as being the most risky given that they have the highest coupon (8.50%), the highest DSCR (1.65*x*), and the lowest LTV (58.93%). The apartment properties are viewed as the safest risk with the lowest coupon (7.62%), the lowest DSCR (1.29*x*), and the highest LTV (76.51%). As can be seen in Exhibits 27–5 and 27–6, 90% of the underlying loans are in the three least risky property types: apartment, office, and retail properties.

EXHIBIT 27–6

Characteristics for Loans Underlying the GMAC 1999-C3 Deal by Property Type

Property Type	Coupon	Due	Current Occupancy	DSCR	LTV	Prepay Lockout
Apartment	7.62%	06/29/09	92.92%	1.29	76.51%	113
Office	7.79%	04/03/09	96.17%	1.33	67.84%	107
Retail	7.95%	09/19/09	95.21%	1.36	69.77%	116
Warehouse	8.13%	06/27/09	99.56%	1.42	68.28%	115
Hotel	8.50%	12/31/08	75.18%	1.65	58.93%	109
Other	7.83%	05/13/09	95.11%	1.54	67.00%	113

Source: S&P Conquest.

Cross-Collateralization

Diversification of the underlying collateral is one way of reducing default risk. Another way to reduce default risk is to use cross-collateralization. Cross-collateralization means that the properties that serve as collateral for the individual loans are pledged against each loan. Thus the cash flows on several properties can be used to make loan payments on a property that has insufficient funds to make a loan payment. This "pooling" mechanism reduces the risk of default. To add some additional enforcement penalties to the cross-collateralization mechanism, the lender can use cross-default, whereby the lender can call each loan within the pool when anyone defaults.

Loan Analysis

There are several products available that provide analysis of the underlying collateral for CMBS deals. An example of a package that allows for the analysis of the CMBS deal and the underlying collateral is Conquest, an online service provided by S&P Conquest from Boston. Conquest provides for a detailed examination of each loan in the underlying portfolio. In addition to simply describing the loan data (DSCR, LTV, loan maturity, prepayment lock type, etc.), Conquest provides default-risk (delinquency) analysis as well. Using vendors such as PPR, Conquest forecasts the growth in net operating income and value for each property in the underlying portfolio.

Stress Testing at the Loan Level

Stress testing the collateral in a CMBS deal is important from both the underwriter and investor perspectives. By allowing the forecasts on net operating income and value to be varied over time, underwriters and investors can better understand the default- and extension-risk likelihoods and how these, in turn, affect CMBS cash flows.

For CMBS markets, stress tests must be performed in a manner that is consistent with modern portfolio theory. While diversification across property type and economic region reduces the default risk of the underlying loan pool, the effects of diversification are negated if the stress test ignores the covariance between the properties. For example, there should be some degree of common variance across all properties (reflecting general economic conditions). Furthermore, there should be some degree of common variance across property type and economic regions.

In addition to being able to create a diversification index, the user can construct a default-risk/extension-risk index as well. As the underlying loans are stressed, a distribution of outcomes in terms of default and extension risk can be obtained. This would allow users to compare CMBS deals not only for the diversification of the underlying loan portfolio but also for sensitivity to the stress test. Firms such as S&P and Trepp have excellent analytics that permit the stress testing of loans underlying CMBS deals.

Historical Loan Performance for CMBS Deals

According to a Fitch report entitled "2003 CMBS Conduit Loan Default Study," only 2.73% of loans in CMBS transactions rated by Fitch went into default. At the low end of the default spectrum, multifamily loans had a default rate of 1.92%, and office had a default rate of 1.48%. At the high end of the default spectrum were hotels with a default rate of 11.15% and health care with a default rate of 8.46%. In terms of deal-specific defaults, 6 CMBS deals had over 20 defaults and 19 CMBS deals had over 10 defaults. Despite the relatively high default rates in these particular deals, the aggregate default experience in the remaining CMBS deals has been quite good.

Despite the historical performance of these deals, analysts must be careful about projecting these results for current deals. Prepayment lockouts, which are more popular now than they were several years ago, will be more effective in determining prepayments than simple yield maintenance provisions. Also, longer-term mortgage loans will extend the duration of the underlying loan pool (keeping the performance loan ratio higher for a longer period of time). Finally, improvements in underwriting and the investor's ability to understand the underlying collateral should improve default and foreclosure risk over time.

In terms of the GMAC 1999-C3 deal, there has been only one instance of real estate owned (REO) as of April 2004 (Exhibit 27–7). Five of the loans are with the special servicer, and one loan is late. Only three loans have prepaid, and one loan is defeased (Exhibit 27–8). Compared with other 1999 vintage CMBS deals, the GMAC 1999-C3 deal is performing quite well in terms of default risk. Of the five loans that are in the hands of the special servicer, the loans are 6, 4, 3, 2, and 0 months delinquent. While the first four loans make sense to be in the hands of the special servicer, an interested analyst should inquire as to why a loan that is not delinquent rests with the special servicer.

THE ROLE OF THE SERVICER

The servicer on a CMBS deal plays an important role. The servicer collects monthly loan payments, keeps records relating to payments, maintains escrow accounts, monitors the condition of underlying properties, prepares reports for the trustee, and transfers collected funds to the trustee for payment.

There are three types of servicers: the subservicer, the master servicer, and the special servicer. The *subservicer* is typically the loan originator in a conduit deal that has decided to sell the loan but retain the servicing. The subservicer will then send all payments and property information to the *master servicer*. The master servicer oversees the deal and makes sure that the servicing agreements are maintained. In addition, the master servicer must facilitate the timely payment of interest and principal. When a loan goes into default, the master servicer has the responsibility to provide for servicing advances.

EXHIBIT 27–7

Current Status for the Top 20 Loans Underlying the GMAC 1999-C3 (as of 4/29/04)

	Name	Status
1	Biltmore Fashion	Performing
2	Prime Outlets	Special
3	Equity Inns	Grace
4	One Colorado	Performing
5	Comerica Bank	Grace
6	120 Monument	Performing
7	125 Maiden	Performing
8	Texas Development	Performing
9	Sherman Plaza	Performing
10	Alliance TP	Performing
11	Bush Tower	Performing
12	County Line	Performing
13	Sherwood Lakes	Grace
14	Laurel Portfolio	Performing
15	Sweet Paper	Performing
16	Sheraton Portsmouth	Performing
17	Trinity Commons	Performing
18	Village Square	REO
19	Golden Books	Performing
20	Air Touch	Performing

Source: S&P Conquest.

Unlike the subservicer and the master servicer, the *special servicer* generally enters the picture when a loan becomes more than 60 days past due. Often the special servicer is empowered to extend the loan, restructure the loan, or foreclose on the loan (and sell the property). This critical role is of great importance to the subordinated tranche owners because the timing of the loss can affect the loss severity significantly, which in turn can greatly affect subordinated returns. Thus first-loss investors usually want to either control the appointment of the special servicer or perform the role themselves. This creates a potential moral hazard problem because the special servicer may act in its own self-interest and potentially at the expense of the other tranche holders.

Recently, a special servicer (ORIX) was downgraded by a rating agency (Fitch) because of the excessive use of litigation.[1] Fitch stated that the special servicer in

1. "Fitch Downgrades ORIX Capital Markets Ratings," Reuters, March 9, 2004.

EXHIBIT 27–8

Performance of the GMAC 1999-C3 Deal as of 4/29/04

Name	Status
REO	1
Special	5
Late	1
Grace	20
Performing	107
Prepaid	3
Defeased	1
TOTAL	138

Source: S&P Conquest.

question "... often pursues resolution of perceived errors or loopholes in loan or deal documents by initiating aggressive litigation." Fitch said that after surveying five of the most active CMBS special servicers, each said that it began litigation on 2% to 6% of problem loans, not related to foreclosure or bankruptcy, over three years. ORIX, on the other hand, reported 27% for the same period. Furthermore, Fitch stated, "While the legal pursuit of claims could yield superior returns, the strategy presents a risk of producing very significant losses." Fitch said that the special servicer ORIX's aggressive litigation strategy could result in higher loan losses.[2]

Aggressive litigation by the special servicer can be harmful to certificate holders in a CMBS deal. Clearly, the possibility of producing significant losses will harm the value of the B pieces. Furthermore, since the principal from a foreclosure is treated as a prepayment for the senior tranches, certificate holders possibly will receive less principal than expected and earlier than expected. Interest may be reduced as well (which would adversely affect the value of any interest-only security). Finally, excessive litigation can lead to performing loans being terminated prematurely, which can damage certificate holder value.

LOAN ORIGINATION, THE LEMONS MARKET, AND THE PRICING OF CMBS

There exists a potential problem with asymmetric information between borrowers and lenders in that the borrower can have information that the lender does not have. As a consequence, the lender in the underwriting process requires a substantial

2. In fairness to ORIX, they have posted responses to Fitch's downgrade: http://www.orixcm.com/communic/news/Fitch_ss.asp. The interested reader is encouraged to read both the Fitch downgrade and the replies by ORIX.

amount of loan documentation and verification. This creation of a paper trail is important to the functioning of any securitized market because it provides investors with a certain degree of security in knowing that proper due diligence was exercised in the underwriting of the loans. Unfortunately, the CMBS market does not have perfectly uniform loan underwriting and reporting standards, which increases the likelihood that some information about the borrower may be unknown to the lender (or originator). The unknown information may be passed on to the underwriter of the CMBS deal without the originator being aware of the problem. As a result, investors in CMBS deals purchase their tranches with the understanding that there is a possibility that there is missing information.

As with other lemons markets (where buyers cannot perfectly distinguish between quality of products), there is a discount applied to the pricing of any CMBS deal. Efforts to standardize underwriting and reporting standards should reduce the lemons market discount, but there is a substantial amount of heterogeneity among commercial mortgage loans owing to the importance of local risk factors (and the lack of understanding by market participants) that it will be difficult to completely identify and report the risks related to the property underlying the mortgage loans. Hence the lemons market discount likely will persist in the CMBS market.

Once a CMBS deal has been priced at origination, there is some probability that the special servicer will discover missing information (such as a violation of representations and warranties). It is important to understand that the initial pricing of a CMBS deal will contain not only a discount based on the perceived economic risks facing the loans underlying the deal but also a discount related to the "noisiness" in information flowing from the borrower to the lender (originator) to the underwriter. Furthermore, since the investors in the CMBS certificates understand the mechanism for resolving "reps and warranties" disputes, this too is fully reflected in the prices of the CMBS certificates.

SUMMARY

The purpose of this chapter was to provide a broad overview of the CMBS market from the point of view of a sample CMBS deal. Although CMBS deals tend to be prepayment-insensitive, bonds (or tranches) still will be somewhat sensitive to interest-rate changes because lockouts usually dissolve after 10 years. Default risk is a concern with CMBS, and the underlying collateral needs to be examined on a loan-by-loan basis. Products such as Conquest in conjunction with add-on features such as PPR property market forecasts make this task much more tractable.

CHAPTER

TWENTY-EIGHT

CREDIT CARD ASSET-BACKED SECURITIES

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Credit card asset-backed securities (ABS) have been issued in the public debt market since 1987. Because of its liquidity, transparency, and relatively high-credit-quality issuers, credit card ABS has become something of a safe haven in times of trouble for ABS investors. Indeed, investors making their first foray into ABS generally dip their toes into credit cards before diving into the many other asset types available. The size of the credit card ABS sector corresponds with the growth in the credit card market overall as consumers have come to rely on credit cards as a convenient method of payment for an expanding universe of goods and services, and as a means of accessing credit. This chapter summarizes the key structural features of credit card securitizations and provides an overview of the credit card ABS market.

SECURITIZATION OF CREDIT CARD RECEIVABLES

The earliest credit card securitizations in the late 1980s were executed as a means of diversifying the funding sources for banks active in the credit card market. In the early 1990s, the banking industry faced the imposition of stricter capital standards by regulators. Securitization provided a vehicle to help meet these new standards by reducing balance sheet assets, thereby improving regulatory capital ratios. Securitization also allowed for specialized credit card banks to enter the market and grow rapidly without having to rely heavily on customer deposit accounts as a funding source. These specialty banks, such as MBNA, First USA, and Capital One, were able to access the credit markets directly and achieve funding costs that were more comparable with established bankcard issuers. Much of the increased competition and innovation in the credit card market seen during the 1990s can be traced to these banks, which could not have grown as rapidly as they did without the benefits afforded by securitization.

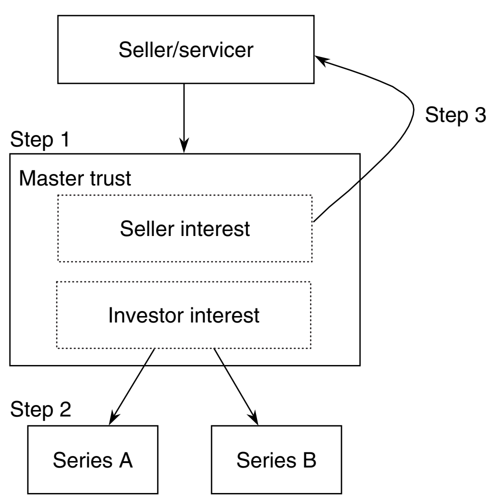
Basic Master Trust Structure

The structure used for credit card securitization until 1991 was a stand-alone trust formed with a dedicated pool of credit card accounts and the receivables generated by those accounts. Each securitization required a new trust and a new pool of collateral. Since 1991, the master trust has become the predominant structure used in the credit card market (Exhibit 28–1). As the name implies, the credit card issuer establishes a single trust that can accept numerous additions of accounts and receivables and issue additional securities. All the securities issued by the master trust are supported by the cash flows from all the receivables contributed to it. The collateral pool is not segregated to support any individual securities.

For the credit card issuer, this structure lowers costs and provides greater flexibility because a new trust need not be established using a unique set of accounts each time additional securities are issued. From the investors' point of view, assessing the credit quality of a new issue requires less effort because there is only one pool of collateral to review. As the collateral pool grows, it becomes more diversified. While the characteristics of the collateral pool can change over time owing to changes in interest rates, underwriting criteria, industry competition, and so on, any change in a master trust would be more gradual than would be the differences in stand-alone pools.

EXHIBIT 28–1

Basic Master Trust Structure



Step 1: Receivables from designated accounts are transferred to the master trust.
Step 2: Pro-rata share of charge-offs and cash flows are allocated to investors.
Step 3: Pro-rata share of charge-offs and cash flows are allocated to the seller.

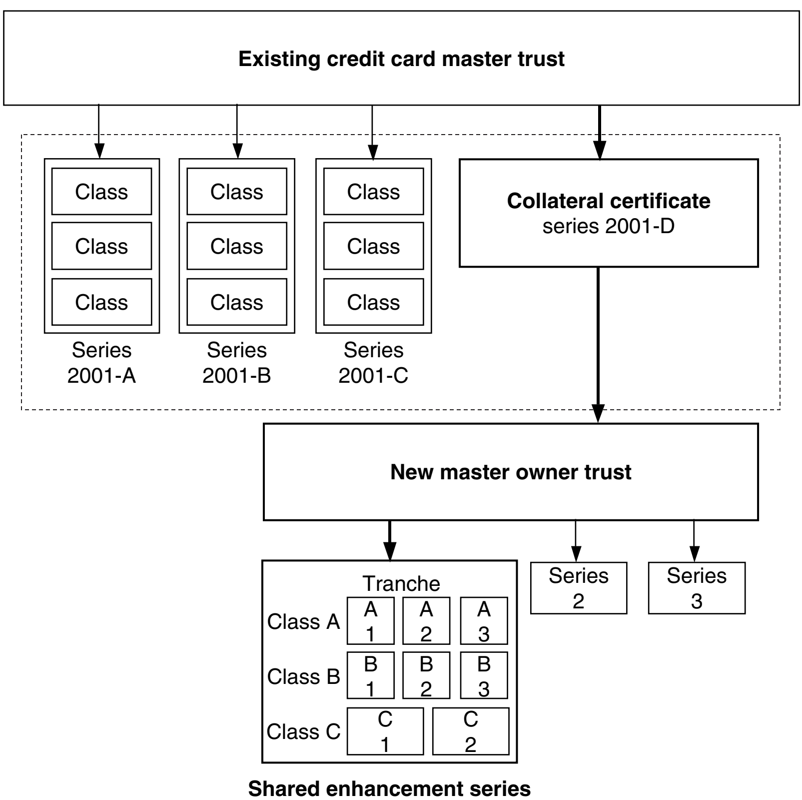
Master Owner Trust Structures

The state of the art in credit card structures has evolved in the last two years to the master note trust or master owner trust (MOT) structure. The most prolific credit card ABS issuers have already adopted or are in the process of readying issuance vehicles that make use of the latest technology. The securities issued by the MOT are still backed by a revolving pool of credit card receivables, and the credit analysis required of the underlying collateral pool is not affected. However, there are important structural differences from previously issued credit card ABS using earlier master trust technology.

Most issuers adopting the MOT structure already have existing credit card master trusts, and some banks service more than one outstanding master trust because of the consolidation that has taken place in the credit card industry. Exhibit 28–2 presents an example of an MOT structured for an issuer currently active in the ABS

EXHIBIT 28–2

Master Owner Trust (MOT) Structure



market. The issuer's existing credit card master trust issues a *collateral certificate,* which is treated like any other series issued by the master trust. The collateral certificate represents an undivided interest in the assets of the master trust and is allocated its proportionate share of principal collections, finance charges, losses, and servicing fees. For credit card banks with more than one existing credit card master trust, it is conceivable that each one could issue a collateral certificate that could be used to back ABS. The cash flows allocated to the collateral certificate are passed through to the MOT. Securities are issued by the MOT to ABS investors.

Credit card ABS issuers may prefer the MOT structure for several different reasons. First, MOT structures can incorporate flexibility similar to that of a corporate medium-term-note program. For example, different classes of a series can be issued at different times, in varying sizes, and with different maturity profiles. Flexibility of this sort allows the issuer to be opportunistic with regard to the market timing of a new issue and to tailor securities to a target investor base. This characteristic of the MOT is sometimes referred to as a "delinked" issuance structure because the AAA securities can be issued separately from the A-rated or BBB-rated securities that provide credit enhancement for the senior notes. Most credit card ABS currently outstanding have been issued as a single series with senior and subordinate classes issued concurrently and having the same maturity. The subordinate classes support only the senior class they were issued with.

In the MOT structure, all the subordinate classes outstanding support all the senior classes outstanding. These are known as *shared enhancement series* (see Exhibit 28–2). Senior securities can only be issued to the extent that there is a sufficient amount of subordinate notes already outstanding. For example, in order to issue class B securities, there must be a sufficient amount of class C notes outstanding to support them. A "sufficient amount" is that amount determined by the rating agencies to provide credit enhancement to maintain the desired ratings on the notes.

In turn, to issue class A securities, there must be the appropriate amount of class B and class C notes outstanding. The subordinate notes are allowed to have a different maturity date than the class A notes. If a class of subordinate notes matures prior to the senior class, then a replacement subordinate note must be issued prior to the existing subordinate note's maturity. To the extent that a replacement note is not issued before paying the maturing note, then principal collections will be deposited into an account that will be used to support the senior notes. Thus the senior notes always will have the required amount of credit enhancement outstanding. Senior notes benefit from subordination up to and including the required amount. They do not have the benefit of subordinate notes issued in excess of the required amount. Even if delinked series are issued, other securities issued by MOTs still can be structured to allow for the issuance of credit card ABS in a single series with "linked" subordinate classes that do not provide shared enhancement (classic credit card ABS). Series 2 and series 3 in Exhibit 28–2 depict such a scenario.

Another reason for the MOT structure is that issuers can expand their potential investor base by structuring securities to be issued as notes rather than as pass-through certificates. By doing this, all classes of a series issued, including the subordinate classes, can achieve ERISA (Employee Retirement Income Security Act) eligibility. This feature is important because pension funds, a significant source of fixed income investor funds, can only buy securities that meet ERISA guidelines. In this way, the total investor base for credit card ABS expands, especially for the subordinate bonds, where liquidity has lagged the senior classes. In addition to expanding the investor base, the flexibility in the MOT structure allows for better and more timely execution of reverse-inquiry issuance.

Investor Interest/Seller Interest

Credit card master trusts allocate cash flow between the ABS investors and the credit card issuer. The *investor interest* is simply the principal amount owed to investors in the ABS. The *seller interest* is a residual ownership interest that the credit card issuer is required to maintain. This seller interest aligns the incentives of the seller with those of the investors because it has a *pari passu* claim on the cash flows. The minimum required seller interest for most master trusts tends to be in the 4% to 7% range of outstanding receivables. The seller interest in a master trust is likely to be higher in practice, in some cases much higher, than the minimum. The actual level of seller interest will be driven by the issuer's strategy with regard to its use of securitization for its funding needs.

The seller interest absorbs seasonal fluctuations in the amount of outstanding receivables and is allocated dilutions from returned merchandise and ineligible receivables. The seller interest does *not* provide credit enhancement for the ABS. Credit enhancement for the ABS, discussed more fully below, is provided by subordinated securities, which are part of the investor interest, or by other means provided for in the structure of the series.

As an issuer's credit card business grows, accounts that meet the eligibility criteria can be added to a master trust. An account addition normally requires rating agency approval unless it is a relatively small percentage of the current balance (usually 10% to 15%). Sellers are obligated to add accounts if the seller interest falls below its required minimum level. If the seller is unable to add accounts to the trust, then an early amortization event is triggered, and investors begin receiving principal payments immediately. The risk of an early amortization gives the seller a powerful incentive to keep the seller interest above the minimum level.

The Credit Card ABS Life Cycle

Under normal circumstances, the life cycle of credit card ABS is divided into two periods: the revolving period and the amortization period. We discuss each period below.

Revolving Period

During the revolving period, investors receive interest payments only. Principal collections on the receivables are used to purchase new receivables or to purchase a portion of the seller interest if there are not enough new receivables generated by the designated accounts. The revolving period is used by an issuer to finance short-term credit card loans over a longer time period. The revolving period is used to maintain a stable average life and to create more certainty for the expected maturity date.

Amortization Period

After the end of the revolving period, the amortization period begins, and principal collections are used to repay ABS investors. The amortization period may be longer or shorter depending on the monthly payment rate of the accounts in the master trust. The payment rate is the percentage of the outstanding receivables balance paid each month. Trusts with lower monthly payment rates will require longer amortization periods. For example, credit card ABS with a five-year expected maturity might revolve for 48 months and then enter amortization for the final 12 months of its life. This part of the credit card ABS life cycle is usually accomplished through one of two mechanisms: controlled amortization or controlled accumulation.

In a *controlled amortization,* principal is paid to the ABS investors in equal payments (Exhibit 28–3). The example assumes one series issued out of the master trust with two classes, a class A senior certificate and a class B subordinated certificate. During the four-year revolving period, investors receive only interest payments. Principal collections are used to purchase new receivables. The total amount

EXHIBIT 28–3

Controlled Amortization

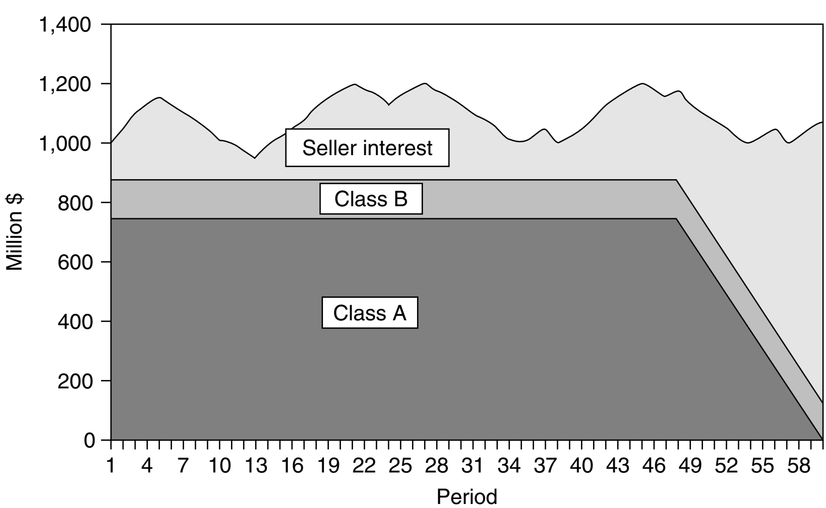
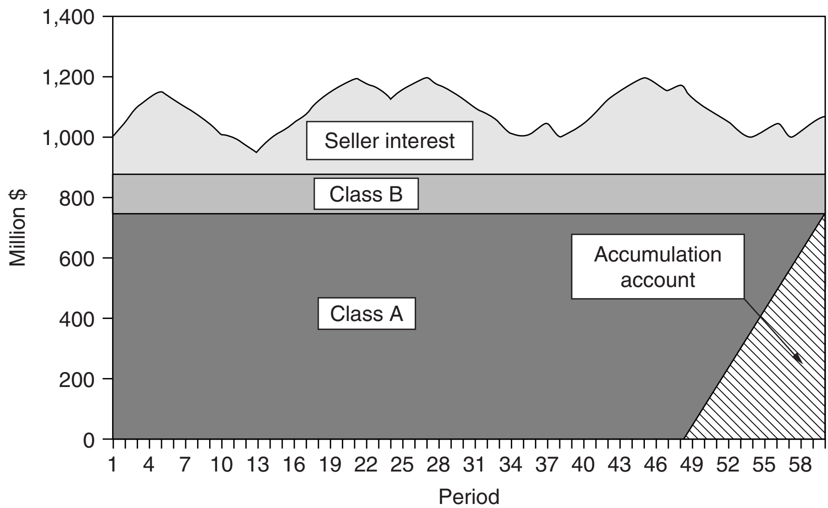


EXHIBIT 28–4

Controlled Accumulation



of receivables varies over time, and these fluctuations are absorbed by the seller interest. At the beginning of year 5, the revolving period ends, and a controlled amortization begins. Investors receive principal payments in 12 equal installments. Principal collections not needed to repay ABS investors are used to purchase new receivables. Interest payments continue based on the declining-principal balance of the ABS. The class B amount remains fixed during class A amortization, and the seller interest grows proportionately until the ABS investors are repaid.

In a *controlled accumulation,* principal collections needed to repay ABS investors are deposited into a trust account each month and held until maturity after the end of the revolving period (Exhibit 28–4). This example again assumes a simple senior/subordinated structure and a four-year revolving period. After the end of the revolving period, principal collections are trapped in an account in 12 equal installments to be used to repay the class A investors. Excess principal collections are used to purchase new receivables. Interest payments to investors during the accumulation period are made based on the original outstanding invested amount. A single "bullet" payment of principal is made at maturity to the ABS investors. This structural device developed as a way to emulate the cash-flow characteristics of a corporate bond.

Early Amortization

Under certain circumstances, such as poor credit performance or a financially troubled servicer, an early amortization of the ABS could occur. Trigger events are put in place to reduce the length of time that investors would be exposed to a troubled transaction. Exhibit 28–5 lists common early amortization trigger events found in

EXHIBIT 28–5

Common Early Amortization Triggers

Seller/servicer issues

1. Failure to make required deposits or payments
2. Failure to transfer receivables to the trust when necessary
3. Breach of representations or warranties
4. Events of default, bankruptcy, or insolvency of the seller or servicer

Collateral performance issues

5. Three-month average excess spread falls below zero
6. Seller interest falls below the minimum level
7. Collateral portfolio balance falls below the invested amount

Legal issues

8. Trust is reclassified as an "investment company" under the Investment Company Act of 1940.

credit card master trusts. If an early amortization trigger is hit, then a transaction that is in its revolving period stops revolving and immediately begins to pass principal collections through to the ABS investors. One structural enhancement available to protect investors allows for principal to be passed through on an uncontrolled or rapid amortization basis. This mechanism diverts principal due to the seller toward payment of the ABS in order to get investors repaid more quickly.

Cash-Flow Allocations

Groups

A credit card master trust may use the concept of a "group," which is a structural device used to help allocate cash flow. Within the hierarchy of the master trust, one or more groups may be established, and each series of securities issued to investors will be assigned to a group. At its highest level, the master trust allocates cash on a pro-rata basis between the investor interest and seller interest. The investor interest is subdivided further on a pro-rata basis at the group level. While many trusts have only one group that encompasses all the series issued, other trusts may have two or more. In trusts with more than one group, series with similar characteristics could be grouped together. For example, a master trust with two groups could place all the fixed-rate coupon series in one group and all the floating-rate coupon series in a second group. The sharing of excess principal or finance charge collections, if called for in the master trust structure, will be determined at the group level.

Finance Charge Allocations

The components of the finance charge collected by a master trust include the monthly interest on the account balance, annual or late fees, recoveries on charged-off receivables, interchange,[1] and discounted receivables.[2] When expressed as a percentage of the trust's receivables balance, finance charges are called the *portfolio yield*.

Finance charge collections are allocated by most master trusts pro rata based on the outstanding invested amount of each series. This "floating" allocation adjusts as a series amortizes or accumulates principal collections in a principal funding account. Excess finance charge collections may or may not be shared by series in the same group depending on the structure of the master trust. Some master trusts, such as Discover Card Master Trust, use a "fixed" allocation of finance charges. In this structure, the proportion to be allocated to a particular series is fixed at the end of the revolving period and is based on the original principal balance of the series. This structure allows for a greater relative proportion of finance charge collections to go to amortizing series. In an early amortization, a portion of the seller's finance charges can be reallocated to investors to cover any potential shortfall when the portfolio is under stress.

Master trusts that allocate finance charges pro rata based on the size of the series invested amount are known as *nonsocialized* master trusts. Finance charges are available to each series to cover its allocated charge-offs and servicing fees and to pay the coupon to the ABS investors each month. Some nonsocialized master trusts do not share excess finance charges. In other nonsocialized trusts, once all the expenses are covered, the series included in the same group may share excess finance charges. If excess finance charges are shared by the series in a group, then they are distributed to the other series based on need. Any excess finance charges left over are considered excess spread.

The advantage of a nonsocialized master trust is that the risk of early amortization can be isolated at the series level. The disadvantage is that high-coupon series are at a relatively greater risk of early amortization if there is a shortfall in finance charge collections. The sharing of excess finance charges helps mitigate, but does not eliminate, this risk. Most master trusts, such as the Sears Credit Card Master Trust II, are structured as nonsocialized trusts that allow for sharing excess finance charges.

An alternative structure used by a small number of credit card ABS issuers is a *socialized* master trust. In such a structure, finance charges are allocated to series within a group based on need. Need is determined by the costs of each series—the coupon, servicing fees, and allocated charge-offs. Charge-offs are allocated to a series pro rata based on its size within the group. The expenses for the group are the weighted average of the expenses for each series. Series with

1. *Interchange* is a fee paid to the bank that issues the credit card. It compensates the bank for taking on credit risk and allowing a grace period. Interchange is created when a bank discounts the amount paid to a merchant for a credit card transaction. Interchange is shared by the merchant's bank, the bank issuing the credit card, and Visa or MasterCard for clearing the transaction.
2. Some master trusts allow receivables to be added at a discount. The discount typically ranges between 1% and 5%. When the face amount of the receivable is collected, the discounted portion is included as a finance charge collection. This practice can temporarily increase the portfolio yield on the collateral pool.

higher coupon costs will receive a larger allocation of finance charge collections. The advantage of socialization is that finance charge collections are combined to help support higher-cost series and thus help to avoid an early amortization. However, the fates of all series are linked. All series in a group will make payments as expected, or they will all enter early amortization together. Citibank Credit Card Master Trust I and Household Affinity Master Trust I are two examples of socialized master trusts. The master owner trust structures also allocate cash flow on a socialized basis.

Principal Collections

Principal collections are allocated on a pro-rata basis to each series in the same group based on the size of its invested amount. The allocation of principal to each series is determined by where it is in the ABS life cycle. Series that are in their revolving period receive no principal collections. Their principal collections can be reallocated and may be shared with other series that are amortizing. Sharing principal collections is a structural enhancement that helps to ensure the timely payment of principal to ABS investors. Principal that is not needed to repay investors is reinvested in new receivables.

For a series in its amortization or accumulation period, principal collections allocated to it will be used to repay investors. The allocation of principal is determined by the size of the invested amount of the series at the end of its revolving period. Even though the certificates are amortizing, the allocation percentage to the series will be fixed based on its original invested amount. If the credit card ABS accumulate principal or amortize over 12 months, then 1/12 of the principal amount of that series will be paid to it. Principal collections in excess of what is necessary for amortization, depending on the structure of the trust, may be shared with other series in the same group as needed to meet their amortization schedules. Otherwise, excess principal is used to purchase additional receivables.

Credit Enhancement

In order to establish an investment-grade rating on credit card ABS, credit enhancement is necessary to absorb losses. The amount of credit enhancement needed will vary from one master trust to another based on the desired rating level and the credit performance of an issuer's credit card portfolio. Early credit card transactions carried letters of credit from commercial banks as credit enhancement. However, downgrades of a number of credit enhancers exposed ABS investors to downgrades on their investments. While some issuers still rely on surety bonds, internal forms of credit enhancement have become the norm.

Excess Spread

Excess spread is perhaps the most important measure of the health of a credit card master trust, is a key early amortization trigger, and is the first line of defense against losses. Excess spread is simply the cash flow left over each month after the

EXHIBIT 28–6

Excess Spread Calculation

Gross portfolio yield	19%
Less:	
Charge-offs	6%
Net portfolio yield	13%
Less:	
Investor coupon	6%
Servicing fee	2%
Excess spread	5%

investor coupon, servicing fees, and charge-offs have been allocated to each series. The calculation of excess spread is fairly straightforward, as shown in Exhibit 28–6, with the values expressed as an annualized percentage of the outstanding receivables balance. If the three-month moving average of excess spread for a particular series in a nonsocialized master trust falls below zero, then an early amortization event with regard to that series has occurred. In socialized master trusts, the excess spread for all series in the same group will be equal because they share finance charge collections based on the weighted-average cost of the group. An early amortization trigger based on a decline in excess spread therefore will affect all series in the group.

Cash Collateral Account

A *cash collateral account* (CCA) is a cash reserve account funded at closing and held by the trust. The cash to fund the CCA usually is lent by a third party and invested in high-grade short-term securities. The CCA is used to protect against shortfalls in cash flow owing to rising charge-offs, and any draws on it are reimbursed from future excess spread.

Collateral Invested Amount

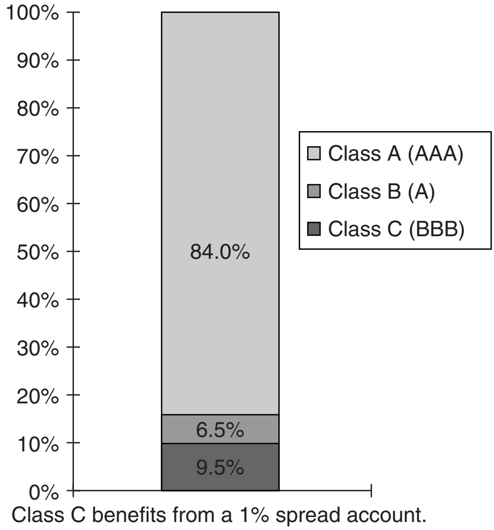
An alternative to a cash reserve is a *collateral invested amount* (CIA), which is a privately placed subordinated tranche of a series. The CIA is placed with a third-party investor, and the investor may or may not require a rating on the CIA. The CIA is an improvement for the issuer over the CCA because this tranche is backed by collateral from the master trust rather than cash. Like the CCA, the CIA is available to protect against shortfalls in cash flow owing to declining excess spread. The CIA tranche has the benefit of a spread account, which is not available as credit enhancement to other investors. Draws on the CIA also are reimbursed through excess spread.

Subordination

As credit card ABS have evolved, structures have become more complex. Letters of credit have given way to CCAs or CIAs, which, in turn, have been replaced with

EXHIBIT 28–7

Credit Card Series Structure



rated subordinated securities. The subordinated classes also are placed with public ABS investors and tend to be rated in the single-A or triple-B categories. A typical structure might include AAA-rated class A senior certificates, a single-A-rated class B subordinated tranche, and a class C tranche issued to investors rated at the triple-B level (Exhibit 28–7). The class C tranche is credit enhanced by a spread account that can trap additional cash out of excess spread if certain credit performance triggers are tripped. Using subordinated tranches allows the issuer to monetize a larger portion of its collateral portfolio and permits it to reach a wider investor audience. As noted earlier, the development of the MOT is the latest step toward a liquid, ERISA-eligible, subordinated credit card ABS market sector.

Rating-Agency Considerations

Rating-agency criteria have evolved over time as new structures, such as rated C-pieces or the master owner trust, have been introduced. In general, the rating criteria from the agencies are not substantially different for the MOT structure than they were for the classic credit card master trusts. Stressing the historical performance of critical variables related to the cash flows tests the structural integrity of credit card ABS. The rating agencies generally require three to five years of historical data and will examine vintage data in order to estimate loss curves and the ultimate level of charge-offs. Once baseline performance is determined, then different cash-flow stresses are used depending on the desired rating.

The key quantitative variables for analyzing credit card securitizations include portfolio yield, charge-offs, monthly payment rate, monthly purchase rate, and the investor coupon.[3] Each is discussed below.

- *Portfolio yield,* as noted earlier, is a measure of the income generated by the credit card receivables. While portfolio yield is driven largely by the annual percentage rate (APR) on accounts and fees, usage by account holders also plays an important role. All else equal, a portfolio with proportionately more revolving accounts relative to convenience users will translate into a higher portfolio yield.
- *Charge-offs* are the credit losses experienced by the portfolio and are taken by most issuers at 180 days past due. Peak losses on a static pool basis for credit card accounts have been observed at about 24 months of seasoning.
- The *monthly payment rate* is an important variable in the analysis because high payment rates can be a source of strength and implied credit enhancement. A large proportion of convenience users, while depressing portfolio yield, can increase payment rates sharply. A higher payment rate means that investors can be repaid more quickly during an early amortization.
- Related to the payment rate is the *purchase rate,* which is the generation of new receivables by the designated accounts. Higher purchase rates mean that more receivables are being generated to support outstanding ABS. Bankruptcy of the seller of the receivables, such as a department store chain, is the main risk with regard to the purchase rate because cardholders may stop using the card. As the amount of receivables declines, the credit quality of the portfolio may deteriorate.
- *Floating-rate ABS* generally require more credit enhancement than fixed-rate transactions because the rating agencies assume in their stress scenarios that market interest rates increase dramatically. Higher funding costs for the ABS reduce the available excess spread.

The stress tests run by the rating agencies force portfolio yields, payment rates, and purchase rates down sharply at the same time that charge-offs rise. This combination compresses excess spread and causes an early amortization of the transaction. Exhibit 28–8 shows generic stress scenarios for credit card ABS transactions for Standard & Poor's. The rating agencies may deviate from these benchmark levels depending on the qualitative factors of a seller's business. Some of the key qualitative elements that go into the rating analysis are new account underwriting, servicing and collections, marketing, card type (private label versus general purpose), geographic diversification, strategic objectives of the firm,

3. The methodology and variables used are based on Standard & Poor's rating criteria. The other rating agencies perform a similar analysis when rating credit card ABS.

EXHIBIT 28–8

Standard & Poor's Benchmark Stress Scenarios

	AAA Rating	A Rating
Charge-offs	3–5× steady-state levels	2–3× steady-state levels
Portfolio yield*	11%–12% annual rate	12% annual rate
Payment rate	45%–55% of steady-state level	50%–60% of steady-state level
Purchase rate	0%–5% annual rate	0%–5% annual rate
Investor coupon†	15%	14%

*Based on proposed legislative caps.

†Coupon for uncapped floaters.

account seasoning, and the competitive position of the issuer. These qualitative factors, among others, determine how the generic stress factors will be modified and applied to an individual issuer's credit card portfolio.

THE CREDIT CARD ABS MARKET

Credit card ABS is the largest and most liquid part of the ABS market. In 2003, total new public issuance of credit card ABS reached $64.5 billion. In addition, outstanding credit card ABS is about $400 billion according to Bond Market Association data. The number of issuers, their strong corporate credit ratings, and the total dollar amount of securities outstanding make this sector particularly active for secondary trading. Consequently, pricing spreads for credit card ABS tend to be used as a benchmark for comparison with other ABS sectors.

During the past decade, the credit card industry has experienced rapid growth and increasing competition. This dynamic culminated in sharp increases in outstanding receivables in 1995 and 1996 and was reflected in the amount of new credit card ABS issued during that period. However, rapid growth and intense competition also led to problems with asset quality. Charge-offs rose steadily, and excess spreads compressed from the middle of 1995 through the middle of 1997 as consumer bankruptcy rates reached record levels. It has been acknowledged generally that competition for new accounts, the use of introductory "teaser rates," and weaker underwriting led to many of the credit problems seen in the credit card sector.

Credit performance stabilized in the late 1990s as credit card companies reexamined their marketing strategies and underwriting procedures. Charge-off rates slowly fell back to about 5% by the summer of 2000, but excess spreads remained relatively high as banks instituted more thorough risk-based pricing of customer accounts. As the economy slowed and the recession took hold, charge-off rates began to drift higher. Nevertheless, excess spreads increased sharply owing to dramatically lower short-term interest rates, and the majority of ABS are issued as floating-rate notes. As LIBOR rates fell, funding costs dropped, and margins on credit card master trusts soared to record levels.

Industry Consolidation

To better meet their credit underwriting and customer service needs, stronger credit card companies invested heavily in technology and increased their scale of operations to spread the costs of that investment over more accounts. Many smaller or weaker firms were unable or unwilling to meet the challenge of the new competitive environment and decided to exit the business. As a result, consolidation has been one of the key themes in the credit card business over the past several years. To illustrate, at the start of 1987, there were slightly more than $80 billion of credit card receivables outstanding in the United States, and the top 10 credit card companies had a combined market share of about 40%. By the end of 2002, there were more than $730 billion of outstanding credit card receivables, and the top 10 credit card companies had a combined market share of 75%.

As the credit card industry has consolidated, so has the market for credit card ABS. The three largest credit card issuers accounted for about 51% of credit card ABS issuance in 2003, and the top five were responsible for approximately 72%. While consolidation has reduced the number of issuers in the market, the overall credit quality of those which remain has improved. Seven of the top 10 sponsors have corporate debt ratings of A2/A or better. From the standpoint of liquidity and issuer quality, this sector may be the strongest in the ABS market.

Credit Card Market Segments

The major issuers of credit card ABS fall into four major categories: commercial banks, consumer finance companies, independent networks, and retailers. The following list presents some examples of the issuers in each of these categories.

Commercial banks:	Bank One, Citibank, Chase, BankAmerica
Consumer finance:	MBNA, Household, Capital One, Providian
Independent networks:	Discover, American Express
Retailers:	Sears, Target, World Financial Network

General-Purpose Cards

The credit card ABS market is divided into two major segments: general-purpose cards and private-label cards. The larger of these two segments includes transactions sponsored by issuers of general-purpose credit cards. General-purpose credit cards include both Visa and MasterCard cards issued by commercial banks and consumer finance companies, as well as the independent networks of merchants built by Discover Card and American Express. This group of issuers represents the vast majority of the credit card ABS market. Issuers of general-purpose cards tend to price new ABS at tighter spreads relative to private-label issuers. Tiering in that market favors the largest, most frequent issuers with stable credit performance. Nevertheless, most issuers price new credit card ABS transactions within a very tight range of only a few basis points.

"Teaser Rate" Cards

In an attempt to gain market share in the face of fierce competition, credit card issuers devised a number of innovations to establish brand loyalty with new customers. Low-price cards, with no annual fee and upfront "teaser rates," have been used to lure customers away from competitors. These accounts often allow the new customer to transfer existing balances from other higher-interest-rate cards. The teaser rate usually is in effect for 6 to 12 months and then steps up to a higher rate based on the borrower's credit risk. Balance transfers have been used to great effect by card issuers, although many borrowers have become adept at rolling balances from one card to another at the end of the teaser rate period. One of the problems with this approach is the potential for adverse selection in the account base. Borrowers with poor credit are more likely to respond to a teaser rate and may be less likely to roll balances to a new card in the future because they have fewer credit options. Most credit card banks have moved away from the blanket marketing of teaser rate accounts to concentrate on other ways to establish brand loyalty among cardholders.

Affinity and Cobranded Programs

One of the uses of the technological investment made by credit card issuers has been in the customer retention effort. A package of interest rates, credit limits, and other services can be offered to entice customers to stay once the teaser period ends. These packages may come in thousands of possible combinations and are offered based on the credit profile and card usage patterns of the cardholder. The method of *mass customization* is made possible by the sophisticated computer systems that search for new customers in huge databases and track the credit performance and profitability of existing customers. One of the most successful issuers practicing a mass customization strategy is Capital One.

Two popular products created by issuers to differentiate themselves in the minds of cardholders and retain them as customers are *affinity* and *cobranded* programs. Affinity cards are issued by a bank in association with a special interest group, such as a college alumni association, professional group, or sports team. The group receives a fee from the bank, and the bank uses its affinity program to attract a certain demographic group to use its card. Cobranded cards are programs that associate a bank's credit card with a particular commercial firm.

Customers can earn certain rewards from the commercial firm for making purchases with the card, such as mileage awards toward free tickets on airlines, which is probably the most popular of the bank cobrand programs.

Private-Label Credit Cards

The other, much smaller segment of the credit card market includes private-label credit cards, which are sponsored by retailers for use in their own stores. This segment has been dominated by issuance from Sears, which represents about one-third of the private-label market. Private-label credit card accounts are viewed most often by the sponsor as a means to increase sales, and credit underwriting may not be as stringent as it is for general-purpose credit cards. As a result, charge-offs tend to be higher on private-label credit card master trusts than they are for general-purpose card master trusts. On the other hand, APRs and portfolio yields do tend to be higher to compensate for the greater risk in the private-label portfolio. Private-label credit card ABS transactions tend to be less frequent and somewhat smaller, and as a result, they tend to price at a concession to ABS transactions sponsored by general-purpose card issuers. Nevertheless, good value can be found among private-label issuers by investors willing to investigate them.

CONCLUSION

The credit card ABS market currently is the largest and most liquid asset-backed sector. For this reason, it is viewed by many as a safe haven for ABS investors in stressful market times. Indeed, spreads on credit card ABS are usually the first to recover from market dislocations. Over the past several years, a growing economy, healthy consumer balance sheets, and greater acceptance of credit cards for nontraditional uses led to a sharp increase in outstanding receivables. Meanwhile, the market weathered a deteriorating credit situation from 1995 through 1997. Nevertheless, a growing need for technology and intense competition led to consolidation in the industry, although competition still appears to be quite strong. Credit card ABS seems to have done fairly well in the most recent recession and sluggish recovery, although certain issuers have seen their portfolios undergo substantial stress. Increasing issuance in the European market should produce a more global credit card ABS market in coming years, and additional innovations are sure to follow. Given the commitment most credit card issuers have made to the ABS market, it seems likely that the credit card ABS market should continue to be a benchmark sector for the foreseeable future.

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CHAPTER

TWENTY-NINE

SECURITIES BACKED BY AUTOMOBILE LOANS AND LEASES

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Bonds collateralized by retail auto loans and leases play a prominent role within the U.S. asset-backed securities (ABS) market, accounting for almost 20% of the market's outstanding balance at year-end 2003. The auto sector is among the most widely traded and most liquid segments of the U.S. ABS market.

The purpose of this chapter is to provide an introduction to the realm of auto ABS. The chapter covers ABS collateralized by retail loans and leases. The chapter considers issues surrounding collateral performance, ABS structuring, and relative value analysis.

To fully appreciate auto ABS, it is critical to have a thorough understanding of the underlying collateral, including how it was originated, how it is serviced, and how it is expected to behave over time. For this reason, we will begin by looking at the U.S. auto finance industry and the environment that produces auto ABS collateral.

U.S. AUTO FINANCE INDUSTRY

During 2003, approximately 60 million cars and light trucks were sold in the United States. Of this number, approximately three-quarters were financed using loans and leases. Loans were used about three times as often as leases.

Auto loans are originated via two channels. In the direct auto lending channel, consumers seek out a loan from a bank, credit union, or financial institution of their choice. In the indirect lending channel, the dealer acts as an intermediary between the customer and a financial institution that is willing to provide credit.

Mr. Roever was Head of Global Securitization for Banc One Capital Markets, Inc. when this chapter was written.

Typically, a dealer will maintain relationships with numerous banks and auto finance companies in order to best serve its customer base and to maximize its own profit. Banks, captive finance subsidiaries of major manufacturers, and independent finance companies compete intensely for dealer-originated business. Several factors influence a dealer's choice of lender, including competitive loan pricing, fast underwriting approval, and various funding incentives available to the customer or dealer. A dealer's choice also may be influenced by broader business relationships with a lender, for example, if a lender also provides floorplan (inventory) or real estate financing. The source a dealer uses usually is determined at the loan level. A given lender's interest may be influenced by factors such as the model of the vehicle or the credit profile of the borrower.

In both channels, lenders must evaluate the creditworthiness of the potential borrower before deciding whether to lend money and at what terms they may be willing to extend credit. As part of the underwriting process, lenders gather an array of information from the borrower, typically using a standardized application form. Direct lenders gather the information needed to evaluate borrower credit directly from the applicants, whereas in indirect lending dealers gather much of the relevant information and then disseminate that information to one or more lenders. Data gathered by lenders include borrower income, employment history, and housing profile. Lenders also will access borrower credit history from one or more credit bureaus, usually including a generic credit score (often called a *FICO score,* after Fair, Isaac & Co., the firm that developed the scoring methodology). Collected applicant information is combined with facts regarding the vehicle and the trade-in and/or the amount of cash the applicant is able to put down. The whole of the collected data is evaluated through the lens of the lender's established credit policy. Based on this evaluation, the lender will determine if, and at what terms, it is willing to make a loan. While obligor quality can be important, it is often not the sole determinant of whether a lender will accept a loan. Other transaction-specific factors, such as loan-to-value (LTV) ratio, also play an important role. It is a common case where, all else being equal, a lender is willing to make a low-LTV loan to a customer with a lower credit score but would be unwilling to lend to the same customer against the same vehicle at a higher LTV ratio.

Although the underwriting process used by direct and indirect lenders is similar, the competitive nature of indirect lending dictates that lenders reach a decision quickly. Most indirect lenders have developed customized underwriting criteria to quickly evaluate the information and can return a credit decision quickly to the dealer. Often applications from customers with high credit bureau scores and low debt-to-income levels are routed through an automated approval process.

A lender's risk preference often is related to its underlying business model. Captive finance subsidiaries lend to a broad range of customers, nearly all of whom are sourced through the manufacturers' franchised dealer networks. The captives' primary business purpose is to promote and support the sales of their parents' manufacturing operations. For this reason, an incentive exists for captives to price loans aggressively in order to promote unit sales. Banks typically underwrite to the narrower, higher-quality credit range based on regulatory limitations and lower return on equity (ROE) requirements. Independent finance companies often are focused on higher-yielding but riskier loans.

Borrowers often are characterized broadly as "prime," "nonprime," or "subprime" depending on how lenders view their credit. While there are no universally accepted definitions of these terms, there is a general market understanding of what they mean. Prime obligors have a strong credit history, characterized by timely payment of all debt obligations, that results in a high credit bureau score, generally above 680. Nonprime, sometimes called "near-prime," obligors usually have good credit histories marked by a few delinquent payments. Bureau scores for these obligors tend to be in the low to middle 600s. Subprime obligors usually have a history of missed or seriously delinquent loan payments and may have previously filed for bankruptcy. Bureau scores are usually in the low 600s and below. Exhibit 29–1 illustrates the relationship between credit history and bureau scores.

When a lender approves a loan, it is agreeing to provide credit at its own specific terms. Often a borrower may have multiple loans to choose from and will choose the one that best meets his needs. Lenders closely monitor their loan approval rate (percentage of applications approved to completed applications received) to compare their loan terms with other lenders in the market. Changes in the approval rate or in the terms of the loans being approved often foreshadow changes in portfolio performance. Indirect lenders also use loan approval rates as a way to monitor dealer performance. High approval rates are usually an indicator of a strong dealer relationship, whereas lower rates can be a sign of problems with a particular dealer.

Cashing is an industry term that refers to the funding of a loan. In indirect lending, loans are cashed only when the terms are accepted by the borrower and the dealer. Since indirect lending can be very competitive, it is not uncommon for multiple lenders to propose loans to the borrower with the same maturity and annual percentage rate (APR) levels. In such cases, the dealer may determine which lender gets the loan based on factors that affect the dealer's profitability. These factors include dealer incentives offered by the lender and the size of the dealer reserve (the difference between the contract APR and the rate at which the lender is willing to buy the contract). As with the approval ratio, lenders closely monitor their cashing ratio (percentage of loans funded to approved applications) for signs of changing market conditions.

Once a lender acquires a contract, the loan servicing process begins. *Boarding* refers to the steps needed to develop the loan file and initial servicing records. Key customer data are captured electronically in the servicing and collections software. Original paper copies of signed credit application and loan contract are filed, as are the vehicle title and related documents. The servicer also will initiate contact with the borrower with a "welcome letter" in which it will provide details about loan payment terms and methods. While many borrowers now choose to pay their loans via automatic debit from their bank accounts, other high-quality borrowers still prefer to use coupon books that must be sent by the servicer. Likewise, many lower-quality borrowers will be invoiced monthly by the servicer for their payments.

The primary goal of most auto loan servicers is to minimize credit losses to their portfolios. To meet this goal, servicers closely monitor obligor performance by

EXHIBIT 29–1

Making Sense of Obligor Quality

Borrower Quality:	Prime			Nonprime		Subprime
Borrower Grade:	**A+**	**A**	**A–**	**B**	**C**	**D**
FICO Scale:*	**900**	**720**	**660**	**620**	**600**	**500**
Credit history:	Good credit, no derogatories		Very minor, explainable problems	Moderate, perhaps recurring problems	Serious, recurring problems	Severe problems, demonstrated unwillingness to pay
Typical weighted average collateral coupon:		8 < 12%		12 < 16%	16 < 20%	20% or greater (up to state usury limits)
Typical pool delinquency rate:		<2.5%		<5%	<10%	10 < 25%
Typical pool cumulative foreclosure rate:		<3%		<6%	<20%	<40%
Typical pool cumulative losses:		<2%		<4%	<10%	>10%

*FICO scores are a product of Fair, Issac, and Company and are based on predictive data available in individual credit bureau reports. The scores shown are intended as general indicator of obligor credit quality and are based on research conducted by Banc One Captital Markets. The scores presented are not endorsed by Fair, Isaac and Company. Different lenders can have varying interpretations of credit scores.

tracking delinquencies and through the use of sophisticated risk-management software that uses changes in individual borrower behavior to predict potential problems. Servicers attempt to keep delinquencies to a minimum within the terms of the original loans. Occasionally, when faced with a chronically troubled borrower, a servicer will choose between amending the terms of the loan or, if the situation warrants, repossessing and selling the vehicle. The choice usually is dictated by which strategy will minimize the lender's loss and is influenced strongly by the lender's perception of the borrower's ability and willingness to pay under the amended terms.

Servicers generally belong to one of two schools of thought about collecting from obligors. Some servicers use a "cradle to grave" approach, where one collector or collection team is responsible for a particular loan between the time it is boarded through its voluntary or involuntary termination. Firms using this collections approach believe that they can minimize losses by having the same person or team manage problem credits through to their resolution. Other servicers prefer a specialized approach depending on the loan's status (e.g., delinquent, seriously delinquent, repossession, in bankruptcy, etc.). Servicers choosing this approach believe that the gains from functional specialization outweigh the value of a consistent point of contact. There does not appear to be any industry-wide evidence proving that either approach is superior.

Regardless of the collections approach applied, most servicers deal with delinquencies in similar ways. Five to ten days after an original payment due date is missed, a delinquency notification letter is generated automatically and mailed to the customer. Unless payment is received in the interim, a second notice usually is generated at 15 to 20 days past due. Sometime after the twentieth day of delinquency, an auto dialer will attempt to make contact with the customer. A collector will attempt to gather information from the obligor and extract a promise to pay within a specific time. Following the forty-fifth day of delinquency, if no payment has been received, or if multiple promises to pay have been broken, then the vehicle repossession process may be started. For accounting purposes, servicers usually charge off loans after 90 or 120 days past due or on the repossession date, whichever comes earlier. Repossessed vehicles usually are auctioned off, and the proceeds (less repossession expenses) are subtracted from the gross amount charged off to determine the net loss amount.

Most auto lenders service their own loan portfolios. Loan servicing is a critical function, and although there are incentives to control overall servicing costs, most lenders invest heavily in this area in order to minimize loan losses. Significant economies of scale can be realized in the servicing function through efficiency gains and the spreading out of fixed costs.

In securitizations, servicers are treated as if they are a third party, even if their firm originated the loans. They are paid a fixed, periodic fee, commonly ranging from 0.50% to 2.00% of a pool's remaining collateral balance. They are expected to meet specific performance standards and are subject to replacement should they fail to meet standards. In addition to their responsibilities for risk management, collections, and legal compliance, ABS servicers also have to produce monthly investor reports detailing the performance of the various pools they administer.

UNDERSTANDING LOAN COLLATERAL PERFORMANCE

The credit performance of auto loan collateral pools generally reflects the business strategy of the originating firm. Collateral pools comprised of loans to prime, nonprime, and subprime obligors will perform differently with respect to delinquencies, credit losses, and prepayment speed.

Exhibit 29–2 provides a comparison of three loan pools of the same vintage. Pool P was originated by a captive finance company and is comprised predominantly of loans to prime-quality obligors. Pool N was originated by an independent finance company and is comprised predominantly of loans to non-prime-quality obligors. Pool S was originated by an independent finance company and is comprised of loans to subprime-quality obligors.

Exhibit 29–3 compares monthly delinquencies as a percentage of remaining pool balances. Likewise, Exhibit 29–4 depicts the cumulative losses, net of recoveries, as a percentage of the original pool balance. Clearly, the nonprime and subprime pools performed markedly worse than the prime pool. However, the relative performance is consistent with lender expectations. In a securitization, this expected performance is taken into consideration by the credit rating agencies when they size credit enhancement. The weaker the expected performance, the greater is the amount of credit enhancement needed to achieve a given rating.

Over time, collateral performance can be affected by general economic conditions as well as by conditions that affect the automotive industry. As data from Moody's Prime Auto Loan Indexes illustrate (Exhibit 29–5), delinquencies and losses tend to surge during recessions. Losses also can be sensitive to used

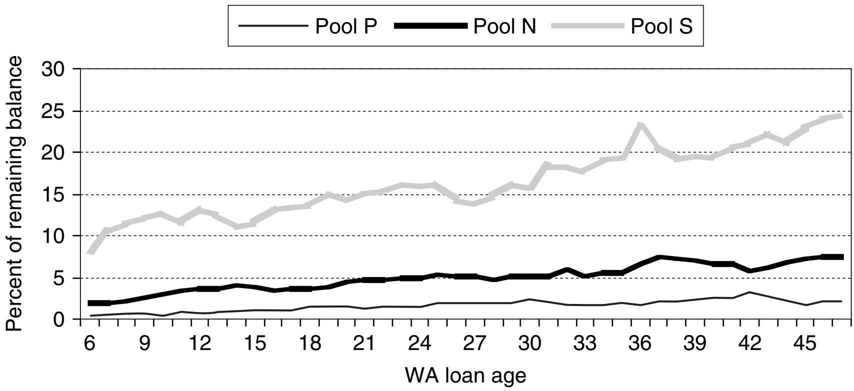
EXHIBIT 29–2

Pool Comparison

	Pool P	Pool N	Pool S
Obligor quality:	Prime	Nonprime	Subprime
Lender type:	Captive finance company	Independent finance company	Independent finance company
Average original contract size ($):	24,000	18,000	18,000
Average original loan term (mo.):	55	60	60
Percent new/used:	80/20	40/60	20/80
WAC:	5.50%	11.00%	18.50%

EXHIBIT 29–3

Comparison of Total Delinquencies as a Percentage of Pool Outstandings



car prices; as used car values fall, losses tend to rise. Also, it's worth noting that subprime pools tend to be more procyclic than prime pools.

Another important dimension of collateral performance for ABS investors is the rate at which loan pools prepay. Prepayment rates reflect the speed at which principal is returned to investors. By market convention, auto loan prepayment speeds are measured using a scale known as *absolute prepayment speed* (ABS). The ABS scale measures the number of loans that are prepaid during a given period as a percent of the original number of loans in the pool. This differs from the conditional prepayment rate (CPR) metric used with most securitized assets, which measures the annualized rate of monthly prepayments as a percentage of the outstanding balance at the beginning of the period. Mathematically, a stable

EXHIBIT 29–4

Cumulative Net Loss Rate as Percent of Original Balance

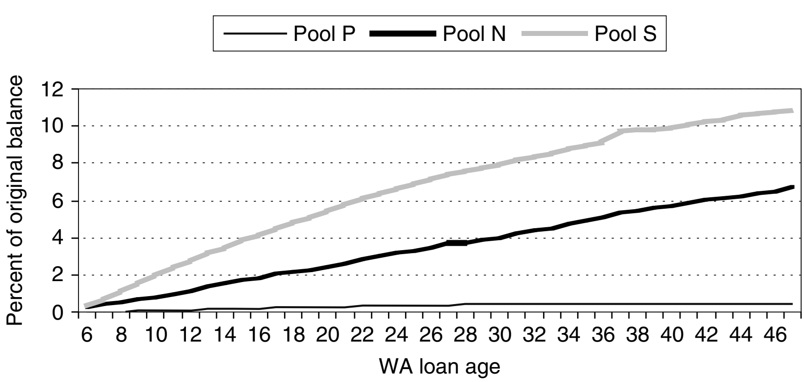
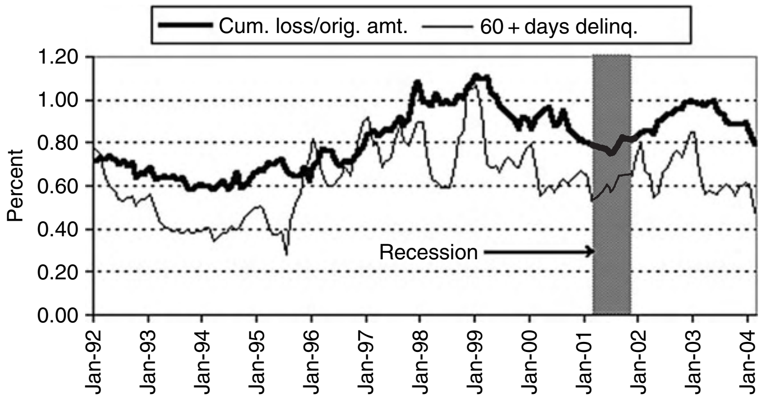


EXHIBIT 29–5

Moody's Prime Auto Loan Indexes



Source: Moody's Investor Service, March 2004.

ABS translates into a rising CPR, a relationship that reflects the reality that auto prepayments tend to increase with loan age[1] (Exhibit 29–6).

Unlike mortgage prepayments, auto prepayment speeds are largely unaffected by interest rates because auto loans are less efficient to refinance than mortgages. The relatively small size and short lives of auto loans compared with mortgage loans constrain the savings available from refinancing into a lower-cost loan. For example, refinancing a $20,000, 60-month loan from a 6% APR to a 5% APR would only lower the borrower's monthly payment less than $10. Another reality limiting rate-related vehicle refinancing is that vehicles, unlike real property, are depreciating assets. Over time, a vehicle's value often declines faster than the principal value of the loan financing the vehicle. In many cases, the loan may be "underwater," meaning that the market value of the vehicle is less than the remaining value of the loan. Under such circumstances, lenders typically are unwilling to lend enough to fully refinance the initial loan, and the

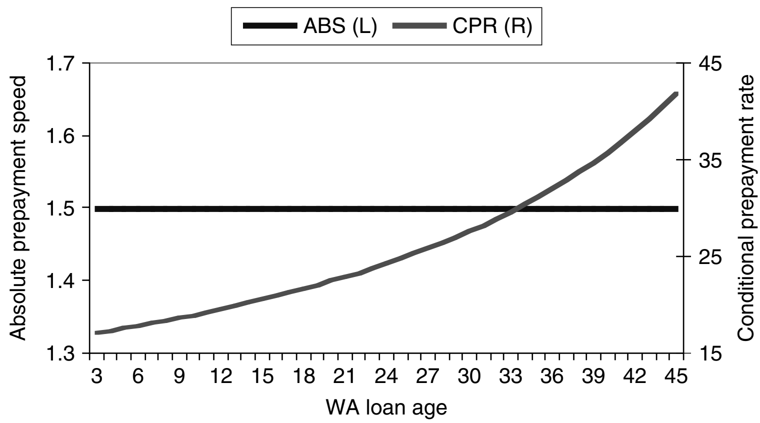
1. Collateral prepayment speeds using the ABS scale can be converted to the CPR scale using the following approach. First, convert ABS to the single monthly mortality rate (SMM) using the following formula:

$$\text{SMM} = \frac{100 \times \text{ABS}}{100 - \text{ABS} \times (\text{month} - 1)}$$

where month is the pool's weighted-average loan age measured in months. The SMM can then be converted to CPR using the standard methodology. (Source: *Standard Formulas for the Analysis of Mortgage-Backed Securities and Other Related Securities,* The Bond Market Association, 1999).

EXHIBIT 29–6

Approximate CPR Equivalent of 1.5% ABS

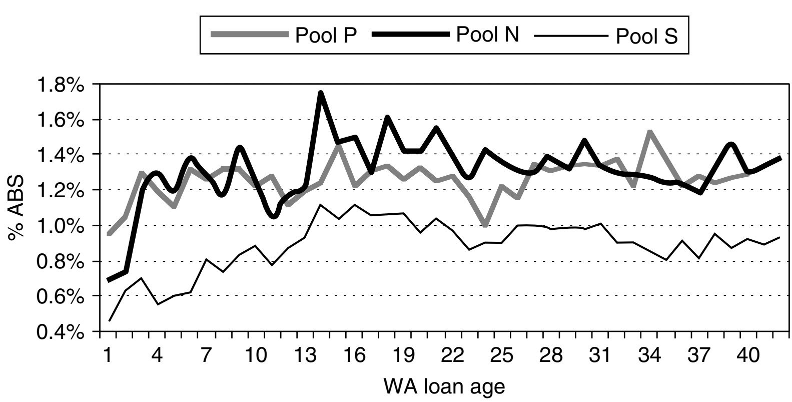


borrower would have to put more of her own money into the transaction to make up the difference between the two loans.

On a pool-wide basis, vehicle loan prepayment rates are not driven by refinancing. Rather, prepayments are a function of real activity, such as borrowers trading in vehicles or paying off loans early, casualty losses from insurance proceeds, or loan servicers advancing funds that they expect to recover from defaulted loans. Generally, pools backed by loans to higher-quality borrowers tend to prepay at a slower rate than those backed by loans to lower-quality borrowers (Exhibit 29–7). Lower-quality pools have higher default rates, and although

EXHIBIT 29–7

Comparision of Prepayment Speed by Pool Quality



borrowers often are financially constrained, they have on margin a greater incentive to prepay the more expensive loans.

AUTO LOAN ABS STRUCTURES

In any securitization, structure is used both to protect against various risks and to provide economic funding for the issuer. Structural techniques used must protect ABS investors from risks that may arise outside the securitization (external risks) and risks inherent to the securitization (internal risks). In both cases, credit rating agencies are intimately involved in order to ensure that the techniques employed adequately address the risks that are present and are consistent with the ratings issued.

External Risks

Because repayment of the ABS depends on the available cash flow from the collateral, it is essential to legally segregate the collateral for the exclusive benefit of the ABS owners. To do this, the collateral must be isolated from the bankruptcy or insolvency risk of the lender or other entities involved in the securitization. This is usually achieved through the legal transfer of the loans from the originating firm, or the seller, to one or more bankruptcy remote special-purpose entities (SPE). An SPE is a limited-purpose legal vehicle (e.g., corporation, limited-liability corporation, business trust), separate and distinct from originator, that is designed to protect the collateral from claims of the seller's creditors in the event that the seller enters bankruptcy. Ideally, an SPE will be restricted in its ability to incur debt, pledge its assets, and merge or reorganize.

The transfer of auto loans from the seller to the SPE should be accomplished through one or more "true sales"—arm's-length transactions that transfer ownership of the collateral from the seller to the SPE. Under the *Uniform Commercial Code* (UCC) of most states, both the sale of and the grant of a security interest in the auto loans can be perfected either through the possession of the original loan documents or the filing of UCC financing statements. Because it is usually the quicker and cheaper alternative, collateral transfers typically are perfected by filing UCC statements. Counsel for the seller will render legal opinions addressing the perfection of these transfers among the various parties.

To ensure that the requirements of the rating are met, rating agencies will conduct a review of legal documentation involving these transfers, including the legal opinions and other documents.

Internal Risks

Structural techniques are also used to protect ABS investors from risks inherent to the transaction, such as collateral risk (delinquency and default) and servicing risk. A primary responsibility of the credit rating agencies is to determine levels of credit enhancement that will mitigate these risks to a degree consistent with the ratings they issue. Rating agencies will conduct a review of the originator's underwriting criteria, the servicer's collection capabilities, the performance of the loan portfolio over time with regard to delinquencies and defaults, the transaction structure, and any pertinent legal issues. Each of these factors plays a role in the calculation of the credit enhancement levels.

The quality of the originator's underwriting criteria and its ability to service the portfolio are key elements in a transaction's rating. The rating agency's due diligence of a company will include a review of its history, management's experience in auto lending and its policies and procedures, the business plan and strategy for the firm's growth, and its capital structure and financial strength. Three to five years of operating history is preferred by the agencies; however, firms with less operating history but more experienced management may be able to pass muster.

The underwriting standards of the originator are one of the critical pieces of the rating agency review. The makeup and consistency of the lending process are closely scrutinized, including key underwriting criteria, the use of credit scoring models, whether loans are originated in a central location or at the branch level, and the terms and conditions of the loan. In addition, the servicing capabilities of the company are an important consideration because good servicing can improve a transaction, and poor servicing can harm an otherwise sound transaction. The elements of a servicer analyzed by the rating agencies include the firm's ratio of accounts to collectors, collection methods, and the ability and speed with which the firm liquidates repossessed inventory.

Despite the emphasis on the ability of the originator/servicer in the due-diligence process, the agencies often will assume that the servicer will go bankrupt and not be available to service the portfolio during the life of the transaction. This is especially true for monoline finance companies or small lenders engaged in the nonprime and subprime market segments. As a result, the provisions for transferring servicing to a backup servicer will be reviewed closely. For some transactions, including those from small or relatively inexperienced issuers, an investment-grade backup servicer may need to be named at the outset.

In conjunction with their analysis of the seller/servicer, the agencies also perform an extensive collateral analysis. Using a combination of the issuer's own history, pool-specific factors, and industry experience, the agencies will determine a base-case level of expected losses. Some of the specific characteristics evaluated on a pool basis include the proportion of used cars relative to new cars, geographic concentrations, advance rates (i.e., loan size relative to manufacturer's suggested retail price or other measure), average loan maturity, and seasoning. Other factors are also considered, including the average level and dispersion of loan coupons, loan prepayment speeds, and expected delinquencies, particularly with respect to their impact on excess spread, an important source of credit enhancement. Based on their evaluation, the rating agencies will size the credit enhancement to absorb a multiple of base-case losses.

Exhibit 29–8 illustrates the typical multiples required for various ratings. For example, a transaction with expected losses of 2% could require between 8% and

EXHIBIT 29–8

Credit Enhancement as a Multiple of Expected Losses

Rating	Minimum Loss Multiples
AAA	4–6× base-case losses
AA	3–4.5×
A	2–3.5×
BBB	1.5–2.5×
BB	1.5–2×

Source: Banc One Capital Markets, Inc., based on rating agency reports.

12% credit enhancement, with the exact level influenced by several factors. These might include the form of credit enhancement, the availability of excess spread, or the presence of collateral performance triggers that can increase enhancement levels or accelerate prepayment in the event of collateral deterioration.

As with other types of ABS, credit enhancement can take several forms. Overcollateralization, subordination, and the use of spread accounts are all common, as are monoline insurance policies, which typically guarantee investors timely payment of interest and the ultimate repayment of their principal by the transaction's legal maturity.

In addition to protecting investors from risks, ABS structures are also designed to minimize the issuer's cost of funds. The most common structures used in auto ABS are pass-through certificates and pay-through securities. Early in the history of auto loan ABS, the typical structure used by issuers was a *grantor trust* that issued pass-through certificates. Grantor trusts are extremely limited in their ability to reinvest cash collections and therefore pass principal and coupon received from the collateral to the certificate holders shortly after collection. Because grantor trusts are restricted from issuing multiple senior interests, they can only issue one class of senior ABS. However, grantor trusts can issue subordinate interests and therefore can issue multiple classes of ABS, each with a different level of priority. Given their operational constraints, use of this structure has declined substantially in recent years.

Issuer demand for more flexible and efficient structures has led to extensive use of pay-through structures such as the *owner trust.* These more flexible platforms give issuers a variety of tools to lower their funding costs. Issuers have the ability to parse ABS capital structure by both time and priority and thereby target specific pockets of investor interest. Likewise, they also can use interest-rate derivatives to create floating-rate classes targeted at specific investors. Issuers also can use expected excess interest collections to collateralize securities in excess of the par value of their pool's loans. These structures also provide flexibility to introduce performance-related triggers that allow for lower credit enhancement costs.

Two typical auto ABS pay-though structures are illustrated in Exhibit 29–9. Both structures feature multiple sequential-pay senior classes, including Rule 2a-7 eligible money market classes, and a subordinate class. In the first example, the subordinate pays down only after the senior bonds have been retired. In the second example, the subordinate class will, under normal circumstances, pay down its balance concurrently with the A-2 through A-4, but not until the money market class is paid off in full. This is so because money market classes must meet strict maturity requirements to qualify for Rule 2a-7 status.

Structures such as either of these may contain a performance or default trigger that under certain specific circumstances would change the principal waterfall. In the first example, following a trigger event, collections (typically including interest collections in excess of amounts needed to pay coupons and certain trust expenses) would first be applied to retire the money market class and then would be used to retire classes A-2 through A-4 *concurrently* (rather than sequentially) and then to retire class B. In the second example, the trigger would convert the waterfall to the same structure described for the first example. In both cases, portfolio losses will be absorbed from the bottom of the capital structure up. Typically, once overcollateralization, reserve accounts, and other forms of credit enhancement have been consumed by losses, subordinate classes will have their values written down as more losses are incurred. After all subordinate classes have been eliminated, senior bonds typically will be written down in a pro-rata fashion.

Another structural element that exists in all auto ABS is the *clean-up call*. The clean-up call allows the servicer to call all outstanding bonds at par once the collateral pool has been paid down to some predetermined low level, usually 10% of its original balance. Clean-ups exist as an administrative convenience to servicers, to help them avoid certain fixed costs as a deal ages. While some costs of servicing must be borne regardless of whether or not a loan is securitized, there are certain administrative costs involved with trust management and reporting that can be avoided by a servicer exercising a clean-up. While clean-up calls can be viewed theoretically as an embedded option, as a practical matter, their valuation is not straightforward. There are mitigating factors that servicers must consider that are not visible to the general market. These include the aforementioned expenses to be avoided, the existence of overcollateralization or restricted cash in reserve accounts, and the likelihood that the issuer has a funding source (a ABCP conduit or warehouse facility) that has an even lower cost of funds than the bonds being called. Although exact data are not available, historically, a very high percentage of auto ABS have had clean-up calls exercised once they have become eligible.

AUTO LEASE ORIGINATION

Auto leases differ from loans in several fundamental respects. In a typical loan-financed vehicle purchase, a customer wanting a new vehicle from a dealer will finance his purchase with a combination of his own cash and money borrowed

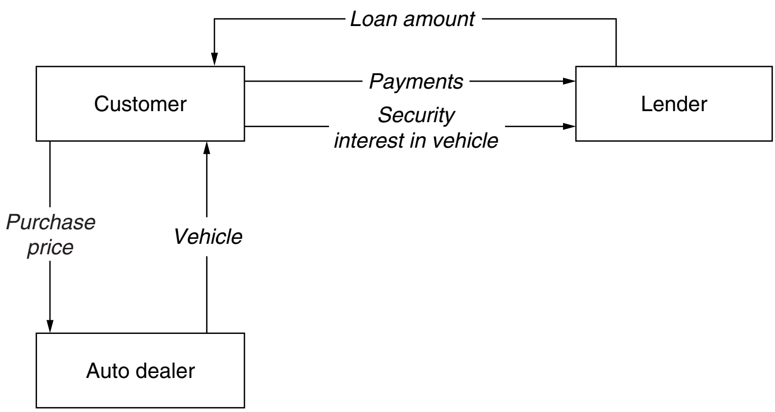
EXHIBIT 29–9

Representative Auto ABS Cash-Flow Structures (Assumes 1.5% Lifetime ABS)

	Class	Ratings	Expected Payment Window to Call (months)	Expected Payment Window to Maturity (months)	WA Life to Call (years)	WA Life to Maturity (years)	Legal Final (months from issue)
Example 1	A-1	P-1/A-1+/F1+	1–7	1–7	0.33	0.33	12
	A-2	Aaa/AAA/AAA	7–18	7–18	1.00	1.00	30
	A-3	Aaa/AAA/AAA	18–33	18–33	2.00	2.00	46
	A-4	Aaa/AAA/AAA	33–38	33–46	3.09	3.25	60
	B	A2/A/A	38	46–58	3.27	4.30	78
Example 2	A-1	P-1/A-1+/F1+	1–7	1–7	0.33	0.33	12
	A-2	Aaa/AAA/AAA	7–18	7–18	1.00	1.00	30
	A-3	Aaa/AAA/AAA	18–33	18–33	2.00	2.00	46
	A-4	Aaa/AAA/AAA	33–42	33–58	3.25	3.60	78
	B	A2/A/A	18–42	18–58	2.54	2.60	78

EXHIBIT 29–10

A Loan-Financed Auto Sale

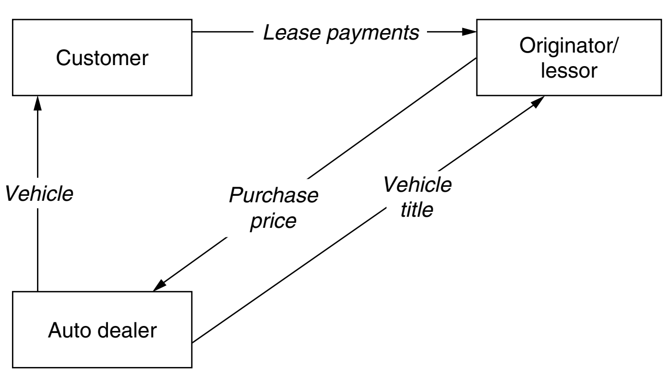


from a lender (Exhibit 29–10). In exchange for the loan, the lender gets a pledge of future repayment, and although the title typically will be issued in the customer's name, the lender will perfect a security interest in the vehicle by filing the appropriate documents with the state department of motor vehicles.

A closed-end lease transaction differs from a loan-financed purchase in that the buyer of the vehicle is not the customer who will use the vehicle. Rather, the owner is a bank or finance company that purchases the vehicle contingent on the customer's agreement to lease the vehicle for some defined period (Exhibit 29–11). At the end of the lease period, the customer (and if not the customer, then the dealer) will have the option to purchase the vehicle at a predetermined (residual) value. If neither the lessee nor the dealer exercises their option, then the lessor will continue to own the vehicle until it is re-leased or sold.

EXHIBIT 29–11

A Lease-Financed Auto Sale



For the customer, the cost advantage of leasing arises mainly from the lower monthly payment. Scheduled lease payments are based on the portion of the vehicle to be used during the lease term or, equivalently, the value of the vehicle in excess of the residual. In contrast, loan payments are based on the entire value of the vehicle less the down payment. The lessee also realizes other savings from the elimination of a down payment and a substantial reduction in sales taxes. Given the lower costs involved with leasing, customers may either pocket their savings or choose to upgrade to more expensive vehicles.

Like the auto lending side of the business, leasing is populated by a variety of firms, including captives, independent finance companies, and banks and other depository institutions. Captives dominate the market for auto leases, accounting for about 75% of new lease originations.[2] This dominance is partly driven by competition in the auto industry and the use of subvention programs by manufacturers to promote auto sales. The goal of these programs is to lower the monthly payments faced by consumers and may involve techniques such as offering leases with artificially high residual values. This creates risk for the leasing company because it increases the likelihood that a vehicle's residual value will be greater than its fair market value at lease end, thereby exposing the lessor to loss equal to the difference. While subvention may increase the lessor's risk of residual loss at lease end, for captives this risk is offset by increased sales at the manufacturer level and their unmatched ability to dispose of used vehicles through their extensive dealer networks.

Lacking these advantages, banks, independent finance companies, and other firms rarely engage in subvention. Instead, these lessors are focused on the return earned on their leases. This bias leads them to greater conservatism in setting their residual values. The most commonly used resource for forecasting residual values is the *Automotive Lease Guide* (ALG). Historically, ALG values have proven to be less than actual wholesale used car prices, making ALG values a fairly conservative standard. However, lessors are not required to use ALG values, and in a competitive leasing environment, they may be incented to set residual values above ALG values in order to lower the lessee's monthly payments.

From the perspective of obligor underwriting and contract servicing, leasing is similar to auto lending. Obligors are evaluated on their ability and willingness to meet the terms of the auto lease using virtually the same criteria as would be used to evaluate a loan. Likewise, lease contract servicing is in most respects identical to that for loans.

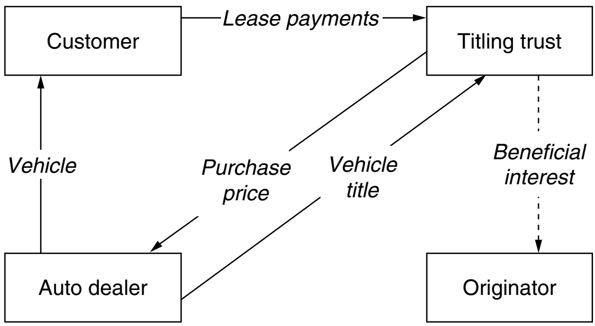
AUTO LEASE SECURITIZATION

While auto lease ABS are subject to some of the same risks as auto loan ABS (such as risk of obligor delinquency or default), lease transactions also face some unique risks that are mitigated through required various structural accommodations not found in auto loan ABS.

2. *The Used Car Market Report*, Manheim Auctions, Atlanta, GA, 2004.

EXHIBIT 29–12

A Lease-Financed Auto Sale to a Titling Trust



One of the most significant differences between loan and lease transactions arises from the need to insulate the securitization from risks relating to the bankruptcy or insolvency of the lessor. In the closed-end lease scenario described earlier, the lessor's assets resulting from the lease are the lease contract and the underlying vehicle. In the event of the lessor's bankruptcy, these assets would be fair game for the lessor's creditors. In order to securitize the leases, both the leases and title to the vehicle need to be held by a bankruptcy-remote special-purpose entity. However, since title to a motor vehicle can only be transferred following a time-consuming process that typically requires the payment of retitling fees and/or transfer taxes on each vehicle, retitling existing portfolios of leased vehicles can become a prohibitively expensive exercise. Without a cost-effective means of transferring and isolating leases and the related vehicles, it becomes practically impossible for auto lease securitization to take place.

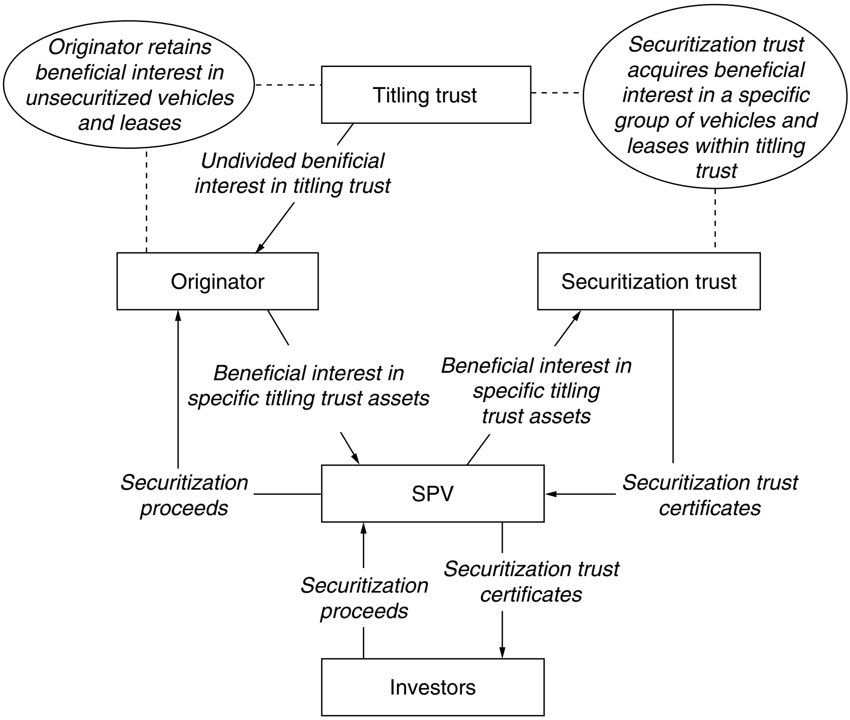
An answer to the problems posed by the retitling of leased vehicles is the titling trust. A *titling trust* is a special-purpose bankruptcy-remote entity formed by lease originators in order to purchase leases directly from dealers as new leases are executed (Exhibit 29–12). Title to the leased vehicles is held by the titling trust, and the originator is removed from the chain of title.

Although the originator is removed from the line of title, it still retains a beneficial interest in all leases and related vehicles in the titling trust. When the originator decides that it is ready to complete a securitization, it can allocate a beneficial interest in a specified pool of titling trust assets to a securitization trust. This beneficial interest in a specified pool within the titling trust is the asset supporting the issuance of auto lease-backed ABS. Ownership of the actual leases and vehicles remains with the titling trust. The securitization trust acquires no claim on any assets of the titling trust other than those in its specified pool. Exhibit 29–13 presents a simplified example of how a securitization using a titling trust might work.

While titling trusts have proven a workable solution for newly originated leases, they generally have not eliminated the retitling problems of existing lease

EXHIBIT 29–13

Simplified Securitization Using a Titling Trust



portfolios. The combination of the time needed to (1) construct titling trusts, (2) ensure that the trusts are in compliance with the laws of every state in which they operate, and (3) actually fill the trust with newly originated leases has limited the development of auto lease-backed securitization.

Another type of risk attendant with auto leases is vicarious tort liability. In several states the owner of a vehicle is liable for damages caused by individuals who operate the vehicle with the owner's permission. This also applies to lessors, who can be liable for damages caused by lessees. In the case of a securitization, this risk can be limited by requiring lessees to maintain the appropriate insurance coverages, naming the titling trust to the insurance policies of the originator and allowing the titling trust to do business only in states that waive liability for lessors.

One other special risk faced in auto lease-backed transactions is posed by the indirect nature of the securitization trust's relationship to the assets. Since the securitization trust has neither direct ownership nor a perfected security interest in the leases and vehicles, it is possible that the holder of a perfected lien in the assets could have a higher-priority claim than the trust. In practice, minor claims such as tax liens and mechanics liens filed against the owner can and do arise, but these can be mitigated and are inconsequential on a portfolio basis. Of more concern are liens that may arise under the Employee Retirement Security Act of 1974 (ERISA). If the originator has unfunded pension liabilities, ERISA gives the Pension Benefit Guaranty Corporation authority to put a lien on the company's assets, which theoretically could be extended to cover assets in a titling trust. And this claim would have priority over the interest of the securitization trust. For this reason, a downgrade of the ABS could occur if a substantial pension liability were to arise. To offset this possibility, auto lease securitization documents often contain warranties by the originators that they will keep their pension plans funded and/or may contain triggers that lead to credit enhancement increases if pension liabilities reach a certain level.

Auto leases also face greater collateral performance risk than loan-backed transactions. Like auto loans, leases are subject to default and delinquency. When evaluating potential lease transactions, rating agencies will scrutinize the leases for delinquency and default risk in a manner nearly identical to auto loans. However, lease residuals introduce a significant dimension of credit risk that is not present with auto loans and are an important focus of rating agencies in determining the necessary level of credit enhancement.

Difficulties arise with residuals because originators, seeking to finance their lease portfolios via securitization, must finance both the leases and the residual value. The problem posed by securitizing the residual values is that they are not, strictly speaking, receivables because their value can only be realized at the end of the lease term, once the vehicle has been sold. Many of the complications of auto lease securitization arise from attempts to securitize the vehicle's residual value. But these problems are not insurmountable.

Two main factors affect the level of residual risk. The first of these is the rate at which vehicles are turned in at lease end. Since, on a close-end lease, both the lessee and the dealer usually have the option to purchase the vehicle at lease end, the lessor is only exposed to a potential residual loss if these options remain unexercised. The turn-in rate measures the percentage of vehicles coming off lease that are returned to the lessor. Many factors can contribute to higher turn-in rates, including

- *Vehicle depreciation.* All else being equal, turn-in rates will be higher if the market value of the vehicle is less than the residual value. For this reason, the strength of the used car market can have a significant impact on turn-in rates and residual value losses.
- *Duration of the lease.* Turn-in rates generally are higher for leases under three years in length. In these cases, residual value is generally high. Given a choice between paying a large lump sum to purchase the vehicle or leasing a new vehicle at the same payment, most lessees choose to continue leasing.
- *Manufacturer's marketing strategies.* If a manufacturer changes the styling of a model during a lease, it is common for turn-in rates to increase because lessees tend to want to exchange old models for newer

ones. Likewise, even if the model styling remains the same, aggressive pricing on the manufacturer's part can lead to higher turn-in rates, particularly if the new vehicle prices are near or less than the residual value.

- *Customer satisfaction.* All else being equal, models that require greater maintenance or that have been subject to one or more manufacturer recalls are more likely to be turned in.

The second factor affecting residual risk is the difference between the residual value and the market value of turned-in vehicles. If the market value is always greater than the residual value, then there will never be any residual losses. Risk arises because this is not always the case. Even the most conservative lessors can be exposed to the volatility of used vehicle prices

Still, there are several ways residual risks can be mitigated. First, the lessor can attempt to conservatively underwrite the leases so that the residual value is more likely to be less than the expected future value of the vehicle. In a pool of leases, this practice should result in fewer vehicles being returned to the lessor because lessees or dealers are more likely to buy the vehicle if the market price is greater than the residual value. In turn, this should result in recoveries in excess of residual values on returned vehicles. From the originator's point of view, however, this strategy can be noncompetitive because it probably will require the lessee to make higher monthly payments, making the lease relatively less attractive compared with those of its competitors.

Other residual risk-mitigating strategies used by leasing companies include proactive lease termination plans. Under these plans, the lessor will, shortly before the scheduled lease maturity, attempt to get the customer to re-lease or trade in the vehicle. When employed successfully, this strategy can reduce the return rate on vehicles significantly and reduce residual risk significantly. Some lessors are able to achieve early termination on over 80% of their leases.

Residual-value insurance is another method sometimes used by lessors to protect against residual risk. These policies typically pay the lessor 80% to 90% of the difference between the residual value and the market value of a vehicle.

Although these mitigation strategies help to limit residual-value-related losses on average, the variability of expected losses remains substantial. The combination of residual-value risk and default and delinquency risk will result in auto lease transactions having substantially higher credit enhancement requirements than similar auto loan transactions.

RELATIVE VALUE ANALYSIS OF AUTO LOAN AND LEASE ABS

Compared with many other securitized asset types, auto loan and lease ABS benefit from having fairly predictable cash flows that usually are not affected by the level of interest rates. The primary issues investors concern themselves with center around three themes: credit/ratings quality, liquidity, and valuation.

- *Credit/ratings quality.* One of the main investor motivations for investing in auto ABS is their high credit quality and strong ratings track record. In a typical year, 90% to 95% of the dollar volume of new auto ABS issued is rated AAA or the equivalent by at least one rating agency. Between the time it began rating auto loan ABS in January 1998 and March 31, 2004, Moody's Investor Service had, out of the thousands of classes of auto ABS it had rated, downgraded only 87 classes. Of these downgraded classes, approximately 60% were backed by subprime-quality pools and the balance by prime-quality pools. Interestingly, Moody's has not downgraded a prime-quality auto ABS since April of 1993.[3]

  During the same period of time, Moody's upgraded 126 mezzanine and subordinate classes of auto ABS. This track record of upgrades is strong enough that many investors actively pursue a strategy of seeking out upgrade candidates and benefiting from a higher yield in the meantime.
- *Liquidity.* In general, liquidity for both senior and investment-grade-rated subordinate auto ABS is very strong, although there are some variances among issuers and product classes. For instance, auto lease ABS and subprime auto loan ABS usually price at a concession to otherwise comparable auto loan ABS. Such pricing differences often are driven by factors such as transaction complexity, investor perceptions about collateral quality, and the size of the universe of investors that actively participate in a particular kind of transaction. In addition, "headline risk"—negative news regarding a given transactions originator or servicer—sometimes can negatively affect investors' willingness to own ABS of that issuer.
- *Valuation.* Despite their relatively stable cash flows, auto ABS sometimes can be tricky to value. Three common sources of difficulty are determination of the correct payment speed, selection of an appropriate pricing benchmark yield, and treatment of clean-up calls.
  - *Prepayment speed.* The peculiarity of the ABS prepayment metric and its singular application to the auto sector can create confusion. Nearly all auto loan–backed bonds are priced using a single lifetime speed such as 1.5% ABS, implying a constant speed over the deal's life. In reality, the actual percent ABS tends to rise with loan age. This can pose a problem for investors in classes with short original average lives because unseasoned collateral may take a year or more to ramp up to its seasoned speed. All else being equal, with a positively sloped yield curve, pricing a bond with a speed that is faster than the actual speed results in investors overpaying for that bond. Another version of this problem arises when attempting to select a speed to project future

3. *Rating Changes in the U.S. Asset-Backed Securities Market: 2004 First Quarter Update.* New York: Moody's Investor Service, 2004.

cash flows. When looking at seasoned bonds, investors often rely on the reported one-month ABS or the average of one-month speeds as an indicator of life speed to use in pricing a bond. This presents two problems. First, one-month ABS speeds are volatile, and any one speed is not a good indicator of future pool speed. Second, although an average of one-month speeds will smooth out volatility of that data series, the average of one-month speeds over a given period is not mathematically the same as the life speed over that same time. Use of an average speed can underestimate the lifetime speed substantially, and the steeper the yield curve is, the more expensive picking the wrong speed becomes.

- *Benchmark yields.* Once the proper pricing speed has been determined, valuation still can be confused by the selection of the appropriate benchmark yield. By market convention, newly issued bonds with average lives longer than two years price using a yield determined by adding the pricing spread to the interest-rate swap yield matching the average life of the bond (each expected cash flow is discounted by the same yield). In the secondary market the same bond will continue to trade at a spread over swaps until its average life falls below two years. Inside of two years, a bond will trade at a spread above the Eurodollar spot curve (with each cash flow discounted by a unique rate). Depending on the benchmark being used, the spread required to generate a particular yield can vary widely. The challenge for investors trading auto ABS with average lives around two years is to find the right combination of benchmark yields and spreads that justifies the price at which they are willing to trade.
- *Clean-up calls.* As discussed in the section on auto loan ABS structures, clean-up calls can be a source of contention when valuing bonds exposed to the calls. When the yield curve is steep, market participants often debate over whether or not a particular series' clean-up call would be exercised. In the spirit of buying at a low price and selling at a high one, traders and investors would rather buy off of a higher yield-to-maturity and sell off of the lower yield-to-call. The reality is that nearly all issuers historically have exercised clean-up calls regardless of whether the bonds are at a premium or a discount. In the end, the debate usually has less to do with the facts and more to do with one side of the trade trying to negotiate a better price.

CONCLUSION

This chapter's intended purpose was to serve as an introduction to the auto sector of the ABS market. By their nature, securitizations are complex, and as a result, there are details about retail auto loan and lease ABS that, of necessity, have been omitted and which interested readers should explore further. In addition, there are other, less common varieties of auto-related ABS such as floorplan securitizations and fleet-leasing transactions that readers also may be interested in exploring further.

CHAPTER

THIRTY

CASH-COLLATERALIZED DEBT OBLIGATIONS

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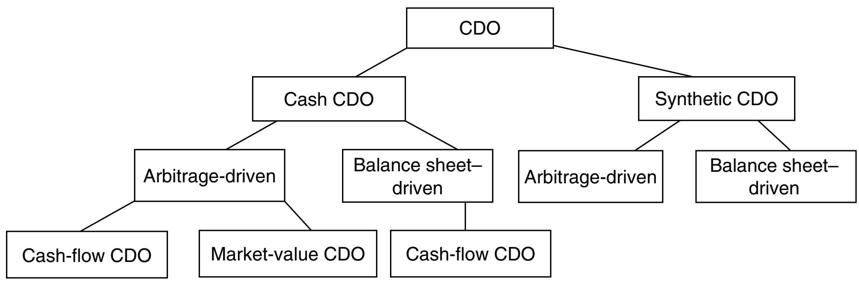
A *collateralized debt obligation* (CDO) is an asset-backed security (ABS) backed by a diversified pool of one or more of the following types of debt obligations: investment-grade and high-yield corporate bonds, emerging market bonds, residential mortgage-backed securities (RMBS), commercial mortgage-backed securities (CMBS), asset-backed securities (ABS), real estate investment trusts (REIT) debt, bank loans, special-situation loans and distressed debt, or other CDOs. When the underlying pool of debt obligations consists of bond-type instruments, a CDO is referred to as a "collateralized bond obligation" (CBO). These CDOs are classified as *corporate bond–backed CDOs*, *emerging market–backed CDOs,* and *structured finance–backed CDOs*. The collateral for the latter includes RMBS, CMBS, ABS, and REIT debt. When the underlying pool of debt obligations is bank loans, a CDO is referred to as a "collateralized loan obligation" (CLO).

In this chapter we explain the basic CDO structure, the types of CDOs, the risks associated with investing in CDOs, and the general principles for creating a portfolio of CDOs. Our focus is on one type of CDO: cash CDOs. Chapter 31 covers another type of CDO: synthetic CDOs.

EXHIBIT 30–1

CDO Family Tree



FAMILY OF CDOs

The CDO family is shown in Exhibit 30–1. While each CDO shown in the exhibit will be discussed in more detail below, we will provide an overview here.

The first distinction in the CDO family is between cash CDOs and synthetic CDOs. A *cash CDO* is backed by a pool of cash-market debt instruments. These were the original types of CDOs issued. A *synthetic CDO* is a CDO where the investor has economic exposure to a pool of debt instruments, but this exposure is realized via credit-derivative instruments rather than the purchase of the cash-market instruments. Synthetic CDOs are discussed in more detail in Chapter 31.

Both a cash CDO and a synthetic CDO are further divided based on the motivation of the sponsor. The motivation is either "balance sheet" or "arbitrage." As explained below, in a *balance sheet CDO,* the motivation of the sponsor is to remove assets from its balance sheet. In an *arbitrage CDO,* the motivations of the sponsor are (1) to gain a fee for managing the CDO's assets and (2) to capture a spread between the return realized on the collateral underlying the CDO and the cost of borrowing funds to purchase that collateral (i.e., the interest rate paid on the CDO's debt).

Cash arbitrage CDOs are further divided into cash-flow and market-value CDOs depending on the credit protection mechanism that ensures repayment of the CDO's debt. In a *cash-flow CDO,* the after-default interest, maturing principal, and default recoveries from the underlying assets provide CDO debt with credit protection. In a *market-value CDO,* the ability of the CDO to realize sufficient proceeds from the sale of its assets to repay its debt provides the CDO debt with credit protection. While balance sheet–motivated CDOs in the 1980s used the market-value credit structure, only cash-flow balance sheet CDOs have been issued since accounting rules changed in the 1990s.

CASH CDOs

In this section we take a closer look at cash CDOs. Before we look at cash-flow and market-value structures, we will look at cash CDOs based on sponsor motivation:

arbitrage and balance sheet transactions. As can be seen in Exhibit 30–1, cash CDOs are categorized according to the motivation of the sponsor of the transaction. In an arbitrage transaction, the motivation of the sponsor is to earn the spread between the yield offered on the debt obligations in the underlying pool and the payments made to the various debt tranches in the structure. In a balance sheet transaction, the motivation of the sponsor is to remove debt instruments (primarily loans) from its balance sheet. Sponsors of balance sheet transactions typically are financial institutions such as banks seeking to reduce their capital requirements by removing loans due to their high risk-based capital requirements. Our focus in this section is on arbitrage transactions because such transactions are the largest part of the cash CDO sector.

Structure of a Cash CDO

In a cash arbitrage CDO, there is an asset manager responsible for managing the portfolio. The manager is referred to as the "CDO manager" or the "collateral manager." There are restrictions imposed (i.e., restrictive covenants) as to what the CDO manager may do and certain tests that must be satisfied for the CDO securities to maintain the credit rating assigned at the time of issuance. We'll discuss some of these requirements later.

The funds to purchase the underlying assets or collateral (i.e., the bonds and loans) are obtained from the issuance of debt obligations. These debt obligations are referred to as "tranches." The tranches are (1) senior tranches, (2) mezzanine tranches, and (3) the subordinate/equity tranche. A rating will be sought for all but the subordinate/equity tranche. Senior tranches typically are rated AAA or AA. Mezzanine tranches typically are rated A through B. Since the subordinate/equity tranche receives the residual cash flow, no rating is sought for this tranche.

The ability of the CDO to make the interest payments to the tranches and pay off the tranches as they mature depends on the performance of the underlying assets. The proceeds to meet the obligations to the CDO tranches (interest and principal repayment) can come from (1) coupon interest payments from the underlying assets, (2) maturing assets in the underlying pool, and (3) sale of assets in the underlying pool.

In a typical structure, most of the debt tranches are floating-rate securities. With the exception of deals backed by bank loans and structured finance securities that pay a floating interest rate, the CDO manager invests in fixed-rate bonds. This creates a mismatch between floating-rate debt and fixed-rate assets. To deal with this problem, rating agencies require that the CDOs use derivative instruments to convert a portion of the fixed-rate payments from the assets into floating-rate cash flow to pay floating-rate tranches. In particular, interest-rate swaps are used. This derivative instrument allows a market participant to swap fixed-rate payments for floating-rate payments or vice versa.

Arbitrage Transactions

The key as to whether it is economically feasible to create an arbitrage CDO is whether a structure can offer a competitive return to the subordinate/equity tranche.

To understand how the subordinate/equity tranche generates cash flows, consider the following basic $100 million CDO structure with the coupon rate to be offered at the time of issuance as follows:

Tranche	Par Value	Coupon Type	Coupon Rate
Senior	$80,000,000	Floating	LIBOR + 70 basis points
Mezzanine	10,000,000	Fixed	Treasury rate + 200 basis points
Subordinate/equity	10,000,000	–	–

Suppose that the collateral consists of bonds that all mature in 10 years, and the coupon rate for every bond is the 10-year Treasury rate plus 400 basis points. The CDO enters into an interest-rate swap agreement with another party with a notional principal of $80 million in which the CDO agrees to do the following:

- Pay a fixed rate each year equal to the 10-year Treasury rate plus 100 basis points
- Receive LIBOR

The interest-rate agreement is simply an agreement to periodically exchange interest payments. The payments are benchmarked off a notional principal. This amount is not exchanged between the two parties. Rather, it is used simply to determine the dollar interest payment of each party. This is all we need to know about an interest-rate swap to understand the economics of an arbitrage CDO transaction. Keep in mind that the goal is to show how the subordinate/equity tranche can be expected to generate a return.

Let's assume that the 10-year Treasury rate at the time the CDO is issued is 7%. Now we can walk through the cash flows for each year. Look first at the collateral. The collateral will pay interest each year (assuming no defaults) equal to the 10-year Treasury rate of 7% plus 400 basis points. So the interest will be

Interest from collateral: $11\% \times \$100{,}000{,}000 = \$11{,}000{,}000$

Now let's determine the interest that must be paid to the senior and mezzanine tranches. For the senior tranche, the interest payment will be:

Interest to senior tranche: $\$80{,}000{,}000 \times (\text{LIBOR} + 70 \text{ basis points})$

The coupon rate for the mezzanine tranche is 7% plus 200 basis points. Thus the coupon rate is 9%, and the interest is:

Interest to mezzanine tranche: $9\% \times \$10{,}000{,}000 = \$900{,}000$

Finally, let's look at the interest-rate swap. In this agreement, the CDO manager is agreeing to pay some third party (the "swap counterparty") 7% each year (the 10-year Treasury rate) plus 100 basis points, or 8%. But 8% of what? As explained earlier, in an interest-rate swap, payments are based on a notional principal. In our illustration, the notional principal is $80 million. The CDO manager selected the $80 million because this is the amount of principal for the senior tranche. Thus the CDO manager pays to the swap counterparty:

Interest to swap counterparty: $8\% \times \$80{,}000{,}000 = \$6{,}400{,}000$

The interest payment received from the swap counterparty is LIBOR based on a notional amount of $80 million. That is,

Interest from swap counterparty: $\$80{,}000{,}000 \times \text{LIBOR}$

Now we can put this all together. Let's look at the interest coming into the CDO:

Interest from collateral	= $11,000,000
Interest from swap counterparty	= $80,000,000 × LIBOR
Total interest received	= $11,000,000 + $80,000,000 × LIBOR

The interest to be paid out to the senior and mezzanine tranches and to the swap counterparty are

Interest to senior tranche	= $80,000,000 × (LIBOR + 70 basis points)
Interest to mezzanine tranche	= $900,000
Interest to swap counterparty	= $6,400,000
Total interest paid	= $7,300,000 + $80,000,000 × (LIBOR + 70 basis points)

Netting the interest payments coming in and going out, we have

Total interest received	= $11,000,000 + $80,000,000 × LIBOR
–Total interest paid	= $7,300,000 + $80,000,000 × (LIBOR + 70 basis points)
Net interest	= $3,700,000 – $80,000,000 × (70 basis points)

Since 70 basis points times $80 million is $560,000, the net interest remaining is $3,140,000 (= $3,700,000 – $560,000). From this amount, any fees (including the asset management fee) must be paid. The balance is then the amount available to pay the subordinate/equity tranche. Suppose that these fees are $614,000. Then the cash flow available to the subordinate/equity tranche is $2.5 million. Since the tranche has a par value of $10 million and is assumed to be sold at par, this means that the potential return is 25%.

Obviously, some simplifying assumptions have been made. For example, it is assumed that there are no defaults. It is assumed that all the issues purchased by the CDO manager are noncallable (or not prepayable), and therefore, the coupon rate would not decline because issues are called. Moreover, as explained later, after some period the CDO must begin repaying principal to the senior and mezzanine tranches. Consequently, the interest-rate swap must be structured to take this into account because the entire amount of the senior tranche is not outstanding for the life of the collateral. Despite these simplifying assumptions, the illustration does demonstrate the basic economics of the CDO, the need for the use of an interest-rate swap, and how the subordinate/equity tranche will realize a return.

CASH-FLOW TRANSACTIONS

In a cash-flow transaction, the objective of the CDO manager is to generate cash flow for the senior and mezzanine tranches without necessarily actively trading the CDO's portfolio. To maintain the credit quality of the CDO's portfolio, trading restrictions are imposed, and the CDO manager is not free to buy and sell bonds. The conditions for disposing of assets are specified and usually are driven by credit-risk considerations. Also, in assembling the portfolio, the CDO manager must meet certain requirements set forth by the agencies that rate the transaction.

There are three relevant periods in the life of a CDO. The first is the ramp-up period. This period usually begins two to six months before the closing date of the transaction and usually ends fewer than six months afterwards when the CDO manager purchases the CDO's initial portfolio. The reinvestment or revolving period is when principal proceeds are reinvested in new collateral assets and usually is 5 to 7 years long. In the final period, the portfolio assets mature or are sold, and the debtholders are paid off as described as follows.

Distribution of Income

Income is derived from interest income and capital appreciation on underlying assets. The income is then used as follows: Payments are first made to the trustee and administrators and then to the CDO manager's senior fee. Once these fees are paid, the senior tranches are paid their interest. At this point, before any other payments are made, certain tests must be passed. These tests are called *coverage tests* and are discussed later. If the coverage tests are passed, then interest is paid to the mezzanine tranches. Once the mezzanine tranches are paid, another set of coverage tests is conducted. If these coverage tests are passed, interest is paid to the subordinate/equity tranche.

In contrast, if either senior or mezzanine coverage tests are failed, then, depending on the CDO's structure and how severely the tests were failed, available income is used either to pay down senior tranche principal or purchase more collateral assets. If the senior tranches are paid off fully but mezzanine coverage tests are failed, then any remaining income after paying interest to the mezzanine tranche is used to redeem the mezzanine tranches. Only after senior debt and mezzanine debt are paid interest and any principal due to the failure of coverage test does any remaining CDO income flow to the subordinate/equity tranche.

Distribution of Principal Cash Flow

Principal cash flow from CDO assets is distributed as follows after the payment of the fees to the trustees, administrators, and senior managers: If there is a shortfall in interest paid to the senior tranches, principal proceeds are used to make up the shortfall. Assuming that the coverage tests are satisfied, during the reinvestment period, principal is reinvested. After the reinvestment period or if the coverage tests are failed, principal cash flow is used to pay down the senior tranches until the coverage tests are satisfied. If all the senior tranches are paid down, then the mezzanine tranches are paid off, and then the subordinate/equity tranche is paid off.

After all the debt obligations are satisfied in full, the subordinate/equity investors are paid. Typically, there are also incentive fees paid to management based on performance. Usually, a target return for the subordinate/equity investors is established at the inception of the transaction. Management is then permitted to share on some pro-rata basis once the target return is achieved.

Restrictions on Management: Coverage Tests

The CDO manager must monitor the collateral to ensure that certain tests are being met. There are two types of tests imposed by rating agencies: coverage tests and quality tests.

Coverage tests are used to ensure that the performance of the collateral is sufficient to make payments to the various tranches. There are two types of coverage tests: *overcollateralization tests* and *interest coverage tests*. Recall that if either of these coverage tests is violated, then income from the collateral is diverted to pay down the senior tranches.

Overcollateralization Tests

The overcollateralization (O/C) ratio for a tranche is found by computing the ratio of the principal balance of the collateral portfolio over the principal balance of that tranche and all tranches senior to it. That is,

$$\text{O/C ratio for a tranche} = \frac{\text{principal (par) value of collateral portfolio}}{\text{principal for tranche} + \text{principal for all tranches senior to it}}$$

The higher the ratio, the greater protection there is for the note holders. Note that the O/C ratio is based on the principal or par value of the assets.[1]

1. For market-value CDOs, overcollateralization tests are based on market values rather than principal or par values.

(Hence an overcollateralization test is also called a *par value test.*) An O/C ratio is computed for specified tranches subject to the overcollateralization test. The overcollateralization test for a tranche involves comparing the tranche's O/C ratio with the tranche's required minimum ratio as specified in the guidelines. The required minimum ratio is called the *overcollateralization trigger.* The overcollateralization test for a tranche is passed if the O/C ratio is greater than or equal to its respective overcollateralization trigger.

For example, suppose that a cash-flow CDO has two rated tranches that are subject to the overcollateralization test—classes A and B. Therefore, two overcollateralization ratios are computed for this deal. For each tranche, the overcollateralization test involves first computing the O/C ratio as follows:

$$\text{O/C ratio for class A} = \frac{\text{principal (par) value of collateral portfolio}}{\text{principal for class A}}$$

$$\text{O/C ratio for class B} = \frac{\text{principal (par) value of collateral portfolio}}{\text{principal for class A} + \text{principal for class B}}$$

Once the O/C ratio for a tranche is computed, it is then compared with the overcollateralization trigger for the tranche as specified in the guidelines. If the computed O/C ratio is greater than or equal to the overcollateralization trigger for the tranche, then the test is passed with respect to that tranche.

Suppose that the overcollateralization trigger is 113% for class A and 101% for class B. Note that the lower is the seniority, the lower is the overcollateralization trigger. The class A overcollateralization test is failed if the ratio falls below 113%, and the class B overcollateralization test is failed if the ratio falls below 101%.

Interest Coverage Tests

The interest coverage (I/C) ratio for a tranche is the ratio of scheduled interest due on the underlying collateral portfolio to scheduled interest to be paid to that tranche and all tranches senior to it. That is,

$$\text{I/C ratio for a tranche} = \frac{\begin{array}{c}\text{scheduled interest due on underlying}\\ \text{collateral portfolio}\end{array}}{\begin{array}{c}\text{scheduled interest}\\ \text{on that tranche}\end{array} + \begin{array}{c}\text{scheduled interest}\\ \text{on all tranches senior}\end{array}}$$

The higher the I/C ratio, the greater is the protection. An I/C ratio is computed for specified tranches subject to the interest coverage test. The interest coverage test for a tranche involves comparing the tranche's I/C ratio with the tranche's interest coverage trigger (i.e., the required minimum ratio as specified in the guidelines). The interest coverage test for a tranche is passed if the computed I/C ratio is greater than or equal to its respective interest coverage trigger.

Consider once again our hypothetical cash-flow CDO where classes A and B are subject to the interest coverage test. The following two I/C ratios therefore are computed:

$$\text{I/C ratio for class A} = \frac{\text{scheduled interest due on underlying collateral portfolio}}{\text{scheduled interest on class A}}$$

$$\text{I/C ratio for class B} = \frac{\text{scheduled interest due on underlying collateral portfolio}}{\text{scheduled interest on class A} + \text{scheduled interest on class B}}$$

Restrictions on Management: Quality Tests

In rating a transaction, the rating agencies are concerned with the credit quality, diversity, and other attributes of the assets. Consequently, a CDO has certain *quality tests*. A CDO manager may not undertake a trade that will result in the violation of any of the quality tests. Quality tests include a (1) minimum collateral diversification score, (2) minimum weighted-average rating. (3) maximum maturity, and (4) minimum weighted-average coupon and weighted-average spread.

A collateral diversification score is used to gauge the diversity of the collateral's assets. All the rating agencies have diversity scores. The greater the score value, the more diverse is the CDO portfolio across industries. Every time the composition of the collateral changes, a diversity measure is computed. The most well-known diversity score is the one developed by Moody's. This rating agency's methodology reduces the number of correlated assets in the CDO's portfolio to a smaller number of uncorrelated assets. For example, for CDOs backed by corporate bonds, a diversity score is calculated by dividing the bonds into different industry classifications. Each industry group is assumed to have a zero correlation with other industry groups. Two securities from different issuers within the same industry group are assumed to have some correlation with each other. At the extreme, two securities from the same issuer are treated as having 100% correlation and hence providing zero diversification.

Reducing the portfolio to the number of independent securities allows the use of a binomial probability distribution. This is the distribution that allows one to figure out the probability of obtaining 9 "heads" in 10 flips of the coin. This distribution also can be applied to a weighted coin, where the probability of "heads" is substantially different from the probability of "tails." Intuitively, each asset is a separate flip of the coin, and the outcomes ("heads" and "tails") correspond to "no default" and "default." The use of this probability distribution makes it possible to define the likelihood of a given number of securities in the portfolio defaulting over the life of a deal.

In order for a corporate debt–backed CDO to merit a high diversity score (which is usually necessary for the economics of the deal to work), most industry groups must be represented in the CDO portfolio. A CDO usually will include at least 20 to 25 (out of 33 possible) different industry groups. Furthermore, most CDOs contain a general guideline that no industry group can represent more than 8% of outstandings. However, there is often an exemption for the two or three largest industry groups, where maximum concentrations as high as 10% to 12% are permitted. As a practical matter, given diversity requirements and rating constraints, it is unlikely that the top three industries will jointly comprise more than 22% of a CDO portfolio.

A measure is also needed to gauge the credit quality of the collateral. Certainly one can describe the distribution of the credit ratings of the collateral in terms of the percentage of the collateral's asset in each credit rating. However, such a measure would be awkward in establishing tests for a minimum credit rating for the collateral. There is a need to have one figure that summarizes the rating distribution test. Moody's and Fitch have developed a measure to summarize the rating distribution. This is commonly called the *weighted-average rating factor* (WARF) for the collateral. This involves assigning a numerical value to each rating. These numerical values are called *rating factors*. The CDO manager must maintain a minimum average rating score. Unlike Moody's and Fitch, S&P uses a different system. S&P specifies required rating percentages that the collateral must maintain. Specifically, S&P requires strict percentage limits for lower-rated assets in the collateral portfolio.

MARKET-VALUE TRANSACTIONS

Cash-flow transactions depend on the ability of the collateral to generate sufficient current cash flow to pay interest and principal on the rated tranches issued by the CDO. The ratings are based on the effect of collateral defaults and recoveries on the receipt of timely interest and principal payments from the collateral. The CDO manager focuses on controlling defaults and recoveries. Overcollateralization, in terms of par value of the collateral's assets, provides important structural protection for bondholders. If par-value (overcollateralization) tests are not met, then cash flow is diverted from the mezzanine and subordinated tranches to pay down senior notes, or reinvested in additional assets. There are no forced collateral liquidations.

In contrast, market-value transactions depend on the ability of the CDO manager to maintain and improve the market value of the collateral. Funds to be used for liability principal payments are obtained from liquidating the collateral. Liability interest payments can be made from collateral interest receipts, as well as collateral liquidation proceeds. Ratings are based on collateral price volatility, liquidity, and market value. The CDO manager focuses on maximizing total return while minimizing market-value volatility.

Overcollateralization tests are conducted regularly. However, in market value transactions, the overcollateralization tests are based on the market value of the collateral portfolio, not the par value. Market-value overcollateralization tests require that the market value of assets multiplied by "advance rates" (discussed later) must be greater than or equal to debt outstanding. If this is not the case, collateral sales and liability redemptions are required to bring O/C ratios back into compliance. As with cash-flow transactions, market-value transactions do have diversity, concentration, and other portfolio constraints, albeit fewer than cash-flow transactions. Exhibit 30–2 summarizes the salient features of cash-flow versus market-value transactions.

Why are market-value structures used? While market-value deals are a distinct minority of CBOs, they are the structure of choice for certain types of collateral (such as distressed debt), where the cash flows are not predictable with a reasonable degree of certainty. It is very difficult to use unpredictable cash flows within the confines of a cash-flow structure. Moreover, market-value structures also may appeal to CDO managers and equity buyers who like the greater trading flexibility inherent in these deals. Finally, market-value transactions also facilitate the purchase of assets that mature beyond the life of the transaction because the price volatility associated with the forced sale of these assets is explicitly considered.

Let's illustrate the structure with the hypothetical transaction shown in Exhibit 30–3. The first column of the exhibit shows the capital structure of the transaction. The capital structure includes a senior facility, senior notes, senior-mezzanine notes, subordinate-mezzanine notes, and subordinate/equity. The senior facility is a floating-rate revolving loan. The second column shows the capital structure at the closing date.

During the ramp-up period, the CDO manager obtains additional funding based on the target leverage. The additional leverage is provided from the senior borrowing facility and senior notes. Additional equity is also injected. The last column shows the capital structure when the transaction is fully ramped up.

The order of priority of the principal payments in the capital structure is as follows: Fees are paid first for trustees, administrators, and managers. After these fees are paid, the senior facility and the senior notes are paid. The two classes in the capital structure are treated *pari passu* (i.e., equal in their rights to their claim on cash proceeds from the underlying assets). That is, their payments are pro rated if there is a shortfall. If the senior facility or senior notes are amortizing, they would have the next priority on the cash proceeds from the underlying assets with respect to payment of the principal due. The senior-subordinated notes would be paid, followed by the subordinated notes. All this assumes that the market-value overcollateralization tests are satisfied. If not, the senior notes are then paid down until the overcollateralization tests are brought into compliance.

The Rating Process for Market-Value Transactions

The credit enhancement for a market-value deal is the cushion between the current market value of the collateral and the face value of the structure's obligations. Within this framework, the collateral normally must be liquidated (either in whole or in part)

EXHIBIT 30–2

Overview of Cash-Flow versus Market-Value Transactions

	Cash-Flow Deal	Market-Value Deal
Objective	Cash-flow deals depend on the ability of the collateral to generate sufficient current cash to pay interest and principal on rated notes issued by the CBO/CLO.	Market-value transactions depend on the ability of the CDO to sell assets and redeem its rated debt.
Rating focus	The ratings are based on the effect of collateral defaults and recoveries on the timely payment of interest and principal.	Ratings are based on collateral price volatility, liquidity, and market value.
Manager focus	Manager focuses on controlling defaults and recoveries.	Manager focuses on maximizing total return while minimizing market value volatility.
Structural protection	Overcollateralization is measured on the basis of the portfolio's par value. If overcollateralization tests are failed, then cash flow is diverted from the mezzanine and subordinated classes to pay down senior notes, or cash flow is reinvested in additional assets. There are no forced collateral liquidations.	Market-value overcollateralization tests are conducted regularly. The market value of assets multiplied by the advance rates* must be greater than or equal to the debt outstanding: otherwise collateral sales and liability redemptions may be required to bring overcollateralization ratios back into compliance.
Diversity and concentration limits	Very strict.	Substantial diversification is required. More is "encouraged" by the structure of advance rates.
Trading limitations	There are limitations on portfolio trading.	There is greater portfolio trading flexibility.
Collateral	Typical cash-flow assets include bank loans, ABS, high-yield bonds, emerging market bonds/loans, and project finance.	Typical market-value assets include assets eligible for inclusion in cash-flow CBOs/CLOs as well as distressed debt, equities, and convertibles.

*Advance rate: percentage of the market value of a particular asset that may be issued as rated debt. Advance rates depend upon the price volatility and quality of price/return data and the liquidity of the assets. Assets with lower price volatility and greater liquidity are typically assigned higher advance rates.

EXHIBIT 30–3

Hypothetical Market-Value Transaction ($millions)

Capital Structure	At Closing Date		Fully Ramped Up	
Senior facility	$ 0	0%	$364	45%
Senior note	40	24%	160	20%
Senior-mezzanine notes	80	48%	80	10%
Subordinated-mezzanine notes	40	24%	40	5%
Subordinate/equity	8	5%	160	20%

if the ratio of the market value of the collateral to the debt obligations falls below a predetermined threshold. The liquidated collateral is used to pay down debt obligations, which brings the structure back into overcollateralization compliance.

The biggest risk in a market-value transaction is a sudden decline in the value of the collateral pool. Thus the rating agencies focus on the price volatility and liquidity of the assets that may be incorporated into these structures. Price volatility and market liquidity are reflected in the advance rates that are designed to provide a cushion against market risk and represent adjustments to the value of each asset.

A market-value deal simply requires that the market value of the collateral times the advance rate (the adjustment to the value of the assets to provide a cushion against market risk) be greater than the par value of the liabilities. Moody's and Fitch, the rating agencies that have rated the majority of market-value deals thus far, both use a set of advance rates to determine how much rated debt can be issued against the market value of an asset.

To get a handle on what this all means, Exhibit 30–4 shows Moody's advance rates in the simplest case of a two-tranche structure, one consisting of a senior debt tranche and a subordinated/equity tranche. In producing the advance rates shown in Exhibit 30–4, Moody's assumed the following portfolio diversification:

1. Maximum allowable investment in one issuer = 5%
2. Maximum allowable investment in any one industry = 20%
3. Maximum allowable investment in any one asset type = 100%

Thus the least diversified portfolio possible consists of 20 issuers, five industries, and one asset type.

If assets consist of performing high-yield bonds rated B, and the CDO liability structure is carved only into a bond rated A2 and equity, then (from Exhibit 30–4) Moody's advance rate would be 0.79. Thus the market value of the deal times the advance rate (0.79 in this case) must be greater than the par value of the bonds. If the

EXHIBIT 30–4

Advance Rates for Different Asset Types and Rating Levels (20 Issuers, 5 Industries, 100% Investment in One Asset Type, 5-Year Maturity)

Asset Type	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3
Performing bank loans valued at $0.90 and above	0.870	0.890	0.895	0.900	0.905	0.910	0.915	0.930	0.935	9.400
Distressed bank loans valued at $0.85 and above	0.760	0.780	0.790	0.795	0.810	0.815	0.820	0.830	0.840	8.700
Performing high-yield bonds rated Baa	0.76	0.79	0.80	0.81	0.83	0.84	0.85	0.87	0.88	0.90
Performing high-yield bonds rated B	0.72	0.75	0.76	0.77	0.78	0.79	0.80	0.82	0.83	0.85
Distressed bank loans valued below $0.85	0.58	0.62	0.63	0.64	0.67	0.68	0.69	0.71	0.72	0.74
Performing high-yield bonds rated below Caa	0.45	0.49	0.50	0.51	0.56	0.58	0.60	0.62	0.64	0.67
Distressed bonds	0.35	0.39	0.40	0.41	0.47	0.48	0.50	0.54	0.56	0.57
Reorganized equities	0.31	0.37	0.38	0.39	0.44	0.46	0.47	0.51	0.52	0.54

Source: Moody's Investors Service, "Moody's Approach to Rating Market-Valued CDOs," (April 13, 1998), New York.

CDO's debt consisted of equal parts of bonds rated A2 and those rated Baa2, each debt tranche would have to pass its own market-value overcollatization test (using a 0.79 advance rate for the A2 debt tranche and a 0.83 advance rate for the Baa2 tranche because there is no weighted-average overcollateralization test). Note that if there were greater diversification within this deal, then the advance rates would be somewhat higher.

In addition to the protection provided by advance rates, Fitch also requires a quarterly minimum-net-worth test to protect the rated debt. This requires that 60% of the original equity remains to protect the senior tranche and 30% to protect the subordinated tranche. If the equity falls below these levels, noteholders of the senior tranche may vote to accelerate payment of the debt, at which point the CDO manager must liquidate assets and fully pay down the debt related to the test that has failed.

Advance rates are the crucial variable in market-value deals. Advance rates determined by the rating agencies are actually a combination of three factors—price volatility of the securities, correlation among securities, and liquidity.

Many CDO investors have tended to steer away from market-value CDOs, believing that purchasing the debt is like making an investment in a hedge fund. As a result, market-value deals trade at similar or slightly wider spreads than cash-flow deals launched at the same time. However, the protections built into market-value deals are quite powerful from the bondholder's point of view, and this paper eventually will trade tighter than paper from cash-flow deals with the same rating issued at the same time. Investors should regard the rated bonds in market-value deals (offered at similar or slightly wider spreads than equivalently rated bonds in cash-flow deals) as a buying opportunity.

SYNTHETIC CDOs

A *synthetic CDO* is so named because the CDO does not actually own the pool of assets on which it has the risk. Stated differently, a synthetic CDO absorbs the economic risks but not the legal ownership of its reference credit exposures. Synthetic CDO structures are now used widely in both arbitrage and balance sheet transactions.

The building block for synthetic CDOs is a credit default swap, which allows counterparties to transfer the credit risk but not the legal ownership of underlying assets. A credit default swap is conceptually similar to an insurance policy. A protection buyer purchases protection against default risk on a reference pool of assets. Those assets can consist of any combination of loans, bonds, derivatives, or receivables. The protection buyer pays a periodic fee (like an insurance premium) and receives, in return, payment from the protection seller in the event of a "credit event" affecting any item in the reference pool. In the event a credit event occurs, there is an intent that the protection buyer be made whole. The protection buyer should be paid the difference between par and the "fair value" of the securities.

A synthetic CDO sells credit protection to a counterparty or counterparties (usually the sponsoring bank but sometimes a variety of counterparties). The CDO then turns around and buys credit protection from its investors so that it stands between one or more protection buyers and one or more protection sellers. The unique twist to a synthetic CDO is that it generally buys credit protection from its investors in tranched form. That is, just as in a cash CDO, the synthetic CDO's subordinate/equity investors are responsible for initial losses on the CDO's entire synthetic portfolio. If the credit protection obligation of the subordinate/equity investors is exhausted, further losses become the responsibility of mezzanine debt investors, and so forth.

Credit events on a debt instrument generally include bankruptcy or failure to pay when due, cross-default/cross-acceleration, repudiation, and restructuring. The bottom line is that the CDO receives a periodic fee from a protection buyer(s) (for accepting the credit risks on the reference pool) and pays a fee to its investors. In the event that a defined "credit event" occurs on those reference assets, the CDO receives a payment from its investors and makes a payment to the counterparties that have bought credit protection from the CDO.

What is the motivation for the creation of synthetic CDOs? By buying credit protections from a synthetic CDO, financial institutions can shed the economic risk of assets without having to notify any borrowers or, worse, seek borrowers' consent to put their loans into "other hands." In traditional balance sheet collateralized loan obligations (CLOs), transfer of a loan to any special-purpose vehicle (SPV) requires at least customer notification and often customer consent. Thus synthetic CDOs were set up initially to accommodate European bank balance sheet deals because it is considered particularly bad form and poor customer relationship management on that continent to sell customer loans.

From an investor's perspective, the concern with synthetic CDOs has been the downgrading of some of the earlier deals. The downgrading reflected the concerns of the rating agencies with respect to the composition of reference pools. Current deals build in substantially better investor protection than was the case in early synthetic CDOs. This improved protection centers on two basic areas: narrowing the definition of credit events in the credit default swap and improving pool disclosure.

SECONDARY MARKET TRADING OPPORTUNITIES

With the steady increase in the volume of CDOs outstanding, the evolution of a secondary market was inevitable. In 2003, $15 billion of CDO bid lists sparked investor interest in the secondary market for corporate-backed CDOs. In bid lists, a holder of CDOs circulates the names of the CDOs it is offering for sale. Bidders are given a period of time to respond, typically one to three weeks. A major problem with the bid-list process is convincing potential investors to do the significant amount of work necessary to arrive at a bid. A potential investor has no assurance that its bid will reach the seller's reserve price for the CDO or that it will not be outbid by a rival purchaser. Yet, enough buyers responded to bid lists in early 2003 to drive secondary spreads narrower.

Dealers responded to the increase in secondary CDO activity by committing traders and balance sheet to the product. This increased liquidity in the secondary market and further tightened spreads. Another contributing factor to secondary CDO market growth was greater use of the INTEX CDO modeling service. INTEX has continuously expanded its CDO coverage and is good about fixing cash-flow modeling problems as they are discovered. More bankers and managers have opened up their CDOs to users of the modeling system, and more investors are now using the system.

By the end of 2003, well-performing first- and second-priority CDOs were trading at spreads similar to those of new-issue CDOs. In fact, seasoned secondary CDOs traded *through* new issues on the reasonable theory that their short remaining life pushed them down the credit curve.

In 2004, many secondary CDO investors decided that they were comfortable enough with the outlook for corporate credit to reach for yield by moving down the CDO capital structure, especially on well-structured CDOs. Mezzanine and subordinate tranches of corporate-backed CDOs became the focus of those seeking a pickup over new-issue spreads. Bid lists consisting of mostly distressed subordinate bonds traded at prices significantly higher than 2003, and the secondary market for corporate-backed paper truly became a seller's market with many more potential buyers than potential sellers.

Synthetic Secondary

Perhaps not as well advertised is the boom in synthetic CDO secondary trading. As corporate spreads tightened in 2003 and the new-issue synthetic CDO market died, par bids were made for mezzanine tranches of acceptable synthetic CDOs, and investors could get out of positions without recording a loss. For investors and dealers, trading synthetic CDOs is much easier than trading cash-collateral CDOs.

The vast majority of synthetic CDOs are manager-less, have static portfolios, and do not have complicated cash-flow redirection mechanisms involving overcollateralization or interest coverage triggers. An investor or dealer does not have to psychoanalyze the motivations of a manager, try to get an updated trustee report, figure out a series of interest-rate swaps and caps, or perform cash-flow modeling. Instead, prices on the single-name credit default swaps that make up the synthetic CDO portfolio usually are readily available. Implied default correlations are also readily available from the tranches of the Dow Jones CDX and IBoxx credit default swap indexes. Dealers also believe they can "delta hedge" positions on their books by buying credit protection via single-name credit default swaps in varying amounts. A minor complication does exist in that some old synthetic CDOs include full, unmodified, restructuring as a credit event.

A lot of secondary trading went on in 2004 in synthetic CDOs, much of it with dealers other than the CDO's original banker. This activity took place over the CDO's entire capital structure from equity through supersenior tranches.

Structured Finance–Backed Secondary

Structured finance–backed CDOs (SF CDOs backed by CMBS, REIT debt, RMBS, and ABS) largely were left out of the 2003 secondary CDO boom. The idiosyncratic nature of structured credit makes credit evaluation and pricing more difficult than it is in either cash or synthetic corporate-backed CDOs. But the lack of liquidity in the secondary SF CDO market changed in 2004. As the easy pickings of high-rated corporate-backed CDOs diminished, many investors focused on SF CDOs. The secondary SF CDO market seemed poised in 2004 to experience what the corporate-backed secondary market experienced in 2003. Only this time the dealer market is better prepared to handle the flow, with traders and balance sheet capacity already in place.

The acquisition of CDOs in the secondary market still offers opportunities for diligent investors to acquire CDOs at very attractive spreads to primary issues, taking advantage of a significant liquidity premium and, on occasion, strong seller motivation. Furthermore, the secondary market has an information advantage over the primary market: the contents of the underlying portfolio are known, and performance history is available.

Secondary supply has grown as the CDO market has matured. Natural sources of supply include investors selling to realize gains, make portfolio adjustments, or change allocations among security types. Moreover, secondary supply continues to trickle out of mergers and acquisitions among institutional investors.

It is important to realize that a large amount of the secondary paper that is available is from deals that are performing poorly or where the tranches are on watch for downgrade. Tranches with an insurance company wrap or tranches that have been performing very well are underrepresented in secondary offerings. This is so because a good part of the selling is "semiforced selling" owing to institutional practices or manager preferences. Some portfolio managers continue to carry their CDOs at original cost, even though the performance of the deals was worse than expected. When it is clear that the cash flows on the deal will fall short of expectations, portfolio managers must begin to write the paper down. Many choose to sell at this point, taking the write-down once and for all. Other portfolio managers do not want to explain to their management that a CDO tranche they have purchased has been downgraded. They would rather quietly take the loss while the deal is on watch. Finally, when there is a merger and a new portfolio manager is in charge, the portfolio manager often will sell poorly performing tranches, rather than hold the paper and have the paper he did not select experience downgrades while on her watch.

Prices in the CDO secondary market reflect the fact that many of the tranches are not pristine. As a result, secondary market spreads are often more attractive than in the primary market paper with the same rating or even with a rating a notch lower. For example, a CDO tranche that is on watch for downgrade usually will trade if it has already been downgraded. In some cases, it will behave as if it has already been downgraded by several notches. This "inefficiency" occurs because there are more sellers than buyers of less pristine bonds. One logical thought: If the CDO manager has excellent information about a deal, why doesn't the manager buy the secondary tranches? The answer is that the CDO manager (1) generally already will have a considerable amount of exposure to the deal and (2) may not run funds where the cheap secondary bond will fit.

Due Diligence Is Easier in the Secondary Market

Let's focus on the information advantage for investors. They are in a better position buying a CDO in the secondary than in the new-issue market because instead of assumed portfolio parameters and guidelines, investors have access to the actual collateral. Given the current holdings, investors can form a much more detailed picture of the manager's performance to date, as well as the portfolio's projected performance under different economic, interest-rate, and credit scenarios than if they bought an otherwise comparable CDO at issue.

When evaluating a secondary CDO, investors' fundamental tools are the offering memo and the most recent trustee's report. The offering memo will detail the structure, investment guidelines, trading requirements and restrictions, and other terms of the original issue. The trustee's report lists portfolio holdings, highlights rating actions on holdings, and provides current average rating, overcollateralization, and interest coverage ratios, as well as the deal's standing in relation to its covenants.

The rating agencies can be sources of additional published information about transactions. The agency surveillance analysts provide considerable insight into the CDO's structure. CDO managers also are excellent sources of information about the portfolio holdings, their anticipated strategies, and other issues relevant to projecting collateral performance and generally prove to be willing to talk to investors.

Indeed, in this regard, investors contemplating secondary CDO trades who are willing to do some digging are at a distinct advantage over dealers because both rating agency analysts and CDO managers tend to be far more forthcoming with investors than with Wall Street traders (as reflects their direct fiduciary responsibility to investors). Questions and answers that might never find their way into print are far more likely to be addressed in phone conversations with these "hands on" sources.

Moreover, with respect to the manager track record, the uncertainty regarding manager performance that exists for buyers of new CDO transactions is largely absent in a secondary market trade. Instead, investors have real evidence in the form of the actual holdings.

Trade-Offs Granted to the CDO Manager

Investors evaluating secondary CDO purchases should bear in mind that the overcollateralization and interest-rate coverage ratios, as well as the WARF and other parameters established for a deal, should be considered together rather than separately. That is, CDO managers can choose to allow one parameter to weaken in order to stabilize another during difficult economic/credit environments. For instance, CDO managers can bolster par value by selling assets priced close to par and replacing them with bonds priced at a discount.

CDO managers holding equity positions in a deal may have an added incentive to do this in order to keep cash flowing to the equity. Trade-offs also can be made between the average rating and triple-C concentration, on the one hand, and overcollateralization levels, on the other. For example, rather than sell an asset at a loss, lowering the par value, the CDO manager might choose to hold it as it tumbles down the credit ladder. The point is that investors looking at the whole picture have a better gauge of the CDO's relative value and are in a better position to discern where CDO managers have made trade-offs in the past and how they may act in the future.

Call/Prepayment Upside

The possibility of early repayment is a further enticement to many secondary CDO trades. The possibility of early repayment typically arises from three sources:

- The average-life convention that the market follows to price CDOs
- Early retirement of senior bonds in the event a coverage test fails
- The possibility of optional redemption of a transaction by the equity holders.

To the extent that CDOs are purchased at a discount, repayment earlier than anticipated at pricing can enhance return significantly.

In order to price a CDO bond class in the secondary market, traders normally take the initial weighted-average life of the bond as reported on Bloomberg (deal details are usually provided by the underwriter) and subtract from that number the amount of time that has elapsed since the transaction's closing date. It is important to note that the initial average life established for a bond class on Bloomberg generally is derived from assumptions that extend the bond to its maximum average life. That is, the underwriter typically assumes that the average life of the assets at closing is at the maximum allowed average life mandated for the transaction (negotiated by the manager and underwriter along with other structural details and incorporated in the indenture and set forth in the offering circular). In turn, the average life of the assets implies a principal repayment schedule and average lives for the bond classes by rating priority.

The divergence between convention and fact creates opportunities for investors. In practice, the average life of the actual assets used as collateral is often much shorter than the mandated maximum average life. This means that the actual average life of the CDO bond class can be much shorter than the average life Bloomberg would imply. This "hidden" foreshortening is realized in a higher yield-to-maturity than anticipated in the price paid and is pure gravy for the buyer.

Failure of a coverage test also can shorten the average life of CDOs. (Again, if failed, interest is diverted to pay down senior-most bond classes until the test is cured.

Such an event is not assumed when tranche average lives are determined.) For investors buying at a discount, this event would provide a yield pickup as well.

Finally, most transactions are structured so that they can be called at the option of a majority of equity holders after a defined period of time has elapsed (three to five years is common). At present, a large number of CDOs issued to date have now been outstanding for two or three years, placing them much closer to their call dates. With access to the actual holdings, a prospective buyer should be able to mark the collateral to market and evaluate directly the likelihood that the deal could be called.

INVESTMENT PRINCIPLES FOR MANAGING A PORTFOLIO OF CDOs

Portfolio managers accumulate positions in a number of CDOs. (In this discussion we refer to a "portfolio manager" as the manager of a portfolio of CDOs and a "CDO manager" as the manager of assets held by a particular CDO.) Some even have quite an extensive collection, with positions in more than 100 different CDO deals. Yet most portfolio managers tend to look at buying each additional CDO as if they were buying their first. In doing that, they spend a disproportionate amount of time trying to evaluate the CDO manager and often end up trying to differentiate on the basis of track record.

Although one should look at individual CDO managers, it is crucial to look at the incentive structure in a CDO. Performance of existing CDOs provides much more information than do general track records of CDO managers. Moreover, it is of utmost import for the portfolio manager to manage a portfolio of CDOs within general portfolio framework and parameters.

The key to diversification in CDOs comes from holding different types of collateral. A CDO with a low diversity score actually may increase the diversity of a portfolio depending on its contents. Style (or asset class) is the most important factor in explaining investment returns. Here are four general rules for CDO portfolio management:

Rule 1. In picking CDO managers, track records cannot be taken at face value. Common sense goes a long way.

Rule 2. Look at the incentive structure for a CDO manager. If possible, see how strong an impact that has had on outstanding deals.

Rule 3. Collect CDOs backed by different types of collateral. Asset class is a far more important determinant of returns than is choice of specific CDO managers. Buy a certain type of CDO when you believe the underlying collateral is cheap.

Rule 4. Look at diversity on a portfolio basis. Buying a number of CDOs backed by different types of collateral creates your own diversification. Thus do not necessarily avoid CDOs with low diversity scores.

We discuss the reasoning behind each of these rules next.

Rule 1: Track Records

When marketing a CDO deal, the first words spoken to the investor are often, "The most important aspect of picking a CDO is selecting a manager, so look at the track record of this manager." However, it is very difficult for investors to assess CDO managers on track record alone because they do not necessarily allow easy comparison. The best one can hope to establish is that a CDO manager has been managing that particular asset class for a long period of time, that his investment approach can be articulated clearly, and that risk-management parameters are strictly adhered to.

There is good reason to be very skeptical about track records. They contain three biases—creation bias, survivorship bias, and size bias. A discussion of these biases is beyond the scope of this chapter. Fortunately, there is a good deal of academic literature on these biases as they pertain to the equity mutual fund arena. The same biases apply to fixed income funds as well.

Rule 1 states that the key to evaluating manager performance is to use common sense. Do not be duped by performance numbers. Here is what to look for: First, make sure the CDO manager's firm has a track record with every asset class it is including in the CDO and that the CDO manager is not stretching into asset classes in which she has not been active historically. Second, make sure that the CDO manager's firm has a disciplined, consistent approach to investing, which is followed in good times and bad. Finally, look at the stability of both the firm and the personnel. A management team that has been at a firm for a long period of time, with significant equity in the firm, is less likely to leave. (Ideally, CDO investors would like to handcuff managers to the firm for the life of their deal. One obviously cannot do this, but bigger manager stakes mean that there is less likelihood of leaving.) Moreover, the longer a group of people has been working together, the less chance there is of a sudden shift in strategy.

There is an assumption on the part of investors that Wall Street dealers who underwrite CDOs act as gatekeepers, bringing only the top-notch performing managers to market. This blind trust, however, is to some extent misplaced. More money management firms wish to manage CDOs than there is dealer pipeline capacity. Thus a dealer wants to underwrite CDOs (from managers) that they believe will sell quickly.

However, there are often other considerations, including the overall quality of the relationship between the dealer and a money manager, as well as help the CDO manager can provide in marketing the deal and taking some of the equity. Consider two money managers; one has a very good track record, and the other has only an average one. The manager with the average track record will take all the equity in the CDOs, plus some of the subordinate securities. The manager with the better track record wants the dealer to place all the equity. Who will the underwriters pick? It's a no-brainer—the manager with the average track record who is willing to provide more help in underwriting the deal.

Realize that the Wall Street dealer community does require at least a minimum performance threshold. The manager's investment philosophy and track record do have to be good enough to market the deal. Moreover, since dealers are looking at the overall quality of the relationship between the dealer and CDO manager, as well as a CDO manager's willingness to take down some of the equity, it is natural that larger, better established money management firms are likely to have an edge. This is a good thing for investors, per our common-sense tests earlier.

Rule 2: Checking Out Incentive Structures

One of the most important pieces of analysis in evaluating a new CDO deal is to look at how managers have responded to incentive structures on their outstanding deals. In most deals, the deal manager owns between 25% and 49.5% of the equity. (If she owned 50% or more, the entire deal would get consolidated onto her balance sheet.) We believe that in a CDO structure, a deal manager usually has a powerful incentive to keep cash flow going to the equity holders, even if that works to the detriment of bondholders and the net asset value of the deal.

Recall that cutting off cash flows to the equity holders owing to violation of coverage tests generally cuts seriously into the return of equity holders. Once equity holders lose the cash flows, it is difficult to get them back later on because the deal begins to delever owing to paying down of the senior and mezzanine bond classes. Thus, when the CDO manager is also the equity holder, the CDO manager has every incentive to avoid tripping the overcollateralization and interest coverage ratios. There are straightforward means available to the CDO manager for doing so. Moody's acknowledged this problem:

> We have noted some managers that are lax in righting a deteriorating portfolio, while concurrently distributing excess interest out of the structure. These CDO managers do not actively utilize the O/C test at a possible corrective lever that can efficiently be used to remedy a deteriorating deal. Some common examples include cases where a CDO manager is tardy at treating a security as a defaulted security, buying deep discounted securities or holding on to severely impaired securities.[2]

It is very difficult for an equity holder to manage a deal and totally ignore her own incentive interests. However, some CDO managers can be egregiously self-serving. This usually can be spotted by looking for a huge deterioration in WARF scores or a big growth in assets that fall into the triple-C-rated bucket.

Realize that poor performance on previous deals is not necessarily indicative of abusive management. Often market conditions have deteriorated, and most CDOs of that asset type have been affected. Thus, if a deal is performing poorly, it is very important to look at the reasons why.

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2. Gus Harris, "Commonly Asked CDO Questions: Moody's Responds," Moody's Investors Service, *Structured Finance: Special Report,* February 23, 2001, New York.

Rule 3: Asset Diversification

So far we have examined what to focus on when looking at an individual deal—making the case that rather than focusing on the CDO manager's track record, focus on the performance of outstanding CDO deals and how the CDO manager has balanced his interests with those of the bondholders in the deal. We now shift gears and examine the argument that not only should CDO buyers look at individual deals, but they also should look at their CDO holding in a portfolio framework.

The key to managing a CDO portfolio is diversification. One of the few indisputable facts is that the types of securities purchased (the style) is key—far more important than the skill of a particular manager. For example, in his analysis of equity mutual funds performance, Roger Ibbotson notes that

> . . . relying on past performance is not as simple as it appears. The investment styles of mutual funds typically explain more than 90 percent of the variation in returns. Just knowing that a fund is a large or small capitalization fund, a growth or value fund, an international stock fund, or a combination of these categories largely explains its performance. The skill of the manager is demonstrated relative to the fund's investment style.[3]

While it is indisputable that style matters, there is a question as to whether good or poor performance in one period is indicative of the performance going forward. That is, are some managers just far superior to others? While there have been studies of mutual funds that have examined this issue, in short, the debate seems to be whether style (asset class) accounts for 90% or 99% of return variation. There is no disputing the fact that it is the key factor. Bottom line: Diversify across asset classes.

Rule 4: Don't Get Hung Up on Diversity Score

Many investors buying a large number of positions still tend to look at each purchase individually. Yes, it is important to look at each deal, but parameters that may be unacceptable if a particular deal was the only one purchased become less important when the security will become part of a portfolio. Diversity is one such parameter.

In fact, it is important to look at holdings on a consolidated basis. Adding deals with low diversification may, in some circumstances, help a portfolio of CDO holdings. For example, a REIT-only deal may have a low diversity score, but if it was part of a larger CDO portfolio, and REIT holdings elsewhere are limited, then purchasing it actually may increase diversification. By contrast, if one purchased three high-yield deals within a short period of time, each with very high diversity scores, the additional diversification provided by buying all three deals actually may be limited because they may own substantially the same securities. The rating agencies generally tend to require less subordination on a deal

3. Roger Ibbotson, "Style Conscious," *Bloomberg Personal,* March–April 2001.

with a higher diversity score. However, when an investor purchases a large number of CDOs, she is creating her own diversification.

In point of fact, favoring deals with low diversity scores actually conflicts with rule 3—trying to collect CDOs backed by different types of collateral. High-yield and investment-grade corporate deals tend to have much higher diversity scores than do structured finance or CDOs backed by other CDO deals. Thus, if one were trying to accumulate deals with low diversity scores, one would be accumulating predominantly ABS deals and not achieving that desired diversification.

Thus the practical advice is (1) an investor should not shun low-diversity-score deals because the investor also creates his own diversification and (2) an investor should look at holdings in his CDO portfolio on a consolidated basis.

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CHAPTER
THIRTY-ONE

SYNTHETIC CDOs

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In the rapidly changing world of collateralized debt securities (CDOs), the synthetic CDO (SCDO) market is perhaps the most dynamic and has generated great interest from issuers and investors alike. Starting as a convenient tool for banks to hedge unwanted risk in their loan portfolios or to obtain regulatory capital relief, SCDOs have become a common fixture in the arbitrage CDO market. In 2002 and 2003, more than half the deals transacted in the United States and Europe were synthetic, up from just above 25% in 2000.

A confluence of three events led to the creation and rapid expansion of the SCDO market. First, the creation of a supersenior tranche significantly reduced the cost of liabilities in SCDOs and permitted these securities to thrive even when the economics of a cash-based transaction were unattractive. Second, increased attention from the rating agencies has given investors confidence that the risk they are taking is commensurate with the premium they receive, opening the door for many additional investors. Finally, the development and standardization of CDS technology, including documentation, has allowed disparate market participants to communicate more efficiently, acquire collateral[1] faster, and hedge more efficiently where appropriate.

The authors would like to thank Steve Altemeier, Manish Desai, Kathleen Harris, Robert Lendino, Anthony Sciacca, Chris Shin, and Ross Van der Linden for their help in writing this chapter.

*Jeffrey Prince was Vice President of CDO Research at Wachovia Securities when he coauthored this chapter.

1. We will take some liberties with the use of the word *collateral* because CDS contracts are not collateral in the true sense of the word. While SCDO purists undoubtedly will find the term *reference portfolio* preferable, we often find that term to be awkward and distracting for the reader.

Given their advantages, the rapid rise of SCDOs should not be surprising. Compared with cash-based CDOs, SCDOs are straightforward and efficient structures. Generally, there is no fixed/floating-interest rate mismatch or maturity mismatch between assets and liabilities. Currency mismatches are handled seamlessly without the need for explicit currency hedges. And there are other advantages as well: quick and easy ramp-up of collateral, greater collateral diversity, payment of fees over time, and generally greater structural flexibility. In fact, synthetic CDO transactions can be tailored around the needs of a single investor.

The first half of this chapter is devoted to a brief history of the synthetic market and an overview of basic SCDO structure. Afterwards, we identify and discuss recent developments and trends in the SCDO market, such as the incorporation of coverage and quality tests, changes to credit derivatives definitions, and the rise of single-tranche CDOs. Finally, we review several investment considerations. Where appropriate, we will compare synthetic to cash-based CDOs, with an eye on the relative advantages of SCDO structures.

GROWTH AND EVOLUTION OF THE SCDO MARKET

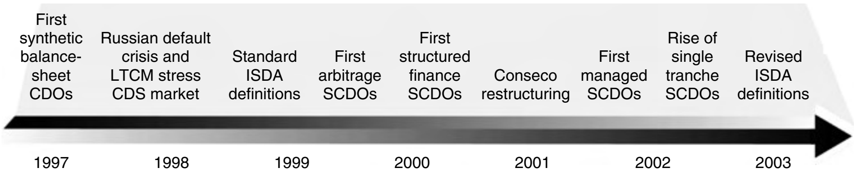
SCDOs originated in the late 1990s as a way for banks to transfer the credit risk of their loan portfolios without removing the loans from their balance sheet. In doing so, a bank could lower its regulatory capital requirement on these assets from 100% to 20%.[2] Transactions motivated by regulatory capital relief or risk management are termed *balance-sheet CDOs* (as opposed to *arbitrage CDOs,* which are discussed later). BISTRO 1997-1, issued in December 1997, was the first bank balance-sheet transaction that closely resembled the synthetic structures of today.[3] As the market has evolved, banks have applied this technology to other assets that carry high risk weightings, the most notable of which are asset-backed securities.

Since the late 1990s, the SCDO market has expanded beyond its European roots as a balance-sheet management tool (key milestones are highlighted in Exhibit 31–1). SCDOs are now issued regularly in the United States, Japan, and Hong Kong. In fact, based on combined European and U.S. numbers for 2002

2. Under Basel I, banks must hold 8% regulatory capital against the par of assets that are 100% risk-weighted. Most regulators will lower this regulatory capital requirement to 1.6% (20% of the 8%), where risk is transferred via a default swap as long as the swap counterparty is an Organization for Economic Cooperation and Development (OECD) institution. If the risk is transferred in a credit-linked note (CLN) format and the collateral for those notes is very high quality, such as Treasurys, the risk weighting could be even lower.
3. Before BISTRO 1997-1, there were a limited number of SCDOs that were issued without a supersenior tranche and were created purely to decrease regulatory capital charges on the balance sheets of the sponsoring banks. Examples include Triangle Funding, Ltd., and SBC Glacier Finance, Ltd.

EXHIBIT 31–1

Key Events That Shaped the SCDO Market



CDOs: Collateralized debt obligations; CDS: Credit default swaps; ISDA: International Swaps and Derivatives Association, Inc.; LTCM: Long-Term Capital Management; SCDOs: Synthetic collateralized debt obligations.
Source: Wachovia Securities.

and 2003, more CDOs have been issued in synthetic form than in cash form[4] (Exhibit 31–2).

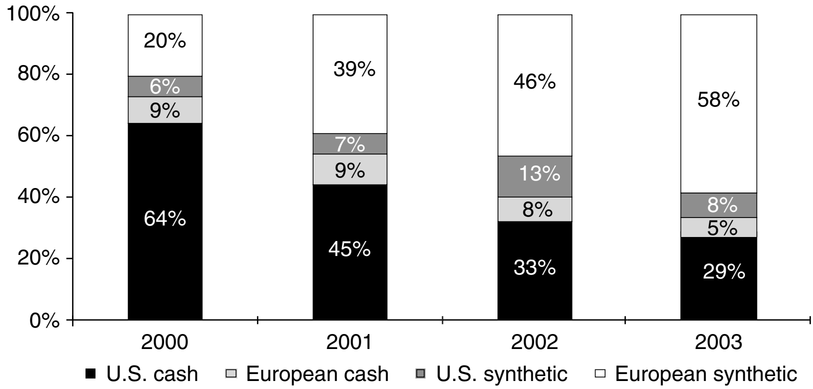
The purpose of synthetic execution also has evolved. Many SCDOs are now executed for arbitrage purposes (transactions designed to exploit inefficiencies in the debt markets). Starting as highly negotiated first-to-default baskets, arbitrage-motivated SCDOs evolved first into static-pool, tranched structures and then into managed tranched structures that incorporate many cash-based CDO features. Arbitrage SCDOs usually are smaller than their balance-sheet counterparts and range from $500 million to $1 billion in notional. Typically, balance-sheet-motivated SCDOs carry a large notional amount ranging from $1 billion to as high as $10 billion and reference investment-grade assets.

Early arbitrage SCDOs were purely synthetic. In other words, transaction assets and liabilities were unfunded and governed solely by a swap confirmation.[5] Often there were only a few participants in a transaction. Starting in 2001, many arbitrage-motivated SCDOs evolved into broadly syndicated structures issued in both funded and unfunded form.[6] This short-lived trend reversed itself in 2002 with the rise of single-tranche (bespoke) CDOs that typically are sold to a single investor.

4. U.S. and European market only; excluding market value CDOs but including European single-tranche synthetic CDOs.
5. In an unfunded transaction, no proceeds are exchanged at the outset of the deal. The protection buyer pays premiums until maturity or a credit event. In the case of a credit event, the protection seller will make a payment to the buyer.
6. Funded portions are issued in a credit-linked note (CLN) format. The performance of a CLN is tied directly to the performance of the reference pool through a CDS. Proceeds from the CLNs are invested in high-quality assets until liquidated to pay for losses in the reference pool or returned to the investor. The high-quality assets generally provide the LIBOR portion of the CLN coupon from interest generated by the high-quality assets, and the margin owed above this is covered by the premium paid by the sponsor.

EXHIBIT 31–2

Synthetics Make Up the Majority of CDO Issuance by Number of Transactions



Source: Moody's Investors Service, Inc., and Wachovia Securities.

As of 2004, the SCDO market is diversified and dynamic, with a growing list of transaction types. Balance-sheet SCDOs reference structured finance assets as well as corporate investment-grade credits. Synthetic arbitrage transactions reference structured finance assets, investment-grade corporate credits, and high-yield corporate credits.[7]

SYNTHETIC CDOs FROM THE GROUND UP

The standardization of credit default swaps (CDSs) has enabled the expansion of the SCDO market beyond its use as a balance-sheet management tool. In fact, the development of arbitrage SCDOs was predicated on the expansion and standardization of the single-name CDS market, which provides the major means for SCDO sponsors to source/hedge their exposure. Therefore, understanding a simple CDS is critical to understanding SCDOs.

Credit Default Swaps

Initially, the CDS market was a small interbank market used to transfer credit risk. Lenders looked to distribute the credit risk of large-loan positions to other banks without selling the loans and possibly jeopardizing bank-client relationships. Each CDS contract was highly negotiated and designed to transfer primarily default risk. From this foundation, CDS contracts become standardized and

7. Through 2003, no pure synthetic high-yield CDO transactions have closed. However, high-yield debt represents a significant portion of the reference pool of several SCDO transactions.

are now traded by bank portfolio managers, insurance companies, and arbitrageurs (e.g., hedge funds and CDOs) to hedge existing credit exposure or to accept new exposure to corporate credit risk. According to the British Bankers' Association (BBA) and the International Swaps and Derivatives Association (ISDA), the credit derivatives market has grown from $180 billion notional in 1997[8] to an estimated $5.0 trillion notional in 2004.[9] The dramatic growth of the market may be attributed to a combination of the following:

- Standardized ISDA documentation, which created market conventions and industry-wide benchmarks, including counterparty posting requirements
- Structured product offerings (i.e., SCDOs) with embedded CDS
- Increased focus and guidance from regulators
- Educated investors that profit from pricing/technical inefficiencies

A CDS is a contract between a protection buyer and a protection seller. Under this agreement, the protection buyer pays a premium to the protection seller in return for payment if a credit event (typically bankruptcy, failure to pay, or restructuring) occurs with respect to the reference entity.[10] Usually, protection payment can be triggered by a default on any borrowed money—even on the most subordinate debt.[11]

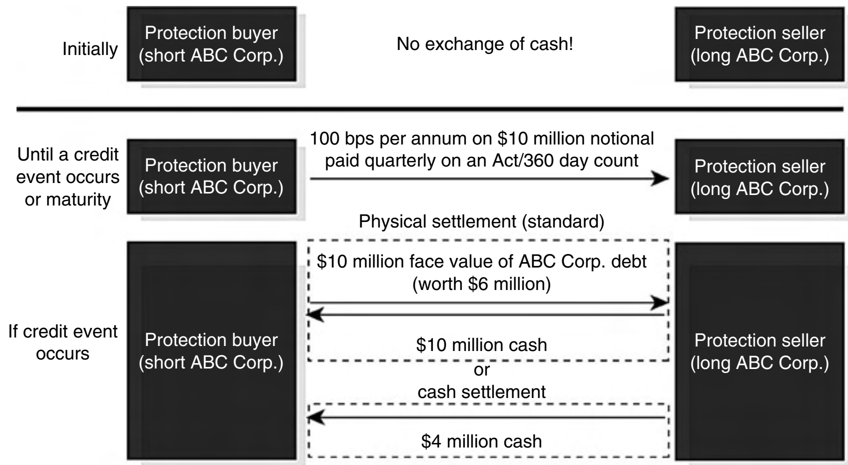
For example, suppose that a protection buyer (e.g., a bank) purchases $10 million of ABC Corp. five-year default protection[12] and agrees to pay 100 basis points per annum to the protection seller (e.g., an investor/SCDO). In this case, the protection buyer pays $25,000 quarterly ($100,000 annually) to the protection seller until a credit event occurs or five years pass and the agreement expires. If a credit event occurs in the five-year period, the protection buyer delivers $10 million in face value of ABC Corp. debt (though likely worth less than the $10 million owing to the credit event) to the protection seller in return for $10 million. This is known as *physical settlement*.

Alternatively, the contract can use *cash settlement* following a credit event, which requires a payment from the protection seller to the protection buyer equal to the difference between the initial price (usually par) and the current price of the

8. BBA Credit Derivatives Report 2003/2004, British Bankers' Association, 2004.
9. International Swaps and Derivatives Association news release, April 1, 2004.
10. Credit events are defined by ISDA as bankruptcy, failure to pay, restructuring, obligation acceleration, obligation default, or repudiation/moratorium, although other events can be negotiated between the related parties to the swap. We discuss the meaning of credit events in more detail under "Credit Events and Defaults."
11. Borrowed money is defined by ISDA as any obligation that is related to funds that the reference entity has borrowed including, but not limited to, loans, bonds, letters of credit, and deposits. This term is broader than bonds and loans but narrower than payment, which includes any obligation for repayment.
12. Five-year default swaps are the market benchmark for CDS contracts, although 3-, 7-, and 10-year contracts also are common.

EXHIBIT 31–3

Credit Default Swap Payment Mechanics



Source: Wachovia Securities.

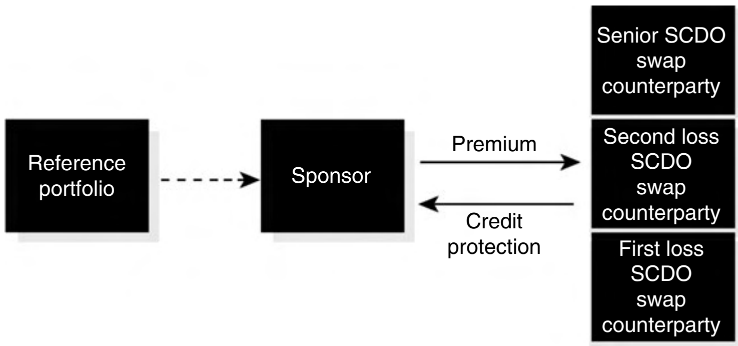
debt based on the valuation procedure indicated in the CDS contract.[13] Using the same example of ABC Corp., if the value of the defaulted debt is determined to be $6 million (the recovery), then the protection seller will pay the protection buyer $4 million (par minus recovery).[14] The payments for physical settlement and cash settlement are shown in Exhibit 31–3.

Buying protection is similar to shorting a cash instrument, and selling protection is similar to going long a cash instrument, but credit default swaps and cash bonds are *not* identical investments. Direct investment in fixed-rate corporate debt contains interest-rate and funding risk, whereas a CDS investment does not. Interest-rate risk is absent from a CDS investment because there is no initial cash outlay, and funding risk is mitigated because there is no need to borrow. In contrast, when an investor borrows money to fund an investment, funding risk is created. If the investor's funding cost increases, the spread between the investment and the investor's cost of funds decreases, lowering the economic benefit of the investment while the risk remains unchanged.[15] Therefore, the unfunded nature of a CDS creates a pure credit risk position.

13. In contrast to physically settled CDS contracts, payments in cash-settled CDS contracts are tied generally to a specific obligation, as indicated in the swap confirmation. Physically settled CDS contracts may reference a specific obligation to clarify the reference entity or the seniority of the deliverable obligation, but any *pari passu* obligation may be delivered.
14. In certain instances, the loss payment may be assigned *a priori* (regardless of the realized recovery), and the cost of protection is adjusted appropriately.
15. Ignoring any collateral posting requirements that may be required owing to the counterparty's credit risk. We describe comparable cash-based transactions in more detail in Appendix 31A.

EXHIBIT 31–4

Unfunded SCDO: No SPV and No Proceeds Exchanged



SCDO: Synthetic collateralized debt obligation.
Source: Wachovia Securities.

Synthetic CDOs

In its simplest form, an SCDO is the application of a CDS to a pool of reference credits. For example, the pool of reference credits could be tied to loans or to structured finance securities that reside on the sponsor's balance sheet (a synthetic balance-sheet transaction). Or the pool of reference credits could be tied to a defined group of corporations (typically an arbitrage transaction).

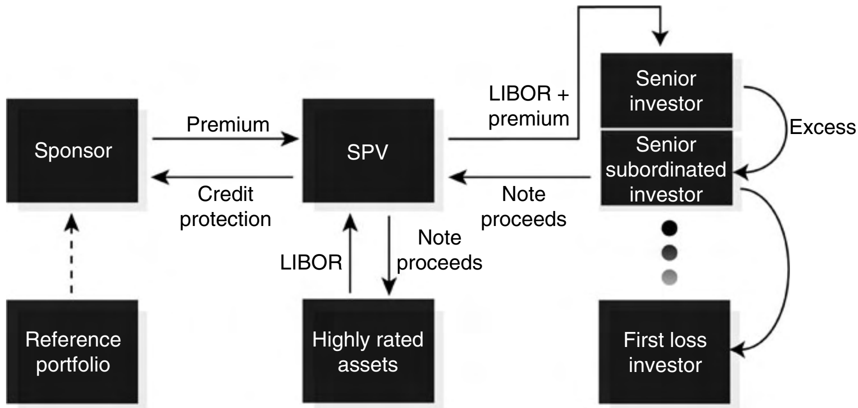
In a synthetic balance-sheet transaction, the sponsor is a buyer of protection, and the investors are the sellers of protection. If certain predefined credit events occur on any of the reference entities, then the sellers of protection must make the buyer whole. For this protection, the sponsor pays a premium based on the notional amount of the pool.[16] If no credit events occur, the only cash transferred throughout the course of the deal would be the premium paid by the protection buyer. If a credit event does occur, then the seller of protection pays a settlement amount to the buyer of protection. At this point CDO technology can be layered in to allow investors to participate at different risk levels (Exhibit 31–4). This type of structure is known as an *unfunded synthetic CDO*. Unfunded arbitrage transactions behave similarly except that the portfolio of reference credits typically is assembled with securitization as the primary goal, and often the reference credits do not reside on the balance sheet of the sponsor.

In unfunded transactions, the sponsor (protection buyer) must rely on the swap counterparty's (investor's or protection seller's) ability to make the required loss payments during the course of the deal because no cash is exchanged at the outset. The terms of payment are specified in the CDS confirmation. Therefore,

16. The notional amount of a pool is also known as the "face amount" and represents the contractual size of the pool on which all calculations of premium and recovery will be based.

EXHIBIT 31–5

Funded SCDO: SPV Added and Proceeds Exchanged for CLNs



SPV: Special-purpose vehicle.
Source: Wachovia Securities.

the investor must be able to execute a CDS, which excludes many pension plans, CDOs, and other fund managers. In addition, counterparties (investors) may be required to post collateral based on how the sponsor views their credit risk. Collateral posting requirements generally are not one-for-one but rather are based on the credit quality of the investor/swap counterparty.

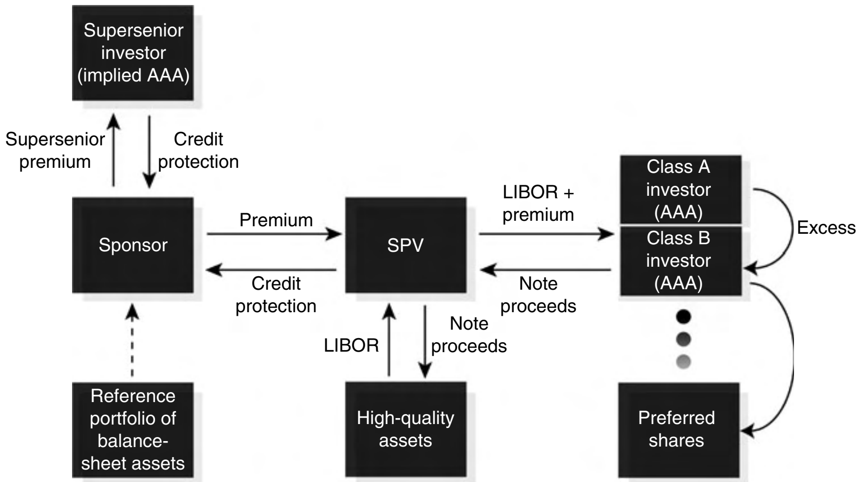
To expand the investor base and to remove counterparty credit risk, sponsors incorporated credit-linked notes (CLNs), which are *funded* instruments, into the SCDO framework. Under this format, a special-purpose vehicle (SPV) normally is created to provide a bankruptcy-remote depository for the high-quality assets purchased with the note proceeds (Exhibit 31–5). An example of this type of transaction is Biltmore 2002-2.

Many SCDO transactions actually are a hybrid of the funded and unfunded structures just described. A single, highly rated investor (typically a monoline insurance company) will invest in the most senior tranche in unfunded form (CDS), whereas the rest of the liability structure is purchased by various investors in funded (CLN) or unfunded form. The unfunded, senior-most tranche is known as the "supersenior" tranche to reflect its position above the AAA-rated tranche.

The supersenior tranche paved the way for the broad-scale application of SCDO technology to bank balance sheets and later to arbitrage transactions backed by investment-grade assets. In the late 1990s, banks were eager to shed much of their investment-grade bank loan risk because those loans often were extended for relationship reasons and generated low returns. In addition, loan assets carry a 100% risk weighting, which means that a bank is charged an 8% regulatory capital charge. Early SCDOs permitted banks to reap the benefits of regulatory capital relief, but they had to bear the high cost of execution provided by transactions with

EXHIBIT 31–6

Partially Funded SCDO: Supersenior Added



SPV: Special-purpose vehicle.
Source: Wachovia Securities.

traditional tranching (i.e., without a supersenior tranche). Often those transactions were not economically attractive. The supersenior tranche dramatically improves SCDO economics and thus facilitates efficient regulatory capital relief.

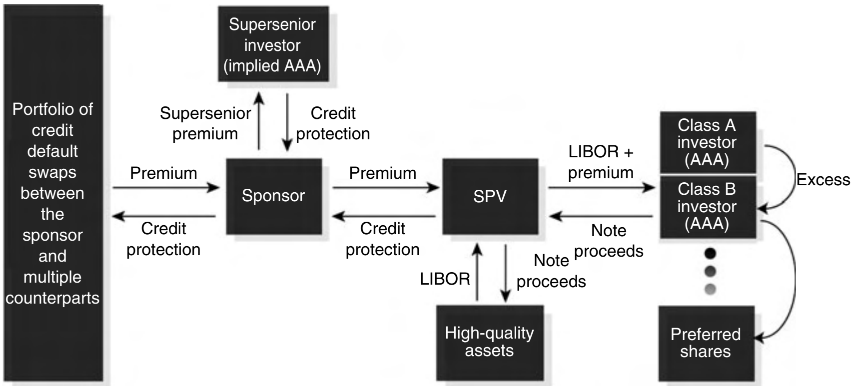
Senior to the AAA tranche, the supersenior frequently accounts for 85% or more of the capital structure (assuming an investment-grade pool of assets) and carries a low spread (e.g., 8 to 15 basis points)—much lower than the spreads commanded by AAA tranches—which reduces the weighted-average cost considerably. A typical balance-sheet SCDO is similar to that seen in Exhibit 31–6.

The credit protection premium is passed from the sponsor to the supersenior investor and to the SCDO. The portion passed to the SCDO is partitioned among the SCDO investors according to the size of their investment and the amount of risk they have taken. When a credit event occurs on a reference entity, high-quality assets are liquidated in an amount equal to the payment obligation on the CDS, and the proceeds are then passed to the sponsor. Losses are applied to the investors in reverse order of priority, although sometimes the realization of the loss is postponed until the end of the transaction, allowing noteholders to earn interest on the entire outstanding amount of their investment.

The structure described in Exhibit 31–6 is typical, but variations are common. In some transactions, the supersenior investor is a counterparty of the SPV, and the entire premium is passed from the sponsor to the SPV, where it is then partitioned. In other transactions, the class A, B, or C notes may be unfunded or

EXHIBIT 31–7

Arbitrage SCDO: Reference to a Portfolio of Credit Default Swaps



SPV: Special-purpose vehicle.
Source: Wachovia Securities.

partially funded. One of the benefits of an SCDO is the versatility afforded to investors and structurers.

The transactions described in Exhibits 31–5 and 31–6 are typical of a balance-sheet-motivated transaction, where the sponsor collects interest and fees from cash assets held on its balance sheet. Based on this structure, an arbitrage transaction can be constructed easily if the sponsor selectively enters CDS contracts with the market (Exhibit 31–7). In this case, preferred shareholders benefit from any premium remaining after payment to the supersenior counterparty and the rated notes.

Settlement Mechanics: Physical or Cash

A CDS may be settled either physically or in cash. Although SCDOs may employ either method, cash settlement is more common. Certain managed SCDO transactions do employ physical settlement, but even in this subset of the SCDO market, physically settled SCDOs remain a minority. For cash-settled transactions, a 2003 study by Fitch Ratings[17] indicates that as many as 12 different valuation methodologies have been employed in transactions that Fitch has rated. All the methodologies involve a bidding process whereby the reference asset is valued by CDS dealers. However, some methods specify multiple valuation rounds and multiple bids, whereas others permit just one round and two bids, of which one could be a party involved in the transaction.

17. Shin Yukawa, Jill Zelter, and Michael Gerity, "Credit Events in Global Synthetic CDOs: 2000–2003," Fitch Ratings, May 12, 2003.

The risk of moral hazard is higher when only a few bids are required, especially if the sponsor provides one of the bids. Therefore, investors should seek transactions with multiple valuation bids. As of 2003, the market standard was at least five nonaffiliated bids for CDS on corporate names and at least three for CDS linked to structured finance securities. Fewer bids are to be expected for structured finance securities because fewer banks are equipped to value these instruments.

As mentioned earlier, physical settlement is used in some managed SCDOs where a "hands on" approach is to be expected. It is also more straightforward because complicated valuation processes are avoided. However, concerns persist in the market over the specific assets that are eligible for delivery (see "Credit Events and Defaults"), and the portfolio manager's ability to work through problem credits is critical. Investors benefit when a manager has the flexibility to maximize recoveries. Therefore, investors should consider whether the portfolio manager has the expertise and the resources to devote to a workout security. There are also practical complications with physical delivery when used in a SCDO. For example, the defaulted security must be funded and is likely not paying interest, which imposes a cash drag on the structure.

A COMPARISON WITH CASH CDOs

Although SCDOs use tranching technology similar to that employed by traditional cash-based CDOs, in many respects the structures are very different. Cash-based transactions tend to be long-dated arbitrage transactions that use a variety of assets, including high-yield bonds, leveraged loans, or structured products, as collateral. In contrast, SCDOs tend to have shorter maturities (five years), are balance-sheet- or arbitrage-motivated, and are referenced to investment-grade corporate obligations or structured finance securities. In this section the general characteristics of an SCDO are compared with those of a typical cash-based CDO (Exhibit 31–8).

Life Cycle

The life cycle of an SCDO may look different from that of a traditional CDO. For instance, SCDOs referenced to IG corporate credits take a short time to ramp up owing to a developed and liquid CDS market. Further, the "collateral" will remain outstanding until maturity, which is usually in bullet form. Amortization does not exist because CDS contracts *reference* a particular entity but not a specific security. The termination date of the contract is freely negotiable; therefore, structurers are free to arrange for simultaneous maturity of all contracts (Exhibit 31–9).

If the portfolio consists of contracts referenced to structured securities and the transaction is managed, there is little difference between SCDOs and cash-based CDOs because the CDS is tied to specific securities instead of reference credits. The ramp-up period is followed by a revolving period and an amortization period. A typical ramp-up period for structured finance SCDOs is six months to one year. The revolving period is generally three to five years,

EXHIBIT 31–8

Comparison of Typical Cash CDO with Typical Synthetic CDO

Characteristic	Typical Cash CDO	Typical Synthetic CDO
Collateral pool	High-yield corporate bonds Leveraged loans Trust-preferred securities Emerging market debt ABS CMBS/REITs	Credit default swap linked to a pool of balance-sheet assets (loans, senior or mezzanine structured finance) or to a reference pool of corporate credits (usually investment grade)
Size	$200 million–$600 million, generally	$1 billion plus
Collateral quality	Investment-grade or below-investment-grade and even distressed collateral	Primarily investment-grade
Diversity	Diversity score of 10 (SF CDOs) to 60 (corporates)	Similar to cash CDOs but generally higher due to the larger size of the transactions
Management	Typically managed	Typically static, though there is a growing managed market
Moral hazard	Possible through the purchase or sale of collateral designed to benefit one class of investors over others	Generally no due to static nature of these transactions
Payment frequency	Quarterly or semiannually	Quarterly
Legal final	Generally 12 years for transactions tied to corporate credits but as long as 30 years for transactions tied to ABS	For balance-sheet or arbitrage transactions linked to corporates, 4–6 years For structured finance deals, 10–30 years
Expected maturities	Generally 7–12 years for transactions tied to corporate credits depending on the payment priority of the investment	For arbitrage and balance-sheet transactions linked to corporates, 3–5 years For structured finance deals, approximately eight years for senior debt and 15 years for subordinate debt
Ramp-up period	0–6 months	Generally, immediate to 1 month although arbitrage SF SCDOs may have periods as long as a year
Prepayment risk	Yes	Generally, no
Reinvestment risk	Yes, for transactions with reinvestment periods	Generally no due to static nature of these transactions

EXHIBIT 31–8

(*Continued*)

Interest-rate risk	Managed with swaps and other derivatives	In unfunded form, there is no interest-rate risk For CLNs, floating-rate assets and liabilities create a natural hedge
Equity leverage	8–12 times due to a generally lower-quality collateral pool	Frequently 30 times but as much as 100 times for transactions linked to IG corporate credits and highly rated structured finance securities

ABS: asset-backed securities; CDO: collateralized debt obligation; CLN: credit-linked note; CMBS: commercial mortgage-backed securities, IG: investment grade; REIT: real estate investment trust; SCDO: synthetic CDO; SF: structured finance.

Source: Wachovia Securities.

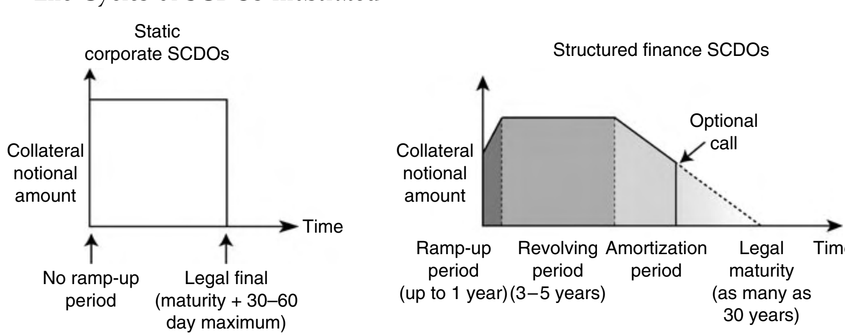
potentially leaving a 25-year amortization period. As in traditional cash-based CDOs, managed synthetic transactions are subject to early termination of the revolving period and acceleration of payment (through the capture of excess spread) if the collateral pool does not perform well.

Trading

Like cash-based balance-sheet CDOs, balance-sheet SCDOs typically are not permitted to trade reference entities in or out of the reference pool on a discretionary basis for regulatory reasons. Limited substitution can take place, however, and both the old and new reference entities are exchanged at a par notional.

EXHIBIT 31–9

Life Cycles of SCDOs Illustrated



SCDOs: Synthetic collateralized debt obligations.

Source: Wachovia Securities.

In contrast, managed arbitrage SCDOs permit trading, although the mechanism is different from that used in a cash-based arbitrage CDO.

A position in the reference pool of a managed SCDO can be removed by either terminating the CDS or buying protection to hedge the position (as opposed to an outright sale in a cash-based transaction). If the position is terminated, an early-termination payment will be made by the SCDO if there is a loss (the CDS spread has widened), or the SCDO will receive cash if there is a gain (the CDS spread has tightened). If an offsetting position is taken after the credit has deteriorated and the CDS spread has widened, the excess spread on the transaction will be negatively affected because the SCDO will pay more in premium on the new CDS than it receives on the original CDS. However, if the credit has improved, then the SCDO can use the same technique to lock in a spread premium on the credit and enter a new contract on another credit.

Rating agencies and noteholders typically favor purchasing protection to offset a CDS if the credit has deteriorated (the spread has widened) because cash flow to equity is reduced, and the collateral balance is maintained. This prevents cash from "leaking" to equity holders despite significant losses in the reference pool. To mitigate excessive spread deterioration, investors and rating agencies impose a minimum spread test to ensure that sufficient interest is available to pay rated noteholder interest. When using offsetting trades, it is advisable to select CDS contracts that have identical terms. However, this is not always possible; therefore, the rating agencies frequently limit the number of offsetting trades permitted.

Market standards regarding the amount of trading that is permitted have not emerged as of January 2004. Many managed transactions limit trades to approximately five per year. These transactions are known as "lightly" managed, and typically the trades are used to shed credit risk positions. "Fully" managed transactions permit all the trading freedoms normally found in a cash-based structure: credit-risk and credit-improved trading and a bucket for discretionary trading (usually 10%). Investors seem to favor lightly managed trading because it permits defensive trading of the portfolio without the cost of a completely managed portfolio.

Some fully managed SCDOs permit portfolio managers to adopt a net short position in a credit (e.g., Jazz CDO B.V. I and II). This allows managers to capitalize on a negative view of a particular credit or to take a relative credit view between competitors by going short one and long the other but maintaining a neutral stance on the industry. To the extent that the portfolio manager is successful in these strategies, equity holders and noteholders will benefit from this added flexibility. To our knowledge, there have been no cash-based transactions with this feature as of 2003.

Coverage and Quality Tests

Synthetic transactions typically do not have overcollateralization (OC) tests but benefit from additional subordination. However, for transactions with OC tests, the senior-most tranche (the supersenior tranche) may be excluded from the OC calculation, which differs from the typical cash OC test. In these synthetic transactions, the OC ratio is calculated as

$$\text{Class X OC ratio} = \frac{\text{cash collateral account balance}}{\text{notional amount of class X notes and notes senior excluding the supersenior}}$$

The OC test is breached if the cash collateral account declines to a level where the OC ratio falls below a certain threshold. Regardless of the method used, credit events and trading losses can result in a breach of the OC test as cash collateral is depleted to cover losses incurred. If the OC test is breached, excess spread is directed away from junior tranches and equity and allocated to a cash account, where it is held to pay future losses. As with cash-based CDOs, quality tests such as the diversity and weighted-average rating factor tests are used to maintain portfolio quality during the ramp-up period and revolving (replenishment) periods.

Credit Events and Defaults

Credit events define the risks that are transferred from the buyer to the seller of protection in a CDS and, theoretically, can be negotiated between the buyer and seller of protection to cover a multitude or only a few risks. However, in 1999, ISDA introduced a standard set of credit derivatives definitions, including credit event definitions, that are now market standard for use in SCDOs referenced to corporate credits (Exhibit 31–10). These definitions may be modified in any given transaction, but they have been successful in creating a common language used by all market participants. Since 1999, ISDA has issued several supplements to the definitions that address weaknesses revealed by various credit events that occurred between 1999 and 2002. In 2003, ISDA introduced another version that incorporates all these changes. However, ISDA definitions were not developed with structured products in mind, and application to that market requires some adjustment to the definitions and an understanding of the context in which they are used, which we discuss later in this section.

Historically, ISDA credit event definitions favored protection buyers (i.e., banks who were hedging risk) and captured a broader spectrum of risks than what most investors and rating agencies would consider "default." In the past, this was not an issue because the CDS transactions were negotiated between two sophisticated parties that were aware of the risks involved. However, as the SCDO market has evolved, and particularly as arbitrage SCDOs have emerged over the past few years, the additional risk transference has become a concern.

Restructuring drew significant attention in October 2000 when Conseco Finance Corp. extended the maturity of its loans, which the market viewed as a positive credit event. Nonetheless, protection buyers triggered on this credit event and delivered longer-dated bonds, which were trading cheaply, in exchange for par from the sellers of protection. This event underscored the risk

EXHIBIT 31–10

Standard Set of Credit Event Definitions*

Credit Event	Layman's Description
Bankruptcy	The dissolution or insolvency of a reference entity, the inability to pay debts, or the shift of control to a secured party, custodian, or receiver
Failure to pay	The failure of the reference entity to make payments due on any obligation before expiration of any applicable grace period
Restructuring	The reference entity or governmental authority changes an obligation by reducing the interest rate or the principal amount, postponing the payment of interest or principal, lowering the payment priority of the obligation, or changing the currency to one that is not permitted
Obligation acceleration	An obligation of the reference entity becomes due and payable before it would otherwise have been due and payable as a result of a default or other similar condition or event other than a failure to pay
Obligation default	An obligation of the reference entity becomes capable of being declared due and payable before it would otherwise have been due and payable as a result of a default or other similar condition or event other than a failure to pay
Repudiation/ moratorium	The validity of an obligation is rejected either by the reference entity or a governmental authority. This event is mostly applicable to sovereign credits

*Paraphrased from the 2003 ISDA Credit Derivatives Definitions.

Source: Wachovia Securities.

of the cheapest-to-deliver option (discussed further below). The following March, Moody's published a report discussing its concerns over the 1999 credit event definitions, including the restructuring credit event.[18]

The rating agency's main concern was maintaining consistency between losses that would result from a credit event in a SCDO with the agency's definition of default for a cash asset. This consistency is important to appropriately size credit enhancement for rated tranches of SCDOs. Restructuring and obligation acceleration were particularly troubling to Moody's because these fell short of their definitions of default and were deemed "soft" credit events—events that capture credit deterioration short of a default and hence make a CDS riskier than a cash position. These contrast with "hard" credit events that fit within the agency's view of default, including bankruptcy and failure to pay.

18. Jeffrey S. Tolk, "Understanding the Risks in Credit Default Swaps," Moody's Investors Service, March 16, 2001.

The SCDO market in the United States responded to the rating agency concerns by altering credit events to include only bankruptcy, failure to pay, and a more limited form of restructuring known as "modified restructuring." However, regulators and the credit default swap market in Europe were not able to come to terms with modified restructuring. Hence the European deals included bankruptcy, failure to pay, and the original restructuring, which became known as "full restructuring." For transactions based on full restructuring, the rating agencies simply increased their default assumptions for the incremental risk from full restructuring or required that tighter language be incorporated into the definition.

As mentioned earlier, ISDA published the 2003 ISDA Credit Derivatives Definitions, which took effect on June 20, 2003. This set of definitions addresses many of the market concerns with the 1999 definitions. In the new definitions, two delivery options for the restructuring event have been created. The first, called *Restructuring Maturity Limitation and Fully Transferable Obligation* or, more commonly, *modified restructuring,* is currently the market standard for U.S. participants and is more restrictive than the second option, called *Modified Restructuring Maturity Limitation and Conditionally Transferable Obligation* or, more commonly, *modified, modified restructuring.*[19] Modified, modified restructuring typically is used among European participants. In both instances, the credit event language tightens the scope of the restructuring credit event to avoid future problems, but one of the risks inherent in a synthetic transaction is documentation risk, and so it remains to be seen if some unforeseen event will reveal further weakness that might necessitate more change. We highlight pertinent differences between each of the restructuring definitions in Exhibit 31–11.

Cheapest-to-Deliver Option

If a reference entity is in default, all *pari passu* debt should trade at roughly the same level, but this is not always the case. Some credit events capture risk beyond that of pure default, such as restructuring and obligation acceleration. These events are called *soft credit events*. In these cases, the market may not view default as imminent, and the value of *pari passu* debt still may carry a time-value factor. When credit events occur, the protection buyer has a cheapest-to-deliver option, which means that the buyer can deliver to the seller a longer-maturity instrument that frequently will be cheaper. In other CDS contracts, this is not the case. For example, in structured-finance SCDOs, the CDS typically references a specific issuance, which eliminates the cheapest-to-deliver option.

The restructuring definition that is used can affect the value of the cheapest-to-deliver option inherent in a CDS. This option is worth the most under full

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19. For clarification, the option called "Restructuring Maturity Limitation and . . ." in the ISDA definitions is known as "modified restructuring" by the market. Meanwhile, "Modified Restructuring Maturity Limitation and . . ." is normally called "modified, modified restructuring" (note *modified* twice). This may cause confusion for new participants.

EXHIBIT 31–11

Differences between the Three Types of Restructuring

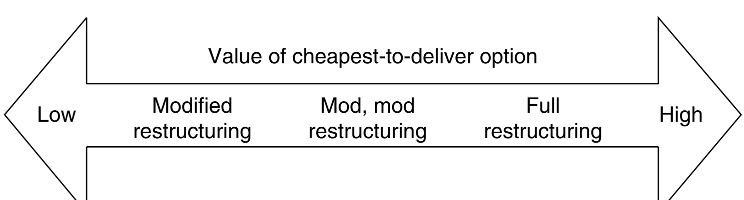
	Full Restructuring	Modified, Modified Restructuring	Modified Restructuring
Maturity limitation of the deliverable obligation	Cannot exceed maturity limitation specified in the confirmation, usually 30 years	Cannot exceed the restructuring date plus 60 months if the delivered obligation is a bond or a loan, or 30 months if it is not a bond or a loan	Cannot be longer than the earlier of the restructuring date plus 30 months or the latest maturity of any restructured bond or loan, and in no instance can it exceed the scheduled termination date of the contract plus 30 months
Transferability of the deliverable obligation	Must meet the reference obligation characteristics specified in the confirmation	Can be conditionally transferable with consent required as long as consent cannot be unreasonably withheld or delayed	Must be fully transferable without consent of the obligor
Eligible transferee	Not applicable	Most financial institutions	Financial institutions that pass a minimum asset test

Source: Wachovia Securities.

restructuring (the broadest language) and worth the least under modified restructuring (the most narrow language) (Exhibit 31–12). We advise SCDO investors to inspect thoroughly the definitions being used to understand the protection they are "selling." This is especially true for secondary market investments because older transactions might include older ISDA language.

EXHIBIT 31–12

Restructuring Language Affects the Cheapest-to-Deliver Option



Structured-Product Credit Events: Unique Definitions Apply

Referencing structured-finance transactions in SCDOs created a new set of challenges for the synthetic market. The ISDA definitions were created with corporate credits in mind and are difficult to apply directly to structured-product transactions. Regardless, many early transactions include the same credit events that were used for corporate transactions, even though events such as bankruptcy are not readily applicable (CDOs are issued from bankruptcy-remote SPVs and therefore are not tied to the performance of a sponsor). Obligation acceleration is another event that is difficult to apply to structured products because it could be a positive development depending on the part of the capital structure that is affected. For instance, a CDO accelerating principal repayment to the senior noteholders because of a coverage test breach actually could lead to an upgrade for those noteholders even though the underlying reference credits might be performing poorly. In fact, of the six credit events that are used commonly in corporate CDS contracts, only failure to pay applies directly to structured-product securities. To fully capture the default risk of structured products, the SCDO market has developed other credit events. Two of the most common, principal write-down and rating downgrade, are summarized in Exhibit 31–13.

Another difference in a structured-finance SCDO is that the credit events reference specific bonds rather than a transaction or an issuer, for example, Ford Credit Auto Owner Trust 2003-A A2B instead of Ford Motor Credit Co. This particular bond

EXHIBIT 31–13

Standard Set of Credit Event Definitions Found in Structured-Finance SCDOs

Credit Event	Layman's Description
Failure to pay	The failure of the reference entity to make payments due on any obligation before the expiration of any applicable grace period; this would not include a tranche that PIKs according to its terms.
Principal write-down (loss event)	Whenever any amount of principal with respect to any reference obligation is permanently reduced due to the allocation of losses, write-offs, charge-offs, defaults, or liquidations; this is not a standard ISDA definition and therefore could be defined in a variety of ways.
Rating downgrade	The assignment of a below-CCC rating in combination with the postponement of interest for two or more periods; this is not a standard ISDA definition and therefore could be defined in a variety of ways.

ISDA, International Swaps and Derivatives Association, Inc.; PIK, payment in kind.

Source: Wachovia Securities.

EXHIBIT 31–14

Typical Credit Events in Corporate and Structured-Finance SCDOs

	Reference Entities Tied to	
Credit Event	**Corporate Debt**	**Structured Finance Assets**
Bankruptcy	Standard	Not standard
Failure to pay	Standard	Standard
Restructuring*	Standard	Not standard
Obligation acceleration	Not standard	Not standard
Obligation default	Not standard	Not standard
Repudiation/moratorium	Not standard	Not standard
Write-down (loss event)	Not standard	Standard
Rating downgrade	Not standard	Occasionally

*Any of full restructuring, modified restructuring, or modified, modified restructuring.

Source: Wachovia Securities.

would have to be impaired as defined by the applicable credit event definitions before protection payments would be made by the seller. Impairment to classes below this class would not trigger a credit event, nor would impairment to the corporate credit of Ford Motor Co. or Ford Motor Credit Co.

Today, market participants generally can expect to find two to three (but possibly more) credit events specified in any given SCDO (Exhibit 31–14).

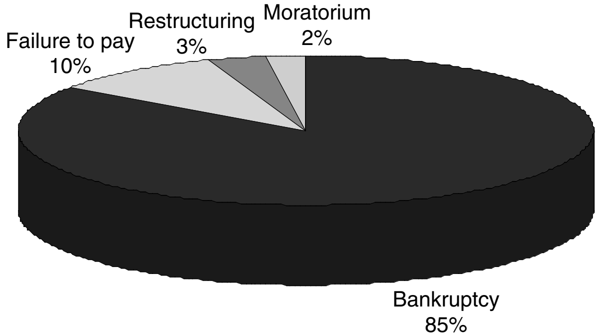
Historical Credit Event Experience: Bankruptcy Dominates

So what credit events are most likely to occur? By and large, most credit events fall under the bankruptcy category. In a May 2003 study of 112 credit events triggered on 28 reference entities across 115 CDOs (some CDOs had no credit events) in the United States and Europe, Fitch found that 84.6% were triggered by bankruptcy, 9.9% by failure to pay, 3.3% by restructuring, and 2.2% by repudiation/moratorium[20] (Exhibit 31–15). Evidently, there were no credit events linked to obligation acceleration or obligation default. Because the study only examined synthetic transactions that referenced corporate credits (and not structured-finance securities), credit events due to write-down (loss) or rating downgrade were not recorded.

20. Shin Yukawa, Jill Zelter, and Michael Gerity, "Credit Events in Global Synthetic CDOs: 2000–2003," Fitch Ratings, May 12, 2003.

EXHIBIT 31–15

Bankruptcy Dominates Credit Event Experience



Source: Fitch Ratings and Wachovia Securities.

Investors Gain from Synthetic CDOs

There are several benefits to the issuer and the investor when implementing an SCDO instead of a cash CDO, including

- Ease of execution
- Greater spread on the assets (CDS)
- Higher diversity
- Lack of prepayment risk in SCDOs linked to corporate credits
- Shorter average lives
- Bullet maturities
- Low cost of liabilities
- High-quality assets

Ease of Execution

Compared with cash-based CDOs, SCDOs are significantly easier to execute because they generally require shorter ramp-up periods, do not require balance-sheet capacity, and have streamlined documentation (if fully synthetic).

Shorter ramp-up periods (one month or less) are possible in transactions referenced to corporate credits because portfolio managers are able to enter into CDS contracts with relative ease in the investment-grade CDS market. For example, a portfolio manager may include ABC Corp. as a reference entity in a five-year SCDO, although ABC Corp. may only have 10-year debt outstanding. In other words, the investment-grade CDS market is not dependent on specific cash assets.

Therefore, SCDO collateral aggregation is not dependent on the forward calendar of issuance or the availability of outstanding debt instruments in the way a cash-based transaction is dependent. Theoretically, the sponsor could declare a reference pool overnight and hedge later as it sees fit. This is possible because a number of dealers make active markets on a broad range of corporate credits.

Synthetic balance-sheet transactions and arbitrage transactions based on corporate credits tend to have the shortest ramp-up periods because the reference obligations are already on the balance sheet or exposure is readily sourced in the CDS market. In contrast, arbitrage structured-finance SCDOs tend to have longer ramp-up periods (up to a year) as issuers arrange hedges by purchasing cash assets.

For issuers that do not already have assets on balance sheet or for those with limited balance-sheet availability, corporate-arbitrage SCDOs have the added benefit of not requiring any balance sheet to ramp-up because CDS are unfunded instruments.

Finally, pure synthetic transactions benefit from simple documentation compared with funded CDOs. If executed in an unfunded form, the only documentation that is necessary is a swap confirmation. Participants in unfunded structures generally employ their own legal counsel to ensure that all the risks are appropriately analyzed.

Greater Spread

Compared with a cash position, CDS often offer wider spreads from a credit protection seller's point of view. This is known as *positive basis*. For example, the five-year default protection on ABC Corp. may trade at 100 basis points, whereas the asset-swapped spread on the five-year cash bond is LIBOR plus 95 basis points (see the appendix to this chapter). The positive basis in this case would be (100 basis points – 95 basis points) = 5 basis points. There are several reasons for a positive basis:

- *Clarity of legal language*. As discussed earlier, protection sellers are frequently selling protection on more than just *default* in the classic sense and demand a premium for potential contractual or definitional problems.
- *Liquidity.* Some CDS may not be as liquid as the corresponding cash assets. Therefore, investors may demand additional spread to compensate for this risk. For example, below-investment-grade CDS are frequently less liquid than their cash brethren; therefore, protection sellers demand a higher premium.
- *Anonymity.* Banks looking to reduce loan exposure without affecting client relationships often purchase credit protection "anonymously" through the CDS market; therefore, protection spreads can increase when a new loan is syndicated.
- *Technical influences.* (1) Position limits and risk constraints may force dealers to reduce credit exposure through the purchase of protection.

Loan or bond trading desks with excess inventory sometimes will purchase protection in the CDS market rather than sell bonds into a weak or thin cash market. (2) Convertible bond arbitrage funds purchase convertible bonds and credit protection simultaneously to create a cheap equity option; therefore, CDS spreads can widen after a new convertible issue hits the market.

- *Optionality.* Physically settled CDS contracts provide a cheapest-to-deliver option to the protection buyer, which is paid for through a wider spread.

At times, there is a negative basis, however. This generally occurs when several buyers of protection come to market. For example, if several large SCDOs are ramping "collateral" on identical reference credits, they could drive the spread (protection premium) tighter and possibly through comparable spread levels found in the cash market.

Higher Diversity

Owing to the large scale of most SCDO transactions ($1 billion to $10 billion), a large number of credits can be referenced. Historically, an arbitrage SCDO of $1 billion notional would reference 100 separate corporate entities but could reference many more. Meanwhile, synthetic balance-sheet transactions could reference as many as 300 or more corporate entities. On the other hand, cash-based arbitrage transactions usually are significantly smaller ($300 million to $600 million) and contain 60 to 100 separate corporate obligations.

Lack of Prepayment Risk for Corporate SCDOs

The portfolio manager, if there is one, and investors benefit from the fact that CDS generally do not prepay. For SCDOs linked to corporate credits, CDS usually are not associated with a specific debt obligation. Therefore, if an entity prepays any of its loans (e.g., renegotiates new terms or terms out in the bond market), the CDS will not be affected. Therefore, the portfolio manager will need to be concerned only with managing overall credit exposure but not collateral maturities. Likewise, static corporate-referenced SCDO investors will be similarly unaffected by prepayment.

For SCDOs linked to structured products, there is some prepayment risk that is dependent on the prepayment of the reference obligations. The supersenior holder bears most of the prepayment risk in these transactions owing to its dominant position in the capital structure.

Bullet Maturities

Owing to the contractual nature of CDS, SCDOs linked to corporate credits offer the attractive benefit of bullet maturities. In conjunction with the lack of prepayment risk, debt and equity investors benefit from bullet maturities, which allow them to plan their investment efficiently. This can be attractive to buy-and-hold investors who have low liquidity requirements and place a high priority on keeping funds invested. Unlike a traditional CDO, all collateral and debt mature simultaneously, and the repayment of noteholders will occur on a single day.[21] Furthermore, the maturity for many corporate SCDO transactions is three to five years (legal final may extend to six years), which is considerably shorter than what is typically available in the cash market.

Despite a certain amount of prepayment risk, the funded notes of SCDOs linked to structured-finance securities likely will be paid in bullet form as well. Many structured-finance SCDOs incorporate cleanup calls that unwind a transaction when the economics become unattractive. When the call is exercised, all rated investors will be paid simultaneously.

Lower Cost of Liabilities

Equity investors benefit considerably from the lower cost of liabilities afforded by synthetic structures. The supersenior tranche typically demands only a fraction of the spread that a traditional AAA CDO investor would require. Because the supersenior tranche represents so much of the capital structure—frequently 85% or more—the overall cost of liabilities for the SCDO is reduced dramatically. The "freed" excess cash is passed to the preferred shareholders. Debt holders also may benefit if provisions are made to trap excess cash when credit events occur and losses are realized. Supersenior investors (primarily monoline insurance companies) are willing to accept a low premium because of the considerable structural support provided them (the AAA investors are subordinate to the supersenior) and the convenience of making their investment in unfunded form.

Transaction cost is driven down even further by generally lower structuring, administrative, and trustee fees. For example, a portfolio manager may earn 50 basis points per annum to manage a $300 million pool of collateral ($1.5 million per annum), whereas an equivalent fee for an SCDO manager requires only 15 basis points per annum on a $1 billion collateral pool. The same principal can be applied to administrative and trustee fees.

In addition, structuring and placement fees in SCDOs generally are paid over the life of the transaction instead of up front, as is typical for cash-based CDOs. This typically leads to higher leverage, which benefits equity holders, and more collateral at closing, which benefits noteholders.

21. It is possible that a portion of the payment could be withheld for a short period (approximately one quarter if static and up to one year for managed deals) if a credit event occurs to one of the reference entities in the collateral pool just before maturity.

High-Quality Assets

The low cost of liabilities found in SCDOs typically allows these transactions to reference higher-quality collateral (where the arbitrage is thinner) than collateral that is used to collateralize cash CDOs. This provides an additional diversification tool for investors who currently have exposure to cash-based CDOs and the credits that usually support them. On the corporate side, synthetic transactions reference assets that typically are rated BBB on average, whereas cash-based CDO collateral usually is rated in the B and BB range. Structured-finance SCDOs usually are referenced to pools of highly rated, often AAA, senior securities compared with cash-structured-finance CDOs, which are collateralized by assets that are rated BBB on average and usually are subordinate or mezzanine. Investors need to be aware that the higher-quality collateral also results in greater leverage and more sensitivity to event risk (see the discussion of event risk later in this chapter).

SINGLE-TRANCHE (BESPOKE) TRANSACTIONS

A niche of the SCDO market is worthy of special consideration. Commonly called *single-tranche CDOs* or *bespoke CDOs,* these transactions are very private in nature and often are highly customized. In these transactions, the investor (protection seller) designs a SCDO around his credit views and risk tolerance: he selects the reference credits (spread, quality) and defines the level of risk to be accepted (e.g., AA). For example, an investor may choose 100 credits with an average rating of BBB and total notional value of $1 billion and indicate a desire for a $20 million exposure to this pool at an A level of risk. In return, the premium received is adjusted to suit the risk.

Single-Tranche Structure

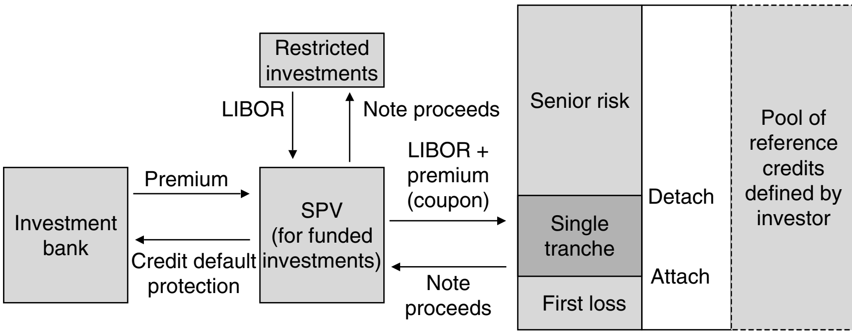
Conceptually, a single-tranche CDO structure is similar to that of conventional synthetic CDOs with one significant difference—only one tranche is issued. A single-tranche CDO effectively represents the sale of credit protection[22] to the swap counterparty (i.e., an investment bank) on a slice of reference pool risk. The attachment and detachment points of the tranche define the slice of risk sold.[23]

22. The person who sells protection accepts a contingent liability (agrees to pay for losses in the reference pool) in return for a coupon to be paid periodically by the protection buyer (receiver of loss payments).

23. For the traditional CDO investor, the attachment point defines the percentage of the capital structure below the tranche, and the detachment point represents the starting point (attachment point) of the tranche immediately above in the capital structure. The difference between the two represents the size of the tranche.

EXHIBIT 31–16

Generic Single-Tranche Structure



SPV: Special-purpose vehicle.
Source: Wachovia Securities.

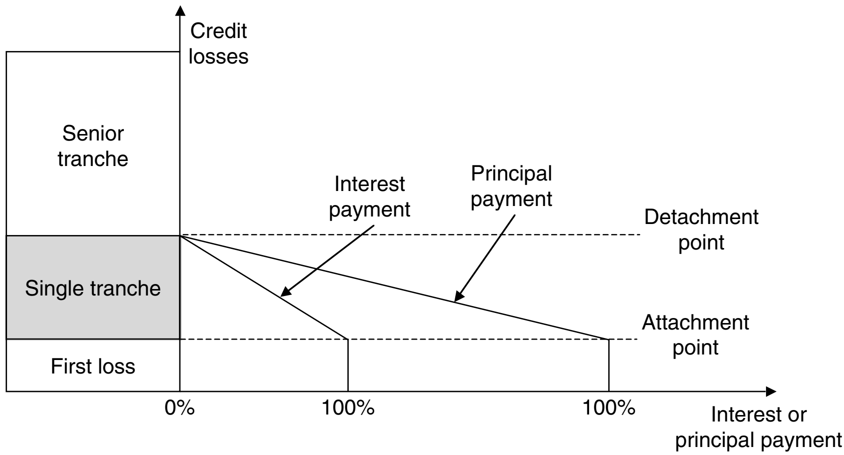
The rest of the risk (what otherwise would constitute the tranches above and below the tranche) is not issued. Exhibit 31–16 depicts a generic single-tranche CDO structure.

The mechanics are straightforward. The investor chooses a pool of reference credits—generally names that are traded in the credit default swap (CDS) market, although nonstandard assets also may be chosen—and indicates the amount and risk level of exposure. The investment bank then creates a customized tranche that meets the investor's criteria. The investor (protection seller) generally buys the tranche at par, and the proceeds are used to purchase restricted investments (usually investments rated AAA/Aaa) having the same notional as the single-tranche issued.[24] In return, the investor receives a coupon equal to the interest generated by the restricted investments (LIBOR) plus the protection premium paid by the investment bank. If the aggregate reference pool losses exceed the amount of subordination (the amount of "unissued" tranches below the attachment point), then the restricted investments are liquidated dollar for dollar to compensate the investment bank, the protection buyer. Consequently, the principal balance of the single-tranche CDO investment may deteriorate over time. If defaults (and losses) continue, additional restricted investments are liquidated, and the investor suffers greater principal loss. Ultimately, the loss is capped at the amount of restricted investments posted (the detachment point). Concurrent with the liquidation of restricted investments, the "interest" paid to the investor is also adjusted downward in proportion to the principal reduction. In other words, losses are realized immediately.[25] These concepts are shown in Exhibit 31–17.

24. Single-tranche CDOs are also available in unfunded form.
25. Structures that do not reduce the coupon on loss can be created for investors who need the certainty of coupon and are willing to incur slightly greater principal loss.

EXHIBIT 31–17

Effect of Losses on Return of Principal and Coupon



Source: Wachovia Securities.

Advantages of the Single-Tranche CDOs

Investors realize several benefits when investing in single-tranche SCDOs, including

- *Credit selection and management.* Single-tranche CDOs are designed to meet the specific needs of individual investors; thus, unlike a conventional CDO investor who might be required to negotiate the characteristics of the transaction with other participants, the investor selects the reference portfolio and other features without interference from other investors. Investors can even elect to lightly manage their pools by replacing a small number of reference obligors per year. The ability to lightly trade the reference portfolio eliminates the so-called manager risk that exists in some multitranche managed CDOs, that is, the possibility that the manager could effect trades that are not necessarily aligned with the long-term good health of the tranche the investor bought.
- Single-tranche CDOs, like SCDOs in general, frequently offer significant diversification advantages. Single-tranche transactions typically reference a high-grade portfolio of 100 to 125 credits compared with a cash CDO, which normally includes 60 to 100 credits. Therefore, relative to the size of an investment, single-tranche transactions offer significant diversification.
- *Risk selection.* Single-tranche transactions allow investors to create investments with specified risk/return profiles through selection of appropriate attachment and detachment points. Once features such as the number of reference obligors, reference obligor ratings, concentration

levels, and diversity are established, the attachment and detachment points are adjusted in conjunction with the rating agencies' requirements to determine the single-tranche rating.

- *Higher spread.* Single-tranche CDO spreads are often higher than those offered by similarly rated conventional cash-flow CDOs because single-tranche spreads depend heavily on the reference pool chosen, the risk level chosen, the number of agency ratings assigned, and the size of the investment—all of which can be modified to improve yield. However, single-tranche spreads can be relatively volatile because they tend to track the premium offered in the credit default swap market, even allowing single-tranche spreads to fall below conventional CDO spread levels for any given reference pool. In contrast, the asset spreads and liability spreads in the traditional cash-based CDO market have not been as closely tied.
- *Ease of execution.* Single-tranche transactions are not dependent on a ramp-up of cash assets or distribution of a full CDO capital structure and therefore can be executed in as little as two to four weeks. In addition to investment customization, these transactions are characterized by relatively quick closing times.

A single-tranche CDO investment also has the popular features of a fully banked synthetic CDO—bullet maturity (typically three to five years), no interest-rate risk, no reinvestment risk, and simple documentation that permits transaction execution within two weeks. In short, a single-tranche CDO investment is virtually identical to a fully banked synthetic CDO but has greater flexibility and additional benefits.

A Word of Caution: Portfolio Selection

The flexibility afforded by single-tranche CDOs can work against an inexperienced investor who may lack the knowledge to assess the risk of the reference portfolio (i.e., the true credit quality and default correlation of the reference obligors). Once the domain of the collateral manager, the selection of reference obligors is now the responsibility of the investor[26]; hence there is a need to carry out more in-depth portfolio analysis. There are two important considerations for investors when selecting a reference pool: the credit quality of the reference pool and the default correlation among the reference obligors. Each of these will have a profound effect on the performance of the CDO investment, and each falls squarely on the investor. Good credit quality is an obvious desire and needs no explanation. However, one cannot always assume that

26. The investor may hire a collateral manager to select and trade the reference portfolio for a fee of 50 to 100 basis points per annum based on the notional amount of the single-tranche investment.

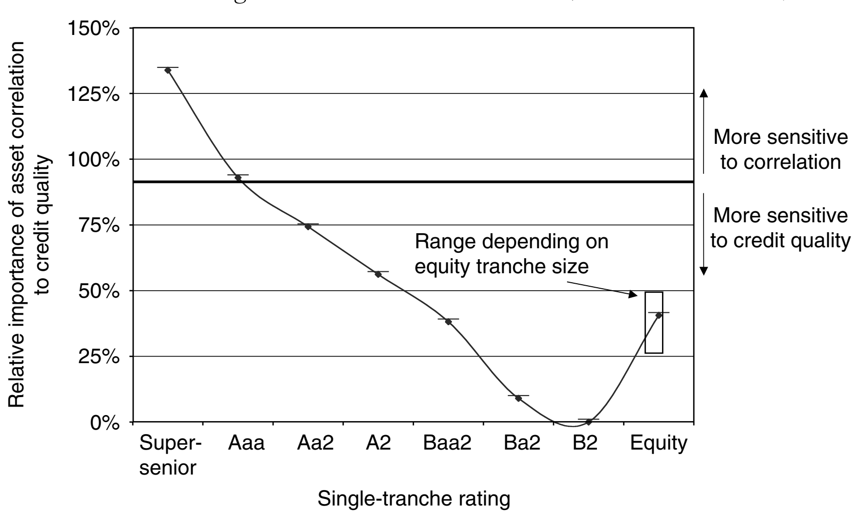
high (or low) default correlation is beneficial. In fact, for some investors, high default correlation is good, whereas for others, it is bad. Therefore, single-tranche CDO investors should keep the following concepts in mind while choosing a reference portfolio:

- Default correlation is particularly important to the senior tranches. In fact, it could be argued that a clear understanding of the reference-pool default correlation characteristics is more important than a clear understanding of the aggregate credit quality of the reference pool for these tranches. Further, default correlation, and particularly low default correlation, becomes even more important to the senior tranches as the quality of the reference pool improves.
- The importance of default correlation decreases for investments lower in the capital structure and reaches a minimum for mezzanine tranches. For these tranches, good credit selection is paramount.
- At the bottom of the capital structure, default correlation again becomes important. However, for these investors, high default correlation is a beneficial reference portfolio characteristic that should be fostered. This desire stands in stark contrast to the desires of senior tranches referencing the same pool.

These concepts are illustrated graphically in Exhibit 31–18.

EXHIBIT 31–18

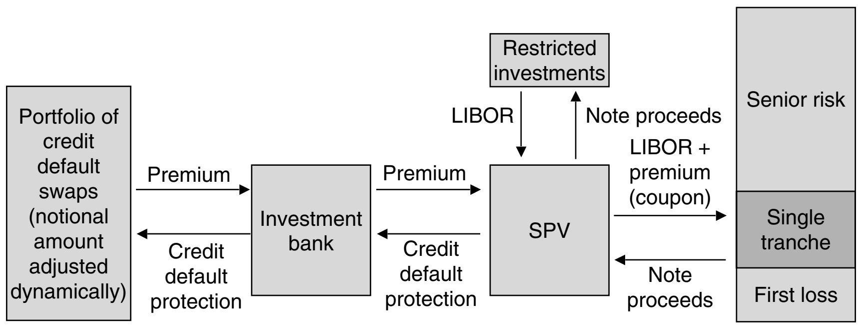
Relative Importance of Asset Correlation to Credit Quality to the Performance of Single-Tranche CDO Investments (BBB Reference Pool)



Source: Wachovia Securities.

EXHIBIT 31–19

Investment Bank Hedging Strategy



Source: Wachovia Securities.

Investment Bank Hedging Strategy

On the other side of the single-tranche CDO trade, the protection buyer (i.e., the investment bank) will "delta hedge" its position through the sale of protection on individual names in the reference portfolio. The initial amount of protection sold for each name is determined by matching the sensitivity of the change in price (value) of the single-tranche to the change in price (value) of the single-name credit default swap. For example, if a 10 basis points spread widening of Ford Motor Co. changes the mark-to-market value of a $10 million[27] CDS tied to Ford by a negative $50,000 (from the perspective of the investment bank as a potential protection seller) and changes the value of the single-tranche by a positive $4,000 (from the perspective of the investment bank as a protection buyer), then the appropriate amount of Ford protection for the investment bank to sell is 8% (4,000/50,000) of $10 million, or $800,000 worth of Ford protection.

As spreads change and reference entities default, the size of the hedge will change, and as a result, the investment bank periodically will alter the amount of single-name protection held through market purchases and sales. Therefore, a complete schematic of a single-tranche CDO transaction is similar to that shown in Exhibit 31–19.

Readers will note that the CDS market generally does not trade in increments of $800,000 notional. For this reason, banks generally desire fairly large correlation books (which are created from the sale of several single-tranche transactions) and will hedge the transactions in aggregate, allowing for finer control of the hedge.

27. Assume that the equivalent "fully banked" structure was tied to 100 CDS contracts of $10 million each.

INVESTOR'S GUIDE TO SYNTHETIC CDOs

There are many investment considerations in connection with CDO investments in general, and SCDOs are no different. Yet the emphasis may be different when looking at a synthetic transaction, and we suggest that the following considerations be included in an investor's due-diligence process in addition to their typical CDO due-diligence process:

- Reference portfolio: Quality and correlation are key
- Portfolio management: Static, lightly, or fully
- Credit event definitions: Capturing the essence of default
- Loss calculation: Methods differ, but multiple bids are best
- Settlement procedures: Now or later
- Discrete defaults: Avoid continuous default assumptions
- Bifurcated risk: Considering the high-quality assets

Reference Portfolio: Quality and Correlation Are Key

We urge investors to pay particular attention to the portfolio of reference credits. Owing to the high leverage of investment-grade SCDOs, just a handful of credit events can have significant implications for the performance of the investment. If the transaction is static and motivated by arbitrage reasons, investors should determine how the portfolio was constructed, including the parties involved and their interests, and carefully consider each name in the portfolio. For senior tranche investors and equity investors, we also urge careful consideration of the default correlation within the reference pool. High default correlation could be devastating to senior investors and beneficial to equity investors (see the earlier discussion "A Word of Caution: Portfolio Selection").

Portfolio Management: Static, Lightly, or Fully

Investors should consider whether the transaction is static, lightly managed, or fully managed. This will guide the due-diligence process. For static transactions, the focus is the portfolio of reference entities, whereas more emphasis is given to the manager in managed transactions. Unique to synthetic transactions is the concept of lightly managed transactions. In a compromise of sorts, equity investors and the supersenior investor have agreed to allow the portfolio manager to engage in a limited number of trades per year; usually these are credit risk trades. Supersenior investors generally favor static transactions because it is easier to quantify the risk associated with their investment, whereas equity owners frequently prefer giving the portfolio manager discretion to remove credits that appear to be deteriorating. Finally, portfolio managers should have experience in CDS documentation and established trading relationships with a broad range of CDS brokers, which demonstrates their market access.

Credit Event Definitions: Capturing the Essence of Default

Much discussion has been devoted to the nuances of what constitutes a credit event, and unfortunately, some of these issues still need resolution. The CDS market has attempted to react as unforeseen events have occurred (e.g., Conseco, Inc., Railtrack, and National Power PLC), but there is still considerable discussion surrounding the definition of restructuring and guarantees.

Investors should study the credit event definitions. Broadly worded definitions will increase the risk to the protection seller, whereas narrowly worded definitions do not. For example, the CDS in an SCDO may specify full restructuring, modified restructuring, or modified, modified restructuring or some variant of any of these as a credit event. Investors should understand these differences (see "Credit Events and Defaults"). The interests of various participating parties drive the definition of credit event, and investors should be aware that the interest of the other parties might conflict with their own. In general, the rating agencies favor terms that simulate the default of a cash investment because their rating methodologies are based on cash-based default and recovery data. However, investors should be sensitive to the differences between a default in the cash market and a credit event in the credit default swap market.

Loss Calculation: Methods Differ but Multiple Bids Are Best

On the occurrence of a credit event, there is tremendous variation in the methods of loss calculation. As mentioned earlier, some methods specify multiple valuation rounds and multiple bids, whereas others permit as little as one round and two bids—of which one could be a party involved in the transaction. We recommend that investors require valuation methods that incorporate at least five nonaffiliated bids for CDS on corporate names and three for CDS linked to structured-finance securities. Furthermore, time constraints should be considered. If fewer than three bids are used to value the defaulted reference obligation or strict time constraints are applied to the pricing process, valuations could be depressed, which could increase the loss incurred by the investor.

Write-Down: Now or Later

When a credit event is cash settled, some SCDOs write down the principal of the equity and notes in reverse order of seniority as credit events occur and are settled, whereas other SCDOs wait until the end of the transaction. If write-down is postponed until the end of the transaction, SCDO debt that may be principally impaired will continue to receive interest on the full notional amount of the investment. Conversely, if the notes are written down immediately, impaired noteholders will receive only a portion of their expected interest payment.

Discrete Defaults: Avoid Continuous Default Assumptions

Investment-grade SCDOs are susceptible to event risk within the pool of reference assets, just like their cash counterparts. The highly leveraged nature of investment-grade CDOs (commonly, the equity tranche consists of less than 3.5% of the entire liability structure) increases the impact of losses on equity holders and junior note holders. By historical standards, a 2% to 3% cumulative default rate that would significantly impair the equity of an investment-grade CDO is high for a five-year period, but in a pool of 100 names this equates to a small number of names experiencing problems. For instance, one default in a pool of 100 names is significantly below the historical average, whereas two defaults are significantly above it. Increasing diversity can mitigate much of the default "lumpiness," but we recommend that investors also identify and evaluate the weakest credits in the collateral pool. In large part the performance of their investment will depend on those securities. Implicitly, therefore, we also recommend that investors measure defaults in terms of the number of defaults and not default rates (e.g., a 0.5% default rate is not possible in a pool of 100 equally weighted credits), which tends to underestimate the possibility of large losses and overestimate the stability of returns.

Other events also can affect equity and note holders adversely. Many would argue that the historical default numbers used to structure many corporate investment-grade CDOs did not anticipate the relatively high incidence of accounting fraud that has rocked the investment-grade market in 2001 and 2002. Investment-grade corporate CDOs created in the late 1990s were not structured with this added stress in mind, and the sudden demise of previously investment-grade credits in this manner does not allow the portfolio manager or deal structure to react effectively.

Bifurcated Risk: Considering the High-Quality Assets

Investors who purchase CLNs depend not only on the creditworthiness of the reference entities but also on the performance of the high-quality assets that support their position. Frequently, the proceeds of the CLNs are invested in a guaranteed investment contract (GIC), but sometimes highly rated asset-backed securities or Treasurys are also used. Regardless, the CLN's performance depends on the performance of those high-quality assets, as well as on the performance of the reference pool. The insolvency of the GIC provider or a default in any of the high-quality holdings would adversely affect the deal's ability to pay principal and interest when due. Although many market participants may consider default by any of these entities a remote possibility, we suggest that investors consider the merits of the high-quality collateral and perform due diligence on the GIC provider, if any.

CONCLUSION

The structured-products market and the credit derivatives market have merged to create SCDOs, a product that is attractive to investors and issuers alike. Investors find SCDOs appealing for a variety of reasons, including more efficient structures that typically feature bullet payments, the ability to source credit risk on a wider variety of credits, and greater structural flexibility. Issuers are also attracted by the structural simplicity of SCDOs, as well as the way in which these structures eliminate currency and interest-rate mismatches. In addition, SCDOs can be executed in a shorter time frame and, in the case of corporate-related credits, offer practically nonexistent ramp-up periods.

The learning curve for investors who currently participate in the cash CDO market should be relatively short because SCDO structures bear similarity to the cash market, and many cash CDO concepts are transferable. Other concepts such as ISDA documentation and credit default swap mechanics have been presented here to provide investors with the basic tools to understand those areas which are different from the cash CDO market.

In the form of SCDOs, the CDO market continues to prove its structural flexibility. Emerging from its humble beginnings as a tool for banks to obtain regulatory capital relief, SCDOs have become a dominant fixture in the greater CDO market. Today, the SCDO market includes arbitrage transactions tied to corporate credits and structured finance securities (e.g., asset-backed securities, commercial mortgage-backed securities, residential mortgage-backed securities) as well as balance-sheet transactions. This variety provides a myriad of investment opportunities tailored to a particular risk appetite and credit exposure that often can be difficult to source in the cash market. Given the flexibility of the SCDO product, market participants should expect continued evolution and expansion of this market.

APPENDIX 31A

Replicating a Credit Default Swap in the Cash Market

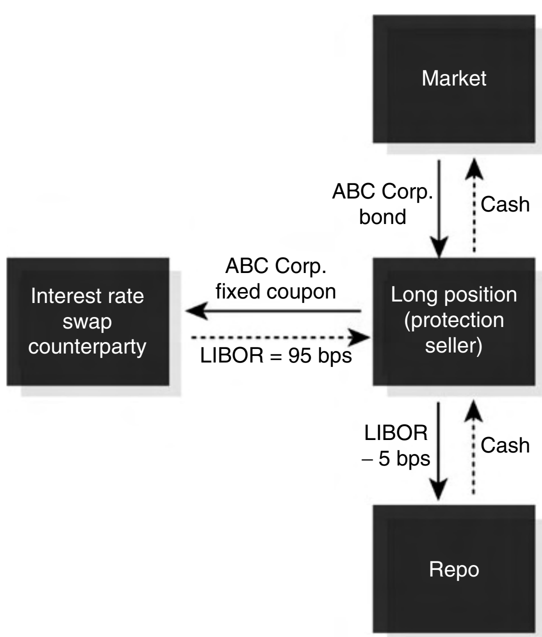
Selling protection (long the credit risk) on ABC Corp. can be replicated in the cash market as follows (Exhibit 31–20):

- The long position funds at LIBOR – 5 basis points to finance the purchase of ABC Corp. bonds in the open market
- The long position enters into an interest-rate swap on the ABC bonds to LIBOR + 95 basis points
- Net long position = (LIBOR + 95 basis points) – (LIBOR – 5 basis points) = 100 basis points

Buying protection (short the credit risk) on ABC Corp. can be replicated in the cash market as follows (Exhibit 31–21):

EXHIBIT 31–20

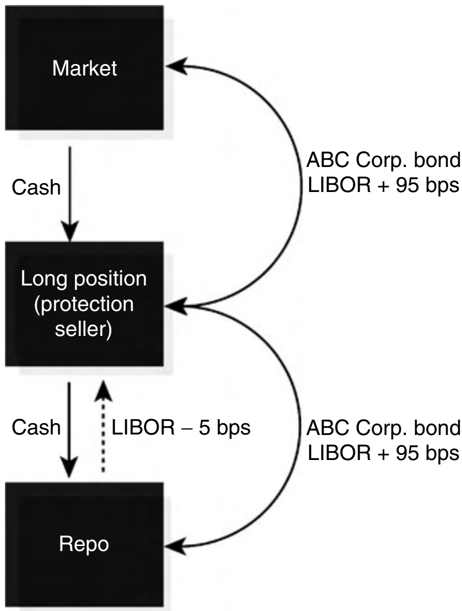
Long Position in the Cash Market



Source: Wachovia Securities.

EXHIBIT 31–21

Short in the Cash Market



Source: Wachovia Securities.

- The short position borrows ABC Corp. bonds in the repo market and earns the repo rate (LIBOR – 5 basis points) on the pledged cash
- The short position sells ABC Corp. bonds in the market (LIBOR + 95 basis points)
- Net short position = (LIBOR – 5 basis points) – (LIBOR + 95 basis points) = –100 basis points

PART
FOUR

CREDIT ANALYSIS AND CREDIT RISK MODELING

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CHAPTER

THIRTY-TWO

CREDIT ANALYSIS FOR CORPORATE BONDS

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The purpose of this chapter is to provide a framework for the credit analysis of corporate bonds. Although there are numerous types of corporate bonds outstanding, three major issuing segments of bonds can be differentiated: industrials, utilities, and finance companies. This chapter primarily will address industrials in its general description of bond analysis and then discuss the utility and finance issues. Special factors that must be considered in the credit analysis of high-yield corporate issues are discussed. At the end of this chapter, credit scoring models for identifying potential issuers that may default are described.

APPROACHES TO CREDIT ANALYSIS

Traditionally, credit analysis for corporate bonds has focused almost exclusively on the default risk of the bond—the chance that the bondholder will not receive the scheduled interest payments and/or principal at maturity. This one-dimensional analysis concerned itself primarily with the calculation of a series of ratios historically associated with fixed income investment. These ratios typically would include fixed charge coverage, leverage, and funds flow/total debt. This approach was deemed appropriate when interest rates were stable and investors purchased bonds with the purpose of holding them to maturity. In this scenario, fluctuations in the market value of the bonds owing to interest-rate changes were minimal, and fluctuations owing to credit changes of the bond issuer were mitigated by the fact that the investor had no intention of selling the bond before maturity. During the past three decades, however, the purpose of buying bonds has changed dramatically. Investors still purchase bonds for security and thereby forgo the higher

The core of this chapter is based on the chapter by Jane Tripp Howe that appeared in previous editions of this book.

expected return of other assets such as common stock. However, an increasing number of investors buy bonds to actively trade them with the purpose of making a profit on changes in interest rates or in absolute or relative credit quality. The second dimension of corporate bond credit analysis addresses the latter purpose of buying a bond. What is the likelihood of a change in credit quality that will affect the price of the bond? This second dimension deals primarily with the ratios and profitability trends, such as return on equity, operating margins, and asset turnover, generally associated with common stock analysis. In practice, both dimensions should be applied in corporate bond analysis. In a sense, both dimensions are addressing the same issue—default or credit risk. However, only by using both dimensions of credit analysis will the analyst address the dual purpose of bondholding: security of interest and principal payments and stability or improvement of credit risk during the life of the bond.

Historically, common stock and bond research areas have been viewed as separate. However, with the development of options theory, the two disciplines are beginning to be viewed as complementary. Credit risk modeling based on option-pricing theory has increased in popularity in recent years.[1]

The value of an option is a direct function of a company's aggregate equity valuation. As the market value of a company's stock increases, the value of the option increases. Conversely, as the market value of a company's stock declines, so does the value of the option. The practical implication of this theory for corporate bond analysis is that the perceptions of both markets should be compared before a final credit judgment is rendered. For the analyst who believes that there is a higher level of efficiency in the stock market than in the bond market, particular attention should be paid to the stock price of the company being analyzed. Of interest will be those situations in which the two markets are judged to differ substantially.

For example, in early 1981, the market-to-book values of the major chemical companies ranged from 0.77 to 2.15. The bond ratings of these same companies ranged from Baa/BBB to Aaa/AAA. The interesting point is not the range of either the market-to-book values or the bond ratings but rather the fact that although there was some correlation between the market/book ratios and bond ratings, there were instances in which there was little or no correlation. Options theory would suggest that there should be more of a relationship between the two. When the relative valuation of the bond as measured by the rating is low compared with the equity valuation as measured by market/book, one or both markets may be incorrectly valuing the company. Given the empirical evidence that bond rating changes generally lag behind market moves, it is likely in this case that the bond rating is too high for the company's financial profile.

Tracking stocks can benefit the bond analyst in two major ways. First, tracking stock movements is an efficient way of monitoring a large bond portfolio.

1. These models, discussed in Chapter 33, are referred to "structural models," "asset-value models," and "firm-value models."

Second, following the stock price of one company may assist the analyst in following an issuer. For example, analysts should value a company's holdings in other companies to the extent possible. Once a company is public, this is accomplished easily, as was the case of Associates and Ford Motor Company. In 1996, Ford Motor Company completed an initial public offering of Associates. Once the IPO was complete, and before Ford spun out the rest of Associates to its shareholders, analysts could easily value Ford's interest in Associates simply by looking up the price of Associates common stock.

Significant price movements may indicate a change in credit quality and should be investigated. At the least, an explanation of major stock price movements either by themselves or relative to the stock prices of other companies should be sought with a call to management and a careful reading of related news stories. Sometimes a sharp run-up in the price of a stock may indicate an acquisition. Acquisitions often are beneficial for the shareholders of the acquired company because of the premium paid for the stock. However, the effect of an acquisition on a bondholder varies from transaction to transaction. In a favorable scenario, the issuer of the bond is acquired by a higher-rated entity. Such was the case in 1997 when AA rated Boeing Company acquired A rated McDonnell Douglas Corporation. In an unfavorable scenario, the issuer of the bond is either acquired or merged with a lower-rated entity, and its ratings are lowered. Such was the case with the debt of BBB rated Ohio Edison after it merged with Centerior Energy and its BB+ rated Cleveland Electric Illuminating and BB rated Toledo Edison operating subsidiaries.

INDUSTRY CONSIDERATIONS

The first step in analyzing a bond is to gain some familiarity with the industry. Only within the context of an industry is a company analysis valid. For example, a company growing at 15% annually may appear attractive. However, if the industry is growing at 50% annually, the company is competitively weak. Industry considerations can be numerous. However, an understanding of the following eight variables discussed in this section should give the general fixed income analyst a sufficient framework to properly interpret a company's prospects:

- Economic cylicality
- Growth prospects
- Research and development expenses
- Competition
- Sources of supply
- Degree of regulation
- Labor
- Accounting

Several of these variables should be considered in a global context. For example, it is not sufficient to consider the competitive position of the automobile industry without considering its global competitive position. As trade barriers fall, the need to become globally competitive increases.

Economic Cyclicality

The economic cyclicality of an industry is the first variable an analyst should consider in reviewing an industry. Does the industry closely follow gross domestic product (GDP) growth, as does the retailing industry, or is it recession-resistant but slow-growing, like the regulated electric utility industry? The growth in earnings per share (EPS) of a company should be measured against the growth trend of its industry. Major deviations from the industry trend should be the focus of further analysis. Some industries may be somewhat dependent on general economic growth but be more sensitive to demographic changes. The nursing home industry is a prime example of this type of sensitivity. With the significant aging of the U.S. population, the nursing home industry is projected to have above-average growth for the foreseeable future. Other industries, such as the banking industry, are sensitive to interest rates. When interest rates are rising, the earnings of banks with a high federal funds exposure underperform the market because their loan rates lag behind increases in the cost of money. Conversely, as interest rates fall, banking earnings outperform the market because the lag in interest change works in the banks' favor.

In general, however, the earnings of few industries correlate perfectly with one economic statistic. Not only are industries sensitive to many economic variables, but often various segments within a company or an industry move countercyclically or at least with different lags in relation to the general economy. For example, the housing industry can be divided between new construction and remodeling and repair. New construction historically has led GDP growth, but repair and remodeling have exhibited less sensitivity to general trends. Therefore, in analyzing a company in the construction industry, the performance of each of its segments must be compared with the performance of the subindustry.

Growth Prospects

A second industry variable related to economic cyclicality is the growth prospects for an industry. Is the growth of the industry projected to increase and be maintained at a high level, such as in the nursing home industry, or is growth expected to decline, as in the defense industry? Each growth scenario has implications for a company. In the case of a fast-growth industry, how much capacity is needed to meet demand, and how will this capacity be financed? In the case of slow-growth industries, is there a movement toward diversification and/or a consolidation within the industry, such as in the railroad industry? A company operating within a fast-growing industry often has a better potential for credit improvement than does a company whose industry's growth prospects are below average. However, barriers to entry and the sustainability of growth must be considered along with growth prospects for an industry. If an industry is growing rapidly, many new participants may enter the business, causing oversupply of product, declining margins, and possible bankruptcies.

The growth prospects of an industry also should be considered in a global context, particularly if a company has international exposure. Frequently, the growth prospects of an industry vary by country. For example, soft drinks are a mature industry in the United States but are a growth industry in other parts of the world.

Research and Development Expenses

The broad assessment of growth prospects is tempered by the third variable—the research and development (R&D) expenditures required to maintain or expand market position. Products with high-tech components can become dated and obsolete quickly. Therefore, although a company may be well situated in an industry, if it does not have the financial resources to maintain a technological lead or at least expend a sufficient amount of money to keep technologically current, its position is likely to deteriorate in the long run. In the short run, however, a company whose R&D expenditures are consistently below industry averages may produce above-average results because of expanded margins.

Evaluation of research and development is further complicated by the direction of technology. Successful companies not only must spend an adequate amount of resources on development, but they also must be correct in their assessment of the direction of the industry. Deployment of significant amounts of capital may not prevent a decline in credit quality if the capital is misdirected. For example, computer companies that persisted in spending a high percentage of their capital expenditures on the mainframe component of their business suffered declines in credit quality because the mainframe business is declining. Clearly, the risk of misdirected capital exists in the telecommunications area. Currently, there is a high degree of capital investment in the telecommunications industry. The direction of investment varies significantly among companies.

Competition

Competition is based on a variety of factors. These factors vary depending on the industry. Most competition is based on quality and price. However, competition is also derived from other sources, such as airlines operating in bankruptcy that are able to lower their costs by eliminating interest on debt and rejecting high-cost leases and thereby gain a cost advantage.

Increasingly, all forms of competition are waged on an international basis and are affected by fluctuations in relative currency values. Companies that fare well are those which compete successfully on a global basis and concentrate on the regions with the highest potential for growth. Consumers are largely indifferent to the country of origin of a product as long as the product is of high quality and reasonably priced. This fact is exemplified by the significant increase in the manufacture of automobiles and automobile parts in Mexico that are shipped to the United States.

Competition within an industry relates directly to the market structure of an industry and has implications for pricing flexibility. An unregulated monopoly is in an enviable position in that it can price its goods at a level that will maximize profits. Most industries encounter some free-market forces and must price their goods in relation to the supply and demand for their goods, as well as the price charged for similar goods. In an oligopoly, a pricing leader is not uncommon. A concern arises when a small company is in an industry that is moving toward oligopoly. In this environment, the small company's costs of production may be higher than those of the industry leaders, and yet it may have to conform to the pricing of the industry leaders. In the extreme, a price war could force the smaller companies out of business. This situation has occurred in the brewing industry. For the past 25 years, as the brewing industry has become increasingly concentrated, the leaders have gained market share at the expense of the small local brewers. Many small local brewers have either been acquired or gone out of business. These local brewers have been at a dual disadvantage: They are in an industry whose structure is moving toward oligopoly, and yet their weak competitive position within the industry largely precludes pricing flexibility.

A concern also arises when there is overcapacity in the industry. Often overcapacity is accompanied by price wars. Generally, price wars result in an industry-wide financial deterioration as battles for market share are accompanied by declining profits or losses.

Sources of Supply

The market structure of an industry and its competitive forces have a direct impact on the fifth industry variable—sources of supply of major production components. A company that is not self-sufficient in its factors of production but is sufficiently powerful in its industry to pass along increased costs is in an enviable position.

Degree of Regulation

The sixth industry consideration is the degree of regulation.The electric utility industry is the classic example of regulation. Nearly all phases of a utility's operations historically have been regulated. However, the industry has a federal mandate to deregulate. Initially, it was thought that deregulation would proceed rapidly. However, the complexity of the process suggests that the deregulation of the electric utility industry will take longer than originally thought.

The analyst should not be concerned with the existence or absence of regulation per se but rather with the direction of regulation and the effect it has on the profitability of the company. For the electric utility industry, the transition to deregulation still will be controlled largely by the regulatory authorities in a given state. In particular, regulatory commissions will have to deal with rates and the treatment of stranded costs. The treatment of these variables varies from state to state. Stranded costs include such items as generating plants whose cost per kilowatt is above current market costs and contracts with independent power producers to purchase power at above market prices. Although all electric utilities will transition to deregulation over the next decade, companies whose regulatory authorities assist in the recovery of stranded costs will be better positioned than companies with unsupportive regulatory authorities. To date, the treatment of stranded-cost recovery has varied widely. Some states have allowed the full recovery of stranded costs through a competitive transition charge on consumers' bills, whereas other states have allowed utilities to reduce stranded costs by using gains on the sale of generation to offset stranded costs. In other jurisdictions, stranded costs are subject to a "true-up mechanism," whereby the actual stranded cost is recalculated at some point in the future, and the difference between the estimated stranded cost and the actual stranded cost calculated is either rebated to customers or paid to the company. True-ups may be significant because the high price of power could lower potential stranded costs for certain generation.

Labor

The labor situation of an industry also should be analyzed. Is the industry heavily unionized? If so, what has been the historical occurrence of strikes? What level of flexibility does management have to reduce the labor force? When do the current contracts expire, and what is the likelihood of timely settlements? The labor situation is also important in nonunionized companies, particularly those whose labor situation is tight. What has been the turnover of professionals and management in the firm? What is the probability of a firm's employees, such as highly skilled engineers, being hired by competing firms? What is the likelihood of union activity in nonunionized companies? Are the states in which unionization is a possibility right-to-work states and therefore more difficult to unionize? How much of a cost advantage do the nonunionized companies have over the unionized companies?

The more labor-intensive an industry, the more significance the labor situation assumes. This fact is evidenced by the domestic automobile industry, in which overcapacity and high unionization have contributed to high fixed costs and cyclic record operating losses.

Occasionally, analysts concentrate on the per-hour wages of the labor force. Such an emphasis is misleading. An evaluation of the labor force should concentrate on work rules because work rules are more important in the overall efficiency of an organization than the wage rates. This is an important factor in the profitability of some automobile supply companies.

Accounting

A final industry factor to be considered is accounting. Does the industry have special accounting practices, such as those in the insurance industry or the electric utility industry? If so, an analyst should become familiar with industry practices before proceeding with a company analysis. Also important is whether a company is liberal or conservative in applying the generally accepted accounting principles. The norm of an industry should be ascertained and the analyst should analyze comparable figures.

Particular attention should be paid to companies that use an accounting system other than U.S. generally accepted accounting principles (GAAP). Reported results should be reconciled with those which would have been reported under U.S. GAAP. In addition, changes in GAAP should be scrutinized.

Care also should be taken when dealing with historical data. Frequently, companies adjust prior years' results to accommodate discontinued operations and changes in accounting. These adjustments can mask unfavorable trends. For example, companies that regularly dispose of underperforming segments and then highlight the more profitable continuing operations may be trying to hide poor management. In order to fully appreciate all trends, both the unadjusted and the adjusted results should be analyzed.

Attention to accounting practices also should be paid when mergers and acquisitions are involved. How much of pro-forma results are attributable to savings that are not yet realized but are allowed in pro-forma results? How much goodwill is generated by the combination? Are any contracts written up because the acquiring company believes that it can improve the historical performance of the company it acquired? A conscientious analyst will be aware of these accounting entries and determine whether they reflect a pro-forma reality or, a too-optimistic assessment of future performance.

FINANCIAL ANALYSIS

Having achieved an understanding of an industry, the analyst is ready to proceed with a financial analysis. The financial analysis should be conducted in three phases. The first phase consists of traditional ratio analysis for bonds. The second phase, generally associated with common stock research, consists of analyzing the components of a company's return on equity. The final phase considers such nonfinancial factors as management and foreign exposure and includes an analysis of the indenture.

Traditional Ratio Analysis

There are numerous ratios that can be calculated in applying traditional ratio analysis to bonds. Of these, the following eight will be discussed in this section:

- Pretax interest coverage
- Leverage

- Cash flow
- Net assets
- Intangibles
- Unfunded pension liabilities
- Age and condition of plant
- Working capital

These selected ratios are the ratios with the widest degree of applicability. In analyzing a particular industry, however, other ratios assume significance and should be considered.

Pretax Interest Coverage

Generally, the first ratio calculated in credit analysis is pretax interest coverage. This ratio measures the number of times interest charges are covered on a pretax basis. Pretax interest coverage is calculated by dividing pretax income plus interest charges by total interest charges. The higher the coverage figure, the safer is the credit. If interest coverage is less than 1×, the company must borrow or use cash flow or proceeds from the sale of assets to meet its interest payments.

Generally, published coverage figures are pretax as opposed to after-tax because interest payments are a pretax expense. Although the pretax interest coverage ratio is useful, its utility is a function of the company's other fixed obligations. For example, if a company has other significant fixed obligations, such as rents or leases, a more appropriate coverage figure would include these other fixed obligations. An example of this is the retail industry, in which companies typically have significant lease obligations. A calculation of simple pretax interest coverage would be misleading in this case because fixed obligations other than interest are significant.

The analyst also should be aware of any contingent liabilities such as a company's guaranteeing another company's debt. For example, there has been a dramatic increase in the insurance industry's guaranteeing of other company's debt. Today, this guaranteed debt exceeds the debt of the industry. Although the company being analyzed may never have to pay interest or principal on the guaranteed debt, the existence of the guarantee diminishes the quality of the pretax coverage. In addition, the quality of the guaranteed debt must be considered.

Once pretax interest coverage and fixed-charge coverage are calculated, it is necessary to analyze the ratios' absolute levels and the numbers relative to those of the industry. For example, pretax interest coverage for an electric utility of 3.0× is consistent with an A rating, whereas the same coverage for a drug company would indicate a lower rating.

Exhibit 32–1 shows the various key pretax interest coverage ratios reported by Standard & Poor's and how they are computed by that rating agency. The exhibit defines each measure used in a ratio and the formula.

EXHIBIT 32–1

S&P Glossary of Terms and Formula for Key Ratios

Glossary

Pretax income from continuing operations: Net income from continuing operations before (1) special items, (2) minority interest, (3) gains or reacquisition of debt, plus income taxes.

Eight times rents: Gross rents paid multiplied by capitalization factor of eight.

Equity: Shareholders' equity (including preferred stock) plus minority interest.

Free operating cash flow: Funds from operations minus capital expenditures and minus (plus) the increase (decrease) in working capital (excluding changes in cash, marketable securities, and short-term debt).

Funds from operations (or funds flow): Net income from continuing operations plus depreciation, amortization, deferred income taxes, and other noncash items.

Gross interest: Gross interest incurred before subtracting (1) capitalized interest, (2) interest income.

Gross rents: Gross operating rents paid before sublease income.

Interest expense: Interest incurred minus capitalized interest.

Long-term debt: As reported, including capitalized lease obligations on the balance sheet.

Operating income: Sales minus cost of goods manufactured (before depreciation and amortization), selling, general and administrative, and research and development costs.

Total debt: Long-term debt plus current maturities, commercial paper, and other short-term borrowings.

Formulas for Key Ratios

Pretax interest coverage

$$= \frac{\text{Pretax income from continuing operations} + \text{Interest expense}}{\text{Gross interest (before subtracting capitalized interest and interest income)}}$$

Pretax interest coverage including rents

$$= \frac{\text{Pretax income from continuing operations} + \text{Interest expense} + \text{Gross rents}}{\text{Gross interest} + \text{Gross rents}}$$

EBITDA interest coverage

$$= \frac{\text{Pretax income from continuing operations} + \text{Interest expense} + \text{Depreciation and amortization}}{\text{Gross interest}}$$

Funds from operations (or funds flow) as a % of total debt

$$= \frac{\text{Funds from operations}}{\text{Total debt}} \times 100$$

$$\text{Free operating cash flow as a \% of total debt} = \frac{\text{Free operating cash flow}}{\text{Total debt}} \times 100$$

EXHIBIT 32–1

(*Continued*)

Pretax return on permanent capital

$$= \frac{\text{Pretax income from continuing operations} + \text{Interest expense}}{\begin{array}{c}\text{Sum of (1) the average of the beginning of year and end of} \\ \text{year current maturities, long-term debt, noncurrent deferred} \\ \text{taxes, minority interest, and shareholders' equity and} \\ \text{(2) average short-term borrowings during year per footnotes} \\ \text{to financial statements}\end{array}} \times 100$$

$$\text{Operating income as a \% of sales} = \frac{\text{Operating income}}{\text{Sales}} \times 100$$

$$\text{Long-term debt as a \% of capitalization} = \frac{\text{Long-term debt}}{\text{Long-term debt} + \text{Equity}} \times 100$$

$$\text{Total debt as a \% of capitalization} + \text{short-term debt} = \frac{\text{Total debt}}{\text{Total debt} + \text{Equity}} \times 100$$

Total debt + 8 times rents as a % of capitalization + short-term debt + 8 times rents

$$= \frac{\text{Total debt} + 8 \text{ times gross rentals paid}}{\text{Total debt} + \text{Equity} + 8 \text{ times gross rentals paid}} \times 100$$

Source: "Adjusted Key U.S. Industrial Financial Ratios," *Standard & Poor's Credit Week*, September 20, 2000, pp. 39–44.

Leverage

A second important ratio is leverage, which can be defined in several ways. The most common definition of *leverage* is long-term debt as a percent of total capitalization. The higher the level of debt, the higher is the percentage of operating income that must be used to meet fixed obligations. If a company is highly leveraged, the analyst also should look at its margin of safety. The *margin of safety* is defined as the percentage by which operating income could decline and still be sufficient to allow the company to meet its fixed obligations.

The most common way to calculate leverage is to use the company's capitalization structure as stated in the most recent balance sheet. In addition to this measure, the analyst should calculate capitalization using a market approximation for the value of the common stock. When a company's common stock is selling significantly below book value, leverage will be understated by the traditional approach. In a similar manner, leverage is overstated when a company's equity is selling significantly above book value. However, traditional measures of leverage should not be replaced by market-adjusted measures. Market-adjusted leverage may appear low when the equity market is at historic highs. However, it should be remembered that high equity values do not generate income to meet fixed charges or repay debt.

The degree of leverage and margin of safety vary dramatically among industries. Finance companies traditionally have been among the most highly leveraged companies, with debt-to-equity ratios of 10:1. Although such leverage is tolerated in the finance industry, an industrial company with similar leverage would have a difficult time issuing debt.

In addition to considering the absolute and relative levels of leverage of a company, the analyst should evaluate the debt itself. How much of the debt has a fixed rate, and how much has a floating rate? A company with a high component of debt tied to the prime rate may find its margins being squeezed as interest rates rise if there is no compensating increase in the price of the firm's goods. Such a debt structure may be beneficial during certain phases of the interest-rate cycle, but it precludes a precise estimate of what interest charges for the year will be. In general, a company with a small percentage of floating-rate debt is preferable to a similarly leveraged company with a high percentage of floating-rate debt.

The maturity structure of the debt also should be evaluated. What is the percentage of debt that is coming due within the next five years? As this debt is refinanced, how will the company's embedded cost of debt be changed?

The existence of material operating leases can understate the leverage of a firm. Operating leases should be capitalized to give a true measure of leverage.

A company's bank lines often comprise a significant portion of a company's total debt. These lines should be analyzed closely in order to determine the flexibility afforded to the company. The lines should be evaluated in terms of undrawn capacity as well as security interests granted. In addition, the analyst should determine whether the line contains a "material adverse change" (MAC) clause under which the line could be withdrawn. For example, a company that has drawn down its bank lines completely and is in jeopardy of activating its MAC clause may have trouble refinancing any debt. In a similar manner, undrawn lines should be evaluated in terms of their capacity to replace commercial paper, if needed. In the event that a company's commercial paper rating is downgraded, the company's access to the commercial paper market may evaporate quickly. In this scenario, the company may be forced to draw on its bank lines to replace its maturing commercial paper. A company whose commercial paper is fully backed by bank lines is in a stronger position than one whose bank lines do not cover its outstanding commercial paper.

Again, Exhibit 32–1 shows the key ratios used by Standard & Poor's and the formula for calculating each ratio.

Cash Flow

A third important ratio is cash flow as a percent of total debt. *Cash flow* is often defined as net income from continuing operations plus depreciation, depletion, amortization, and deferred taxes. In calculating cash flow for credit analysis, the analyst also should subtract noncash contributions from subsidiaries. In essence, the analyst should be concerned with cash from operations. Any extraordinary sources or uses of funds should be excluded when determining the overall trend of cash-flow coverage. Cash dividends from subsidiaries also should be questioned in terms of their appropriateness (too high or too low relative to the subsidiary's earnings) and also in terms of the parent's control over the upstreaming of dividends. Is there a legal limit to the upstreamed dividends? If so, how close is the current level of dividends to the limit?

Net Assets

A fourth significant ratio is net assets to total debt. In analyzing this facet of a bond's quality, consideration should be given to the liquidation value of the assets. Liquidation value often will differ dramatically from the value stated on the balance sheet. At one extreme, consider a nuclear generating plant that has had operating problems and has been closed down and whose chance of receiving an operating license is questionable. This asset is probably overstated on the balance sheet, and the bondholder should take little comfort in reported asset protection. The issue of overstated values on the balance sheet of an electric utility has been highlighted increasingly as the electric utility industry deregulates and has to deal explicitly with stranded investments. At the other extreme is the forest products company whose vast timber acreage is significantly understated on the balance sheet. In addition to the assets' market value, some consideration also should be given to the liquidity of the assets. A company with a high percentage of its assets in cash and marketable securities is in a much stronger asset position than a company whose primary assets are illiquid real estate.

Aggressive accounting also can signal overvalued assets. Numerous firms in the finance industry have securitized their loans in the form of asset-backed securities.[2] Some of these firms adopted "gain on sale" accounting, which allowed them to recognize income against receivables that were securitized. However, the "profits" did not take the form of cash but rather were held as "interest only" securities (IOs) that were considered investments. The value of these IOs was estimated based on prepayment assumptions (voluntary and involuntary) and default and recovery rates for the pool of assets securitized. For some companies, the IOs were overvalued. When such companies failed, the value of the IOs did not provide full recovery to the creditors.

The wave of takeovers, recapitalizations, and other restructurings has increased the importance of asset coverage protection. Unfortunately for some bondholders, mergers or takeovers may decimate their asset coverage by adding layers of debt to the corporate structure that is senior to their holdings. While the analyst may find it difficult to predict takeovers, it is crucial to evaluate the degree of protection from takeovers and other restructurings that the bond indenture offers.

In extreme cases, the analyst must consider asset coverage in the case of bankruptcy. This is particularly important in the case of lease obligations because the debtor has the ability to reject leases in bankruptcy. In the case of lease rejections, the resulting asset protection may depend on a legal determination of whether the

2. The various types of asset-backed securities are discussed in several chapters in this book.

underlying lease is a true lease or a financing arrangement. Even if the lease if determined to be a true lease, the determination of asset protection is further complicated by a determination of whether the lease relates to nonresidential real property or to personal property. The difference in security (i.e., recovery in a bankruptcy) is significant. Damages under a lease of nonresidential real property are limited to three years of lease payments. Damages under a lease of personal property are all due under the lease.

In addition to the major variables just discussed, the analyst also should consider several other financial variables, including intangibles, pension liabilities, the age and condition of the plant, and working capital adequacy.

Intangibles

Intangibles often represent a small portion of the asset side of a balance sheet. Occasionally, particularly with companies that have or have had an active acquisition program, intangibles can represent a significant portion of assets. In this case, the analyst should estimate the actual value of the intangibles and determine whether this value is in concert with a market valuation. A carrying value significantly higher than market value indicates a potential for a write-down of assets. The actual write-down may not occur until the company actually sells a subsidiary with which the intangibles are identified. However, the analyst should recognize the potential and adjust capitalization ratios accordingly.

Pension Liabilities

Unfunded pension liabilities also can affect a credit decision. Although a fully funded pension is not necessary for a high credit assessment, a large unfunded pension liability that is 10% or more of net worth can be a negative. Of concern is the company whose unfunded pension liabilities are sufficiently high to interfere with corporate planning[3]. For example, in the late 1980s, a steel company with high unfunded pension liabilities might have delayed or decided against closing an unprofitable plant because of the pension costs involved. The analyst also should be aware of a company's assumed rate of return on its pension funds and salary-increase assumptions. The higher the assumed rate of return, the lower the contribution a company must make to its pension fund, given a set of actuarial assumptions. Occasionally, a company having difficulty with its earnings will raise its actuarial assumption and thereby lower its pension contribution and increase earnings. The impact on earnings can be dramatic. In other cases, companies have attempted to "raid" the excess funds in an overfunded retirement plan to enhance earnings.

In periods of declining interest rates, the analyst also must consider the discount rate companies use to discount their future obligations. Companies generally

3. For a discussion of the impact of accounting for defined benefit pension plans on key financial measures (leverage, earnings, and cash flow) and a methodology to adjust these measures to reflect the true economic impact of pension plans, see David Zion and Bill Carcache, *The Magic of Pension Accounting: Part II*, Equity Research, Credit Suisse First Boston (October 15, 2003).

use the yield of AA corporate bonds as a discount factor, a benchmark that has been criticized by market analysts.

Age and Condition of Plant

The age of a company's plant also should be estimated, if only to the extent that its age differs dramatically from industry standards. A heavy industrial company whose average plant age is well above that of its competitors is probably already paying for its aged plant through operating inefficiencies. In the longer term, however, the age of the plant is an indication of future capital expenditures for a more modern plant. In addition, underdepreciation of the plant significantly increases reported earnings.

The availability of information regarding the average age and condition of plants varies among companies. On the one hand, airline carriers readily provide the average age of their fleet and the money each will save as they replace older aircraft with more fuel-efficient aircraft that require fewer people in the cockpit. On the other hand, the average age of a plant compared with the industry average is not always available for some companies such as paper companies. Furthermore, management of older plants generally emphasize the capital improvements that have been made to the plants over the years, which distort direct comparisons. In this case, it is helpful to carefully read several years of management's explanation of operating results from the annual reports. Often this section will include reports of above-average maintenance expense and machines that were out of service for a period of time for maintenance. Such comments indicate that the plants and machines may not be as efficient as portrayed initially.

Working Capital

A final variable in assessing a company's financial strength concerns the strength and liquidity of its working capital. *Working capital* is defined as current assets less current liabilities. Working capital is considered a primary measure of a company's financial flexibility. Other such measures include the current ratio (current assets divided by current liabilities) and the acid test (cash, marketable securities, and receivables divided by current liabilities). The stronger the company's liquidity measures, the better it can weather a downturn in business and cash flow.

In assessing this variable, the analyst should consider the normal working capital requirements of a company and industry. The components of working capital also should be analyzed. Although accounts receivable are considered to be liquid, an increase in the average days a receivable is outstanding may be an indication that a higher level of working capital is needed for the efficient running of the operation. In addition, companies frequently have account receivable financing, some with recourse provisions. In this scenario, comparisons among companies in the same industry may be distorted.

The state of contraction or expansion also should be considered in evaluating working capital needs. Automobile manufacturers typically need increased working capital in years when automobile sales increase.

Analysis of the Components of Return on Equity

Once the preceding financial analysis is complete, the bond analyst traditionally examines the earnings progression of the company and its historical return on equity (ROE). This section of analysis often receives less emphasis than the traditional ratio analysis. It is equally important, however, and demands equal emphasis. An analysis of earnings growth and ROE is vital in determining credit quality because it gives the analyst necessary insights into the components of ROE and indications of the sources of future growth. Equity analysts devote a major portion of their time examining the components of ROE, and their work should be recognized as valuable resource material.

A basic approach to the examination of the components of ROE breaks down return on equity into four principal components: pretax margins, asset turnover, leverage, and one minus the tax rate.[4] These four variables multiplied together equal net income/stockholders' equity, or return on equity, as shown below:

$$\text{Net income/equity} = (\text{net pretax income/sales} + \text{operating pretax income/sales}) \times (\text{sales/assets}) \times (\text{assets/equity}) \times (1 - \text{tax rate})$$

The analyst should examine the progression of these four components of ROE for a minimum of five years and through at least one business cycle. The progression of each variable should be compared with the progression of the same variables for the industry, and deviations from industry standards should be further analyzed. For example, perhaps two companies have similar ROEs, but one company is employing a higher level of leverage to achieve its results, whereas the other company has a higher asset-turnover rate. Since the degree of leverage is largely a management decision, the analyst should focus on asset turnover. Why have sales for the former company turned down? Is this downturn a result of a general slowdown in the industry, or is it that assets have been expanded rapidly, and the company is in the process of absorbing these new assets? Conversely, a relatively high rise in asset-turnover rate may indicate a need for more capital. If this is the case, how will the company finance this growth, and what effect will the financing have on the firm's embedded cost of capital?

The analyst should not expect similar components of ROE for all companies in a particular industry. Deviations from industry norms are often indications of management philosophy. For example, one company may emphasize asset turnover, and another company in the same industry may emphasize profit margin. As in any financial analysis, the trend of the components is as important as the absolute levels.

In order to give the analyst a general idea of the types of ratios expected for a particular rating classification, Standard & Poor's publishes medians of key ratios by rating category. The analyst should use such information only in the most general applications. There are three reasons for this. First, industry standards vary

4. The formula was first presented in Jerome B. Cohen, Edward D. Zinbarg, and Arthur Zeikel, *Investment Analysis and Portfolio Management* (Homewood, IL: Richard D. Irwin, 1977).

considerably. Second, financial ratios are only one part of an analysis. Third, major adjustments often need to be made to income statements and balance sheets to make them comparable with the financial statements of other companies. However, the analyst should use this table only in the most general applications for three reasons. First, industry standards vary considerably. Second, financial ratios are only one part of an analysis. Third, major adjustments often need to be made to income statements and balance sheets to make them comparable with the financial statements of other companies.

Analysts interested in financial ratios for specific industries should consult Standard & Poor's CreditStats Service. This service, introduced in October 1989, presents key financial ratios organized into industry groups, as well as ratio analysis by long-term rating category for utility companies.

Nonfinancial Factors

After the traditional bond analysis is completed, the analyst should consider some nonfinancial factors that might modify the evaluation of the company. Among these factors are the degree of foreign exposure, the quality of management, and ownership. The amount of foreign exposure should be ascertainable from the annual report. Sometimes, however, specific country exposure is less clear because the annual report often lists foreign exposure by broad geographic divisions. If there is concern that a major portion of revenue and income is derived from potentially unstable areas, the analyst should carefully consider the total revenue and income derived from the area and the assets committed. Further consideration should be given to available corporate alternatives should nationalization of assets occur. Additionally, the degree of currency exposure should be determined. If currency fluctuations are significant, has management hedged its exposure?

The internationalization of the bond markets and the ability of countries to issue debt in other countries highlight the importance of understanding the effect of currency risks. For example, many Mexican companies issued U.S. dollar–denominated debt in the early 1990s. This issuance had a positive impact on the financials of these Mexican companies because of the generally lower interest rates available in the United States relative to Mexico. However, when the peso was devalued significantly in December 1994, the ability of some of these companies to meet their U.S. dollar–denominated obligations was questioned. Of particular concern were the companies whose revenues were largely denominated in pesos but whose interest expense was denominated in U.S. dollars.

The quality and depth of management are more difficult to evaluate. The best way to evaluate management is to spend time with management, if possible. Earnings progress at the firm is a good indication of the quality of management. Negative aspects would include a firm founded and headed by one person who is approaching retirement and has made no plan for succession. Equally negative is the firm that has had numerous changes of management and philosophy. On the other hand, excessive stability is not always desirable. In discussing the factors it considers in assigning a credit rating, Moody's Investors Service notes the following regarding the quality of management:

> Although difficult to quantify, management quality is one of the most important factors supporting an issuer's credit strength. When the unexpected occurs, it is a management's ability to react appropriately that will sustain the company's performance.[5]

In assessing management quality, the analysts at Moody's, for example, try to understand the business strategies and policies formulated by management. Following are factors that are considered: (1) strategic direction, (2) financial philosophy, (3) conservatism, (4) track record, (5) succession planning, and (6) control systems.

In recent years, focus has been on the corporate governance of the firm and the role of the board of directors. The bylaws are the rules of governance for the corporation. The bylaws define the rights and obligations of officers, members of the board of directors, and shareholders. Several firms have developed services that assess corporate governance. One type of service provides confidential assessment of the relative strength of a firm's corporate governance practices. The customer for this service is a corporation seeking external evaluations of its current practice. The second is a service that rates (or scores) the corporate governance mechanisms of companies. Generally, these ratings are made public at the option of the company requesting an evaluation.

Ownership of the firm also should be considered. If one family or group of investors owns a controlling interest in a firm, they may be too conservative in reacting to changes in the market. Owners also should be judged in terms of whether they are strategic or financial. Often financial buyers invest for the short to intermediate term, hoping to sell their positions (or the entire company) at a profit. If such a sale involves a leveraged buyout, the credit quality of the bonds is lowered, sometimes dramatically.

INDENTURE PROVISIONS

An *indenture* is a legal document that defines the rights and obligations of the borrower and the lender with respect to a bond issue. An analysis of the indenture should be a part of a credit review in that the indenture provisions establish rules for several important spheres of operation for the borrower. These provisions, which can be viewed as safeguards for the lender, cover such areas as the limitation on the issuance of additional debt, sale and leasebacks, and sinking-fund provisions.

Indenture provisions should be analyzed carefully. However, indentures provide little protection in the event of default and therefore are secondary to solid financial analysis. For example, a bondholder will receive little comfort if

5. "Industrial Company Rating Methodology," *Moody's Investors Services: Global Credit Research*, July 1998, p. 6.

the company in which she invests is required to grant her security in the company's assets, but the assets are worth less than the company's debt.

The indentures of bonds of the same industry are often similar in the areas they address. Correlation between the quality rating of the senior debt of a company and the stringency of indenture provisions is not perfect. For example, sometimes the debt test is more severe in A rated securities than in BBB rated securities. However, subordinated debt of one company often will have less restrictive provisions than will the senior debt of the same company. In addition, more restrictive provisions generally are found in private-placement issues. In analyzing a company's indenture, the analyst should look for the standard industry provisions. Differences in these provisions (either more or less restrictive) should be examined more closely. In this regard, a more restrictive nature is not necessarily preferable if the provisions are so restrictive as to hinder the efficient operation of the company.

Bond indentures should be analyzed in conjunction with the covenants of bank lines. Frequently, bank lines can be more restrictive than bond indentures. The analyst should focus on the most restrictive covenants. The management of a company often will direct the analyst to the issue with the most restrictive covenants.

Outlined below are the provisions found most commonly in indentures. These provisions are categorized by industry because the basic provisions are fairly uniform within an industry. A general description of the indenture is found in a company's prospectus. However, notification generally is given that the indenture provisions are only summarized. Often, covenants are ambiguous. Management should provide necessary interpretations. Occasionally, management will state that although a certain activity is permitted under the indenture, such as the sale of significant assets with no provision for debt repayment, the issuing company would not engage in such an activity. *Caveat emptor*. A complete indenture may be obtained from the trustee who is listed in the prospectus.

Careful attention should be paid to the definitions in indentures because they vary from indenture to indenture. Frequently, the definitions of terms specify carveouts, or excluded items, that are material. For example, the definition of consolidated net assets may carve out or exclude changes resulting from unfunded pension liabilities.

Utility Indentures

Security

The security provision is generally the first provision in a utility indenture. This provision specifies the property on which there is a mortgage lien. In addition, the ranking of the new debt relative to outstanding debt is specified. Generally, the new bonds rank equally with all other bonds outstanding under the mortgage. This ranking is necessary, but it has created difficulty for the issuing companies because some mortgage indentures were written more than 50 years ago. Specifically, because all bondholders must be kept equal, companies often must retain antiquated provisions in their indentures. Often these provisions hinder the efficient running of a company owing to structural changes in the industry since the original writing of the indenture. Changes in these provisions can be made, but changes have occurred slowly because of the high percentage of bondholders who must approve a change and the time and expense required to locate the bondholders. Occasionally, a company may retire certain old issues in order to eliminate a covenant that has not been included in recent offerings.

The security provisions of first-mortgage indentures must be scrutinized carefully because of the disaggregation in the industry. Particular attention must be paid to the release and substitution clause of the security provisions. In general, the release and substitution clause specifies the conditions under which collateral for the first-mortgage bonds may either be released from the indenture or other collateral may be substituted. In the context of disaggregation, holders of first-mortgage bonds must pay attention to the ability of a company to remove assets from under its mortgage indenture. Some companies require that removal of assets be made at fair market value, whereas other indentures are silent on this point. Bondholders need to evaluate the degree to which they are protected from having valuable transmission and distribution assets released from the mortgage while retaining higher-risk-generation assets including overvalued nuclear assets. In addition, the ability of an issuer to effectively remove assets through the use of purchased money mortgages should be evaluated.

Issuance of Additional Bonds

The "issuance of additional bonds" provision establishes the conditions under which the company may issue additional first-mortgage or other bonds. Often this provision contains a debt test and/or an earnings test. The debt test generally limits the amount of bonds that may be issued under the mortgage to a certain percentage (often 60%) of net property or net property additions, the principal amount of retired bonds, and deposited cash. The earnings test, on the other hand, restricts the issuance of additional bonds under the mortgage unless earnings for a particular period cover interest payments at a specified level. Generally, the covenants governing issuance of additional debt are operative for the life of the indenture. Occasionally, however, the covenants are operative for a shorter period. Such was the case for Southern California Edison's issuance of notes in November 2000. This issue contained a negative pledge clause that was effective for only 18 months.

Although both these tests may appear straightforward, the analyst must study the definitions contained in the tests carefully.

The potential for such write-downs has become more visible since the implementation of SFAS 90. SFAS 90 requires utilities to record a loss against income for any portion of an investment in an abandoned plant for which recovery has been disallowed. It further requires all costs disallowed for ratemaking purposes to be recognized as a loss against income as soon as the loss becomes probable with respect to disallowances of new plant costs resulting from a cap on expenditures. These losses may be reported by either restating financial statements for prior fiscal years or by recording the cumulative loss the year SFAS 90 is adopted.

The application of FAS 71 similarly may affect electric utilities. Continued use of FAS 71 requires that (1) rates be designed to recover specific costs of regulated service and (2) it is reasonable to assume that rates are set to continue to recover such costs. In the current environment of a transition to deregulation, utilities may be required to partially or totally write down assets that are to be recovered in rates. Such write-downs may affect these companies' ability to issue first-mortgage bonds. In the extreme, should regulators base interim stranded-cost recovery on average prices in a region, as was suggested in February 1997 by the New Hampshire Public Utility Commission, the affected utilities would become ineligible for regulatory accounting and be required to book substantial write-offs. Occasionally, the write-down of assets and the concomitant inability to issue first-mortgage debt can be offset by a quasi-reorganization. Under this accounting treatment, the company is allowed to write up certain assets to partially or totally offset the writedown of other assets. In this manner, the increased leverage (and negative retained earnings) that would result from a writedown of assets will be largely offset. This method was employed by Illinois Power in the fourth quarter of 1998. During the fourth quarter of 1998, Illinois Power wrote off its remaining investment in its Clinton Nuclear Station for a total charge of $1.2 billion. During the same quarter, Illinois Power increased the value of its fossil generation assets by approximately $1.4 billion.

Maintenance and Replacement Fund

The purpose of a maintenance and replacement (M&R) fund is to ensure that the mortgaged property is maintained in good operating condition. To this end, electric utility indentures generally require that a certain percentage of gross operating revenues, a percentage of aggregate bonded indebtedness, or a percentage of the utility's property account be paid to the trustee for the M&R fund. A major portion of the M&R fund requirement historically has been satisfied with normal maintenance expenditures. To the extent that there is a remaining requirement, the company may contribute cash, the pledge of unbonded property additions, or bonds.

Redemption Provisions

The redemption, or call, provision specifies during what period and at what prices a company may call its bonds. Redemption provisions vary. Refunding is an action by a company to replace outstanding bonds with another debt issue sold at a lower interest expense. (Refunding protection does not protect the bondholder from refunding bonds with equity or short-term debt.) The refunding protection is a safeguard for bondholders against their bonds being refunded at a disadvantageous time.

Sinking Fund

A sinking fund is an annual obligation of a company to pay the trustee an amount of cash sufficient to retire a given percentage of bonds. This requirement often can be met with actual bonds or with the pledge of property. In general, electric utilities have 1% sinking funds that commence at the end of the refunding period. However, there are several variations of the sinking-fund provision with which the analyst (and bondholder) should be familiar because they could directly affect the probability of bonds being called for sinking-fund purposes. Some companies have nonspecific, or funnel, sinkers. This type of sinker often entails a 1% or 1.5% sinking-fund applicable to all outstanding bonds. The obligation can be met by the stated percentage of each issue outstanding, by cash, or by applying (or funneling) the whole requirement against one issue or several issues.

Other Provisions

In addition to the provisions just discussed, the indenture covers the events of default, modification of the mortgage, security, limitations on borrowings, priority, and the powers and obligations of the trustee. In general, these provisions are fairly standard. However, differences occur that should be evaluated.

Industrial Indentures

Many of the provisions of an industrial indenture are similar to those of a utility's indenture, although specific items may be changed. In general, there are five indenture provisions that historically have been significant in providing protection for the industrial bondholder.

Negative Pledge Clause

The negative pledge clause provides that the company cannot create or assume liens to the extent that more than a certain percentage of consolidated net tangible assets (CNTAs) is so secured without giving the same security to the bondholders. This provision is important to the bondholders because their security in the specific assets of the company establishes an important protection for their investment. The specific percentage of CNTAs that is exempted from this provision is referred to as "exempted indebtedness," and the exclusion provides some flexibility to the company. The amount of exempted indebtedness can vary widely.

Limitation on Sale and Leaseback Transactions

The indenture provision limiting sale and leaseback parallels the protection offered by the negative pledge clause, except that it provides protection for the bondholder against the company selling and leasing back assets that provide security for the debtholder. In general, this provision requires that assets or cash equal to the property sold and leased back be applied to the retirement of the debt in question or used to acquire another property for the security of the bondholders.

Sale of Assets or Merger

The sale of assets or merger provision protects the bondholder in the event that substantially all of the assets of the company are sold or merged into another company. Under these circumstances, the provision generally states that the debt be retired or be assumed by the merged company. It should be noted that the merged company that assumes the debt may have a different credit rating.

Dividend Test

The dividend test provision establishes rules for the payment of dividends. Generally, it permits the company to pay dividends to the extent that they are no greater than net income from the previous year plus the earnings of a year or two prior. Although this provision allows the company to continue to pay dividends when there is a business decline, it assures the bondholders that the corporation will not be drained by dividend payments.

The dividend or restricted payment test also establishes parameters for the payment of dividends from operating subsidiaries to the holding company. The degree to which payments are allowed varies widely. Clearly, if an issuer is the holding company, a bondholder would favor a lenient restricted payment test because the holding company debt would benefit from the flexibility to upstream funds from the operating subsidiaries. On the other hand, if the issuer is the operating subsidiary, a bondholder would favor more stringent control over the ability of the holding company to upstream funds.

Debt Test

The debt test limits the amount of debt that may be issued by establishing a maximum debt-assets ratio. This provision generally is omitted from current public offerings. However, there are numerous indentures outstanding that include this provision. In addition, private placements often include a debt test. When present, the debt test generally sets a limit on the amount of debt that can be issued per dollar of total assets. This limitation sometimes is stated as a percentage. For example, a 50% debt-asset limit restricts debt to 50% of total assets.

Financial Indentures

Sinking-Fund and Refunding Provisions

Like industrial indentures, indentures for finance issues specify sinking-fund and refunding provisions. In general, finance issues with a short maturity are noncallable, whereas longer issues provide 10-year call protection. Occasionally, an issue can be called early in the event of declining receivables. Sinking funds are not as common in finance issues as they are in industrial issues, although they are standard for some companies.

Dividend Test

Perhaps the most important indenture provision for a bondholder of a finance subsidiary is the dividend test. This test restricts the amount of dividends that can be upstreamed from a finance subsidiary to the parent and thereby protects the bondholder against a parent draining the subsidiary. This provision is common in finance indentures, but it is not universal.

Limitation on Liens

The limitation on liens provision restricts the degree to which a company can pledge its assets without giving the same protection to the bondholder. Generally, only a nominal amount may be pledged or otherwise liened without establishing equal protection for the bondholder.

Restriction on Debt Test

The debt test limits the amount of debt the company can issue. This provision generally is stated in terms of assets and liabilities, although an earnings test has been used occasionally.

Negative Pledge Clause

Negative pledge clauses can be part of a finance company's indenture. However, carveouts may be included. For example, one finance company allows up to 10% of its bank lines to be secured without offering security to bondholders.

UTILITIES

Historically, utilities have been regulated monopolies. These companies generally operate with a high degree of financial leverage and low fixed-charge coverage (relative to industrial companies). These financial parameters have been accepted historically by investors owing to the regulation of the industry and the belief that there is minimal, if any, bankruptcy risk in those securities because of the essential services they provide.

The changing structure of the electric utility industry brought about by significant investment in nuclear generating units and their inherent risk, as well as the transition to deregulation, has changed this belief. Initially, the faltering financial position of General Public Utilities precipitated by the Three Mile Island nuclear accident and the regulatory delays in making a decision regarding the units highlighted the default risk that exists in the industry. Subsequently, the defaults of several Washington Public Power Supply System issues, the restructuring of Tucson Electric Company, and the bankruptcies of Public Service Company of New Hampshire and El Paso Electric Company and the transition to deregulation reemphasized the default risk. In addition, the industry is faced with the acid rain issue and increased uncertainty in construction costs and growth rates.

In 1985, Standard & Poor's developed more conservative financial benchmarks for a given rating to reflect the increased risk in the industry. In 1993, S&P

categorized the electric utilities into three groups to reflect their business risk profiles. In October 1997, S&P revised its analysis with respect to first-mortgage bonds. In its refinement, S&P placed more weight on the ultimate recovery of principal in the event of distress. The revision resulted in numerous one-notch upgrades and several two-notch upgrades for the first-mortgage debt of electric utilities. These revisions were appropriate given the fact that first-mortgage bonds may receive full recovery even in bankruptcy if they are fully collateralized, as was the case with the Public Service Company of New Hampshire. More recently, the rating agencies have addressed the differences between the transmission and distribution business and the generation business in terms of the business risk of each of these segments.

Segments within the Utility Industry

There are three major segments within the utility industry: electric companies, gas companies, and telephone companies. This chapter will deal primarily with electric utilities. A working knowledge of all three utility segments is increasingly important as the electric and gas segments converge and the electric companies increasingly use their access to homes and businesses to develop telecommunication businesses. A working knowledge of the different facets of the electric utility industry is also required as traditional electric utilities diverge in their strategies, with some companies emphasizing transmission and distribution exclusively while other companies emphasize generation.

Nonfinancial Factors

Although financial factors are important in analyzing any company, nonfinancial factors are particularly important in the electric utility industry and may alter a credit assessment. The following nonfinancial factors are of particular importance to the utility industry: (1) regulation, (2) source of the company's energy, (3) growth and stability of the company's territory, (4) capital structure, (5) degree of activity in international and nonutility investments, and (6) competitive position.

The importance of nonfinancial factors led S&P to revise its financial ratios for electric utilities to take these nonfinancial factors explicitly into consideration. Specifically, in October 1993, S&P divided the electric utility universe into three groups according to business profile. These business profiles are above average, average, and below average. Accordingly, the median financial parameters in the financial analysis section are segmented according to business risk as well as rating category. As disaggregation occurs in the electric utility business, the financial parameters will be segmented further, with the more risky generation assets demanding less leverage and higher interest coverage for a given rating than the less risky transmission and distribution operations.

Regulation

Regulation is perhaps the most important variable in the electric utility industry because regulatory commissions largely determine how much profit an electric utility generates and retains. All electric companies are regulated, most by the state or states in which they operate. If a company operates in more than one state, the analyst should weigh the evaluation of the regulatory atmosphere by revenues generated in each state.

The evaluation of regulatory commissions is a dynamic process. The composition of commissions changes because of retirements, appointments, and elections. The implications of personnel changes are not clear until decisions are made. For example, it is not always the case that elected commissioners are pro-consumer and appointments by a conservative governor are pro-business. Several brokerage firms can assist in evaluations of commissions.

In addition, the Federal Energy Regulatory Commission (FERC) regulates interstate operations and the sale of wholesale power. Currently, FERC regulation is considered to be somewhat more favorable than that of the average state regulatory commission.

Utilities that are constructing or operating nuclear reactors are also subject to the regulation of the Nuclear Regulatory Commission (NRC). The NRC has broad regulatory and supervisory jurisdiction over the construction and operation of nuclear reactors. Importantly, the NRC approves licensing of nuclear reactors, as well as the transfer of licenses.

There is potential for more federal regulation of electric utilities in the near term with respect to both deregulation and PUHCA (the Public Utility Holding Company Act). If federal legislation is passed with respect to deregulation, it is unlikely to affect existing state initiatives. Rather, any federal legislation likely would extend the general attributes of existing state initiatives to states that have failed to deregulate, such as Florida. Many utilities would support the repeal of PUHCA in order to allow them more flexibility in mergers and acquisitions. PUHCA is likely to be repealed eventually because it largely has become antiquated. However, the timing of PUHCA repeal is political.

Utilities may be affected by the decisions of state commissions even if the commissions are located in a different state.

Regulation is best quantified by recent rate decisions and the trend of these decisions. Although a company being analyzed may not have had a recent rate case, the commission's decisions for other companies operating within the state may be used as a proxy. Regulatory commissions are either appointed or elected. In either case, the political atmosphere can have a dramatic effect on the trend of decisions. The high power prices in California and public reaction evidence this point. Although Californian politicians were quick to take credit for being the first state to deregulate, they were less quick to admit that their policies were in part to blame for the energy crisis.

The regulators determine innumerable issues in a rate decision, although analysts often mistakenly focus only on the allowed rate of return on equity or the percentage of request granted. For example, a commission might rule that an electric utility must reduce rates by 10%. However, if the commission allows the utility to accelerate its depreciation, the negative effect on the cash flow of the company from the rate reduction may be largely offset, particularly if the company had been or was expected to exceed its allowed ROE. The commissions also determine how much of construction work in progress (CWIP) is allowed into the rate base. A company may appear to have a favorable allowed ROE but be hurt by the fact that only a small portion of the company's capital is permitted to earn that return, and the CWIP earns nothing. Allowance of CWIP in the rate base was of critical importance during the 1980s because of the high construction budgets for nuclear generating plants and the length of time these plants were under construction. Some companies have had more than half their capital in CWIP that was not permitted to earn a return.

The importance of whether CWIP is allowed in the rate base is highlighted by the financial distress and January 1988 bankruptcy filing of Public Service Company of New Hampshire (PSNH). PSNH's Seabrook Nuclear Unit I was virtually complete in 1986. However, licensing delays and New Hampshire's statutory prohibition of CWIP in the rate base were major contributing factors in the bankruptcy filing.

In addition, regulators have a high degree of control over the cash flow of a company through the allowance or disallowance of accounting practices and the speed with which decisions are made on cases.

Source of the Company's Energy

The source of the company's energy is a second important variable. For many years, a company with a high nuclear exposure was viewed less favorably than a company with natural gas or coal units. Nuclear generation was out of favor because of several factors: licensing requirements, high capital costs, and decommissioning expenses. The disrepute of nuclear generation has reversed somewhat as capital costs have been written down, pollution issues of coal generation have escalated, and the price of oil and natural gas has risen. In fact, there is a likelihood that the licenses of several nuclear plants will be extended. Each fuel must be evaluated in the context of the overall cost of running a plant.

Growth and Stability of the Company's Territory

The energy-source variable relates to a third variable—the growth and stability of the company's territory. Although above-average growth is viewed positively in an industrial company, above-average growth has mixed reviews with respect to an electric utility. An electric utility with above-average growth may face construction earlier than its competitors depending on the supply/demand balance and regulation in a company's service territory.

Slow growth is not necessarily positive if it places a utility in a position of excess capacity. The increase in cogeneration and the mergers executed in order to better match supply and demand can place a utility at risk. This could result if utility A were selling power to utility B. If the expiration of the contract coincides with utility B's ability to purchase power for less and results in utility B's nonrenewal of the contract, utility A could be negatively affected unless it can sell the power to a third utility. The issue of growth has been complicated by deregulation and the requirement in many states for disaggregation of generation from transmission and distribution, as well as the requirement that customers be allowed to choose their supplier. In this new era, utilities engaged in generation must be able to match supply and demand for power.

Capital Structure

A fourth variable, whether or not a company is a subsidiary of a holding company, also should be considered. Holding-company status permits nonutility subsidiaries, but these subsidiaries (even if successful) will not necessarily improve the overall credit quality of the company. This depends on the regulatory atmosphere. Furthermore, when there are several electric utility subsidiaries, the parent is more likely to give relatively large equity infusions to the relatively weak subsidiaries. The stronger subsidiary may have to support the other subsidiaries. Finally, holding companies should be analyzed in terms of consolidated debt. Although a particular subsidiary may have relatively strong financial parameters, off-balance-sheet financing may lower the overall assessment.

Degree of Activity in International and Nonutility Investments

The current era of deregulation has contributed to a significant increase in international and nonutility investments. Companies that are active in this area emphasize the potential equity returns of these businesses. However, the analyst must analyze carefully the ability of the holding company to downstream funds to these operations and potentially reduce the overall credit quality of the entity.

Competitive Position

A final nonfinancial factor is the competitive position of a utility. An electric utility with a comparatively low rate structure is generally in a stronger position politically to request rate increases or to request a rate freeze than one with rates higher than national averages and particularly one with rates higher than regional averages.

The competitive position of an electric utility is increasingly important as customer choice increases. Those companies with high overall rates, and particularly those with high commercial rates, may find themselves losing customers as access to transmission and distribution lines increases.

In addition, those utilities with high stranded investments are vulnerable to competition. In the transition period to deregulation, many utilities have negotiated rates with their large industrial customers in order to retain them as customers. This negotiation is only a short-term solution if a utility's embedded costs are higher than those of utilities who have access to their service territory. At best, negotiated rates for industrial customers will buy time for utilities with high costs to lower their costs to make them more in line with the rates of their competitors.

Financial Analysis

The changing competitive nature of the electric industry resulting from deregulation requires that the traditional evaluation of an electric utility be modified. Although historic ratio analysis still should be conducted, an electric company also should be evaluated in the context of its new competitive situation. Is new generation being constructed in its territory that produces energy at a lower cost than the established generation? How does the company plan to expend its excess cash flow? In an era of consolidation, will the company be acquired or be an acquirer? Will the company remain in generation or sell its generation and deal solely with transmission and distribution?

The following major financial ratios should be considered in analyzing an electric utility: (1) leverage, (2) pretax interest coverage, (3) cash flow/spending, and (4) cash flow/capital.

Leverage

Leverage in the electric utility industry is high relative to industrial concerns. This degree of leverage is accepted by investors because of the historical stability of the industry. The expected ranges for AA, A, BBB, and BB companies are outlined below:

	Total Debt/Total Capitalization			
Business position	AA	A	BBB	BB
Above average	47%	52%	59%	65%
Average	42	47	54	60
Below average	—	41	48	54

The ratios discussed below apply to electric utilities that still retain both their generation and transmission and distribution assets. However, as the process of deregulation accelerates, many companies in the electric utility industry will decide (or be required) to either be in generation or wires (transmission and distribution). As a result of these changes, traditional ratios no longer will be applicable to many electric utilities. After a utility has divested of either its generation or wires, the analyst will be required to use benchmark ratios that apply to either generation or transmission and distribution companies.

In calculating the debt leverage of an electric utility, long-term debt/capitalization is standard. However, the amount of short-term debt also should be considered because this is generally variable-rate debt. A high proportion of short-term debt also may indicate the possibility of the near-term issuance of long-term bonds. In addition, several companies guarantee the debt of subsidiaries (regulated or nonregulated). The extent of these guarantees should be considered in calculating leverage. Subsidiary debt is likely to become an increasingly important factor over the next few years as utilities invest in international utility operations through subsidiaries.

Benchmark leverage figures for a given rating will differ materially from the preceding figures if a utility engaged solely in generation is being considered. In this case, leverage of 35% to 45% would be consistent with a single-A rating because of the higher level of risk involved. In a similar manner, higher leverage of 55% to 65% would be consistent with a single-A rating for a utility that is engaged exclusively in the less risky transmission and distribution business.

Fixed-Charge Coverage

Fixed-charge coverage for the electric utilities is also low relative to coverage for industrial companies. Standard & Poor's expected ranges for coverage are as follows:

	Pretax Interest Coverage			
Business Position	AA	A	BBB	BB
Above average	4.0	3.25	2.25	1.75
Average	4.5	4.0	3.0	2.0
Below average	—	5.0	4.0	2.75

These ranges are accepted by investors because of the stability of the industry. However, owing to the changing fundamentals of the industry, as discussed earlier, perhaps less emphasis should be placed on the exact coverage figures and more on the trend and quality of the coverage.

Net Cash Flow/Spending

A third important ratio is net cash flow/spending. This ratio should be approximated for three years (the typical electric company's construction forecast). The absolute level, as well as the trend of this ratio, gives important insights into the trend of other financial parameters. An improving trend indicates that construction spending probably is moderating, whereas a low net cash flow/spending ratio may indicate inadequate rates being approved by the commissions and a heavy construction budget. Estimates for construction spending are published in the company's annual reports. Although these are subject to revision, the time involved in building generation makes these forecasts reasonably reliable.

In 1985, Standard & Poor's deemphasized this ratio primarily owing to its volatility. Although it still will be considered, Standard & Poor's now emphasizes funds from operations/total debt as a preferable indicator of cash flow adequacy. Over the past several years, less emphasis has been placed on the net-cash-flow/capital-expenditures ratio because the majority of electric utilities have generated positive cash flow after capital expenditures. This positive cash flow has been the result of three factors. First, new construction has been minimal in large part owing to uncertainty relating to deregulation. In fact, the majority of new generation over the past several years has been constructed by nontraditional independent power producers or unregulated subsidiaries of traditional utilities. Second, interest rates have declined significantly for most of the past decade, and electric utilities have enjoyed lower interest expense as they have refinanced maturing debt at lower interest rates. Third, the electric utility industry has lowered its operating expenses in preparation for deregulation.

Standard & Poor's benchmarks for net cash flow/capital expenditures and for funds from operations/total debt are as follows:

	Net cash flow/Capital Expenditures			
Business position	AA	A	BBB	BB
Above average	90%	70%	45%	30%
Average	110	85	60	40
Below average	—	105	80	60

	Funds from Operations/Total Debt			
Business position	AA	A	BBB	BB
Above average	26%	19%	14%	11%
Average	32	25	19	13
Below average	—	34	29	20

In calculating cash flow, the standard definition outlined earlier should be followed. However, allowance for funds used during construction (AFUDC) also should be subtracted, and any cash flow from nonregulated subsidiaries should be segregated and analyzed within the total context of the company. The regulatory commissions take divergent views on nonutility subsidiaries. Some commissions do not regulate these subsidiaries at all, whereas other commissions give inadequate rate relief to an electric utility with a profitable nonutility subsidiary under the premise that the company should be looked at as a whole. In the extreme, the latter view has encouraged companies to sell or spin off some subsidiaries.

FINANCE COMPANIES

Finance companies are essentially financial intermediaries. Their function is to purchase funds from public and private sources and to lend them to consumers and other borrowers of funds. Finance companies earn income by maintaining a positive spread between what the funds cost and the interest rate charged to customers. The finance industry is highly fragmented in terms of type of lending and type of ownership. This section will briefly outline the major sectors in the industry and then discuss the principal ratios and other key variables used in the analysis of finance companies.

Segments within the Finance Industry

The finance industry can be segmented by type of business and ownership. Finance companies lend in numerous ways in order to accommodate the diverse financial needs of the economy. Five of the major lending categories are (1) sales finance, (2) commercial lending, (3) wholesale or dealer finance, (4) consumer lending, and (5) leasing. Most often companies are engaged in several of these lines rather than one line exclusively. Sales finance is the purchase of third-party contracts that cover goods or services sold on a credit basis. In most cases, the sales finance company receives an interest in the goods or services sold. Commercial finance is also generally on a secured basis. However, in this type of financing, the security is most often the borrower's accounts receivable. In factoring, another type of commercial lending, the finance company actually purchases the receivables of the company and assumes the credit risk of the receivables.

Dealer or wholesaler finance is the lending of funds to finance inventory. This type of financing is secured by the financed inventory and is short term in nature. Leasing, on the other hand, is intermediate- to long-term lending—the lessor owns the equipment, finances the lessee's use of it, and generally retains the tax benefits related to the ownership.

Consumer lending historically has involved short-term, unsecured loans of relatively small amounts to individual borrowers. In part because of the more lenient bankruptcy rules and higher default rates on consumer loans, consumer finance companies have dramatically expanded the percentage of their loans for second mortgages. The lower rate charged to individuals for this type of loan is offset by the security and lower default risk of the loan.

There are numerous other types of lending in addition to those just described. Among these are real estate lending and export/import financing.

The ownership of a finance company can significantly affect evaluation of the company. In some instances, ownership is the most important variable in the analysis. There are three major types of ownership of finance companies: (1) captives, (2) wholly owned, and (3) independents.

Captive finance companies, such as General Motors Acceptance Corporation, are owned by the parent corporation and are engaged solely or primarily in the financing of the parent's goods or services. Generally, maintenance agreements exist between the parent and the captive finance company under which the parent agrees to maintain one or more of the finance company's financial parameters, such as fixed-charge coverage, at a minimum level. Because of the overriding relationship between a parent and a captive finance subsidiary, the financial strength of the parent is an important variable in the analysis of the finance company. However, captive finance companies can have ratings either above or below those of the parent.

A wholly owned finance company differs from a captive in two ways. First, it primarily finances the goods and services of companies other than the parent. Second, maintenance agreements between the parent and the subsidiary generally are not as formal. Frequently, there are indenture provisions that address the degree to which a parent can upstream dividends from a finance subsidiary. The purpose of these provisions is to prevent a relatively weak parent from draining a healthy finance subsidiary to the detriment of the subsidiary's bondholders.

Independent finance companies are either publicly owned or closely held. Because these entities have no parent, the analysis of this finance sector is strictly a function of the strengths of the company.

Financial Analysis

In analyzing finance companies, several groups of ratios and other variables should be considered. There is more of an interrelationship between these ratios and variables than for any other type of company. For example, a finance company with a high degree of leverage and low liquidity may be considered to be of high investment quality if it has a strong parent and maintenance agreements. Variables should be viewed not in isolation but rather within the context of the whole finance company–parent company relationship.

Asset Quality

The most important variable in analyzing a finance company is asset quality. Unfortunately, there is no definitive way to measure asset quality. However, there are several variables that in the aggregate present a good indication of asset quality.

Diversification is one measure of portfolio quality. Is the portfolio diversified across different types of loans? If the company is concentrated in or deals exclusively in one lending type, is there geographic diversification? A company that deals exclusively in consumer loans in the economically sensitive Detroit area would not be viewed as favorably as a company with broad geographic diversification. Accounting quality is also an important factor in assessing portfolio quality. The security for the loans is also an important variable in portfolio quality. The stronger the underlying security, the higher is the loan quality. The analyst should be concerned primarily with the level of loans compared with levels of similar companies and the risk involved in the type of lending. For example, the expected loan loss from direct unsecured consumer loans is higher than for consumer loans secured by second mortgages. However, the higher fees charged for the former type of loan should compensate the company for the higher risk.

Numerous ratios of asset quality such as loss reserves/net charge-offs, net losses/average receivables, and nonperforming loans/average receivables give good indications of asset quality. However, finance companies have a high level of discretion in terms of what they consider and report to be nonperforming loans and what loans they charge off. Therefore, unadjusted ratios are not comparable among companies. In addition, companies periodically change their charge-off policies.

Despite the drawbacks of the asset-quality ratios, they are useful in indicating trends in quality and profitability. Of these ratios, loss reserves/net charge-offs is perhaps the most important ratio in that it indicates how much cushion a company has. A declining ratio indicates that the company may not be adding sufficient reserves to cover future charge-offs. Such a trend may lead to a future significant increase in the reserves and therefore a decrease in earnings as the increase is expensed. Net losses/average receivables and nonperforming loans/average receivables are other indicators of asset quality. An increasing ratio indicates a deterioration in quality. Declines may be exacerbated by an overall contraction or slow growth in the receivables. On the other hand, because of different accounting treatments, a stable net losses/average receivables ratio under deteriorating economic conditions may indicate a delay in loss recognition. Consideration also should be given to the age of receivables. In recent years, some finance companies have increased their lending dramatically over a short period of time and reported material improvement in their overall financial parameters. These results have been misleading in some cases where the dramatic improvement has been driven by inadequate reserves. Often the dramatic improvement has been followed by increased losses as the portfolio ages.

The long-term history of a company is also an indicator of credit quality. Does management have a history of managing risk conservatively? How long has management been in place? Is there pressure on management to accelerate growth? Has management responded to this type of pressure by expanding into more risky businesses either through acquisition or internal expansion?

Leverage

Leverage is a second important ratio used in finance company analysis. By the nature of the business, finance companies typically and acceptably are more highly leveraged than industrial companies. The leverage is necessary to earn a sufficient return on capital. However, the acceptable range of leverage depends on other factors, such as parental support, portfolio quality, and type of business. The principal ratio to determine leverage is total debt to equity, although such variations as total liabilities to equity also may be used. In a diversified company with high portfolio quality, a leverage ratio of 5 to 1 is acceptable. On the other hand, a ratio of 10 to 1 is also acceptable for a captive with a strong parent and maintenance agreements. The analyst always should view the leverage of a finance company in comparison with similar companies.

Liquidity

The third important variable in finance company analysis is liquidity. Because of the capital structure of finance companies, the primary cause of bankruptcies in this industry is illiquidity. If for some reason a finance company is unable to raise funds in the public or private market, failure could result quickly. This inability to raise funds could result from internal factors, such as a deterioration in earnings, or from external factors, such as a major disruption in the credit markets. Whatever the cause, a company should have some liquidity cushion. The ultimate liquidity cushion, selling assets, is only a last resort because these sales could have long-term detrimental effects on earnings. The traditional liquidity ratio is cash, cash equivalents, and receivables due within one year divided by short-term liabilities. The higher this ratio, the higher is the margin of safety. Also to be considered are the liquidity of the receivables themselves and the existence of bank lines of credit to provide a company with short-term liquidity during a financial crisis. Liquidity calculations also should consider contractual obligations to fund loans. In general, the smaller and weaker companies should have a higher liquidity cushion than companies with strong parental backing who can rely on an interest-free loan from the parent in times of market stress.

Asset Coverage

A fourth important variable in the analysis of finance companies that is related to the three variables just discussed is the asset coverage afforded the bondholder. In assessing asset protection, the analyst should consider the liquidation value of the loan portfolio.

A definitive assessment of the value of assets is difficult because of the flexibility finance companies have in terms of valuing assets. A finance company can value real estate assets on a number of bases. For example, a finance company that plans to liquidate its commercial real estate portfolio over 12 months in a depressed real estate environment will value its assets much lower than if it planned to systematically sell the same assets over a three- to five-year period. The value of interest-only securities (IOs) created from a finance company's asset securitizations is also subjective and depends on future credit experience and prepayments. Is management conservative or aggressive in valuing these instruments? How has management valued the residuals of automobile leases? Are there periodic write-offs or gains on these loans?

Earnings Record

The fifth variable to be considered is the finance company's earnings record. The industry is fairly mature and is somewhat cyclical. The higher the annual EPS growth, the better. However, some cyclicality should be expected. In addition, the analyst should be aware of management's response to major changes in the business environment. The recent easing of personal bankruptcy rules and the fact that personal bankruptcy is becoming more socially acceptable have produced significantly higher loan losses in direct, unsecured consumer loans. Many companies have responded to this change by contracting their unsecured personal loans and expanding their portfolios invested in personal loans secured by second mortgages.

Management

The sixth variable to be considered is the finance company's management. This variable is difficult to assess. However, a company visit combined with an evaluation of business strategies and credit scoring methodologies (i.e., methodologies used for assessing loan applicants) will provide some insight into this variable.

Size

A final factor related to the finance company or subsidiary is size. In general, larger companies are viewed more positively than smaller companies. Size has important implications for market recognition in terms of selling securities and of diversification.

A larger company is more easily able to diversify in terms of type and location of loan than is a smaller company and thereby to lessen the risk of the portfolio.

In addition to an analysis of the financial strength of the company according to the preceding variables, the analyst must incorporate the net effect of any affiliation the finance company has with a parent. If this affiliation is strong, it may be the primary variable in the credit assessment. The affiliation between a parent company and a finance subsidiary is straightforward; it is captive, wholly owned, or independent. However, the degree to which a parent will support a finance subsidiary is not as straightforward. Traditionally, the integral relationship between a parent and a captive finance subsidiary has indicated the highest level of potential support. However, it is becoming increasingly clear that a wholly owned finance subsidiary can have just as strong an affiliation. For example, General Electric Credit Corporation (GECC) finances few or no products manufactured by its parent, General Electric Company. However, General Electric receives substantial tax benefits from its consolidation of tax returns with GECC. Additionally, General Electric has a substantial investment in its credit subsidiary. Therefore, although there are no formal maintenance agreements between General Electric and GECC, it can be assumed that General Electric would protect its investment in GECC if the finance subsidiary were to need assistance. In other instances, it may be that the affiliation and maintenance agreements are strong but that the parent itself is weak. In this case, the strong affiliation would be discounted to the extent that parent profitability is below industry standards.

In addition to affiliation, affiliate profitability, and maintenance agreements, the analyst also should examine any miscellaneous factors that could affect the credit standing of the finance company. Legislative initiatives should be considered to determine significant changes in the structure or profitability of the industry.

THE ANALYSIS OF HIGH-YIELD CORPORATE BONDS

The analysis of high-yield bonds, or "junk bonds" as they are unfortunately nicknamed, is similar to the complete analysis of any other corporate bond, but the emphasis of the analysis must change. Both high-yield and junk bonds are securities that trade primarily on their creditworthiness, as opposed to the level of interest rates. However, an important difference exists between junk and high-yield securities. Both classifications generate high yields. Although the yield of junk bonds reflects the poor quality of the underlying issuer, the yield of many high-yield securities reflects a variety of circumstances such as the small size of a firm, lack of a credit history, or prior financial difficulties. Although rating agencies often penalize such a firm by giving it a low rating or by requiring the firm to exhibit investment-grade financial parameters for a relatively long period of time before an upgrade is granted, the firm may exhibit good credit quality in many areas. It is this difference that presents the challenge and the opportunity to the credit analyst.

The expansion of the high-yield market over the past 30 years presents an opportunity for the analyst to identify quality in issues that the majority of analysts have ignored. This process involves in-depth research. Because many high-yield bonds have short histories, the analyst must necessarily make more projections. Overall, the analysis will be heavily weighted to the second dimension of credit analysis discussed earlier in this chapter—the aspects that are most commonly associated with the analysis of common stock. In addition, the analyst often is faced with innovative characteristics of the security, such as options exercisable only under certain circumstances. These features must be evaluated within the context of the total valuation process.

In the high-yield sector of the corporate bond market, some portfolio managers believe that downgrade risk and spread risk might be better gauged by an analysis of the issuer's equity. Consequently, some portfolio managers strongly believe that high-yield bond analysis should be viewed from an equity analyst's perspective. As Stephen Esser notes,

> Using an equity approach, or at least considering the hybrid nature of high-yield debt, can either validate or contradict the results of traditional credit analysis, causing the analyst to dig further.[6]

He further states:

> For those who work with investing in high-yield bonds, whether issued by public or private companies, dynamic, equity-oriented analysis is invaluable. If analysts think about whether they would want to buy a particular high-yield company's stock and what will happen to the future equity value of that company, they have a useful approach because, as equity values go up, so does the equity cushion beneath the company's debt. All else being equal, the bonds then become better credits and should go up in value relative to competing bond investments.[7]

Owing to space limitations, I will not discuss the techniques for equity analysis. Instead, I will discuss the areas of credit analysis that should be expanded in the analysis of high-yield corporate bonds.

Competition

The size of a company has important credit implications. It is well known that many "small" firms file for bankruptcy each year. It should be noted, however, that these firms are not the same "small" firms that are issuing high-yield debt. The firms labeled small by investors are generally small only in relation to the giants

6. Steven E. Esser, "High-Yield Analysis: The Equity Perspective," in Ashwinpaul C. Sondi (ed.), *Credit Analysis of Nontraditional Debt Securities* (Charlottesville, VA: Association for Investment and Research, 1995), p. 47.
7. *Ibid.*, p. 54.

of the industry. Since the rating agencies favor the very large, well-established firms, the "small" firms suffer by comparison.

In an industry where the leader or leaders can set pricing, a small firm could be at a significant disadvantage. In the scenario where the pricing is set, the small firm must have unit costs approaching, equal to, or lower than the pricing leaders. The small firm that is inefficient cannot withstand a prolonged pricing war. The leaders in this case could launch a pricing war to gain market share and effectively drive the inefficient producers out of business. In certain circumstances, the small firm may be able to differentiate its product and thereby control a certain segment of the market. However, there is always the threat of competition. The company with a market niche must be monitored to ensure that the niche remains the domain of the company in question.

Historically, competition has focused on unit cost. Increasingly, competition has focused on other forms of competition, including safety, convenience, and selection. Moreover, competition changes. The successful analyst must be able to understand trends and invest appropriately. Ten years ago, most people shopped in department stores, and many used a credit card issued by the individual store. Over the past 10 years, large stores dedicated to one category such as Home Depot, outlet stores and malls, and numerous boutiques have emerged. These entrants have cannibalized the sales of the traditional department stores. Will the traditional department store survive, or will customers frequent the newer entrants to the retailing industry? Analysts also must consider site-specific competition. A stand-alone retailer in a rural location may not be affected by a Wal-Mart located 100 miles away. However, the competitive landscape changes dramatically if a Wal-Mart opens within five miles of the stand-alone retailer. In a similar manner, competition from a major airline may disrupt the projections of a start-up carrier.

Cash Flow

One of the most important elements in analyzing a high-yield security is cash flow. Unfortunately, the calculation of cash flow is not straightforward. Historically, cash flow was defined as net income plus depreciation, interest, and taxes. Restructurings and "adjustments" were uncommon.

Restructurings and "adjustments" are common today, distorting results and possibly misleading investors. Often new managements "restructure" operations to establish a base from which the growth of earnings is measured. If restructurings occurred every 10 years or so, they would not be suspect. However, many companies have annual unusual charges.

In presentations, emphasis is placed on "adjusted EBITDA," which is often higher than traditional EBITDA because it ignores the negative effects of the restructurings. Often these restructurings are an indication of poor acquisitions that were later sold at a loss. The pattern and magnitude of these adjustments should be analyzed.

Clearly, an analyst must calculate his own cash flow figures. Does the company have enough cash flow to meet its interest payments and to fund necessary research and growth? Does the company have sufficient cash flow to tide it over during a period of weak economic activity? What borrowing capacity is available? The ability to borrow enabled several large firms such as Chrysler and Ford Motor to meet their debt obligations when these companies were experiencing significant losses. As a result, the companies were granted time to reformulate products and reposition themselves for an upturn in the economy and industry. The smaller firm may not have this advantage. On the other hand, the larger firms, which often have the luxury of expanding borrowings during weak markets, may be trading on their market name long after their credit quality has deteriorated.

The evaluation of cash flow coverage of fixed charges should not be conducted to the exclusion of total fixed-charge coverage. Some high-yield issuers have a high percentage of interest that is zero-coupon or paid-in-kind. The identification of a clear path (or lack thereof) for meeting these obligations when they become cash payments is an integral part of an analysis of a high-yield bond. Future asset sales to meet these obligations may not materialize at the anticipated prices. Some high-yield issuers assume that maturities of fixed obligations will be met by new issuance. Although this possibility is likely, there have been instances where the high-yield new-issue market is essentially closed to all but the most creditworthy of issuers.

The analyst must particularly focus on cash flow in certain leveraged buyout situations. Although the purchaser may have a specific plan for selling assets to reduce debt and related payments, time may be critical. Can the company meet its cash obligations if the sale of assets is delayed? How liquid are the assets that are scheduled for sale? Are the appraised values of these assets accurate? What financial flexibility does the company have in terms of borrowing capacity? Are indenture covenants being met?

Net Assets

In analyzing a bond, the analyst must ascertain or at least approximate the liquidation value of the assets. Are these assets valued properly on the balance sheet? Of particular interest may be real estate holdings. For example, in analyzing the gaming companies, a market assessment of land holdings should be included. On the other hand, one also should consider the likelihood of those assets being available for liquidation, if necessary. To whom do they belong? Are they mortgaged or being used as collateral? Assets are occasionally spun off to the equity owners of the company. In such a circumstance, the bondholders may experience a sudden and dramatic deterioration of credit quality. Other bondholders are secured by specific assets such as railroad cars or a nuclear power station. In these circumstances, the value and marketability of the collateral must be ascertained. Collateral, by definition, must be specific, and so must be the analysis. Ten railroad engines may appear to provide adequate collateral until it is discovered that the engines are not only obsolete but have not been maintained for a number of years. Five aircraft may appear to be adequate collateral until it is discovered that the engines were financed separately and do not constitute collateral.

Particular attention must be paid to the asset protection in a takeover situation. In this instance, assets that originally provided protection for your holdings could be used to secure new debt senior to your holding.

The analyst also must focus on the location of the assets. If the assets are in a foreign country, the analyst should be familiar with that country's laws regarding expatriation of funds. In the extreme case, the analyst should be familiar with that country's laws regarding bankruptcy proceedings. In recent years, some analysts have attributed great value to assets that are not concrete. For example, some analysts attribute a high value per customer or access to such customer. Although this valuation may be valid in the short term, the ability to realize that value depends on rapidly changing variables such as technology. Should a company encounter financial distress, it is likely that the value of these "assets" will decline as customers give their business to another company.

Management

Management is a critical element in the assessment of any firm. Given enough time, poor management can bankrupt the most prosperous firm. Conversely, good management is essential to the long-term survival of all firms. Many successful firms were started by employees of the leaders in an industry. The high-technology area is an example of this. Often employees decide to start their own firms for personal profit. Very often the firms are founded by some of the leading engineers or salespeople. While the creative talents and profit motive in these firms may be high, the whole management team must be evaluated. Is there a strong financial manager? Is there a strong marketing manager? Where are the controls? Start-up operations provide high incentives for success. The ownership of a significant portion of the company by management is generally positive. Too often employees of a large firm relate only to their personal paychecks and not to the overall profitability of the firm.

There are two principal ways to evaluate management. The first way is to judge management by its results. This is accomplished by financial analysis. The second way is to meet with management to personally evaluate their vision for the firm as well as their understanding of the business. This is accomplished by attending roadshows and scheduling private meetings. The analyst should be prepared for such a meeting. An unprepared analyst can be swayed by a slick presentation that promotes the company and the frenzy of Wall Street to market an issue. If the analysis is incomplete, the issue should not be bought. A prepared analyst has a golden opportunity to evaluate management. Such an evaluation could determine whether an issue should be bought or not. In a presentation to potential bondholders, the senior management of a company that manufactured gas pump nozzles stated that the company would generate growth from European operations because of the increase of environmental requirements to reduce gasoline fumes at service stations. In order to estimate this potential, senior management was asked to discuss the state of European environmental laws and how they differed from laws in the United States. They were unable to do so. The company has since filed for bankruptcy.

Access to management is changing because of Securities and Exchange Commission (SEC) Regulation FD, or "Fair Disclosure." The regulation, which took effect on October 23, 2000, establishes the manner in which companies disseminate information. Previously, a lot of information was released to analysts or individual investors before it was released to the public. The SEC deemed this practice unfair to the general investing public and passed Regulation FD to rectify the situation. Companies are taking the new regulation seriously. As a result, the market may become more volatile as major releases (such as changes in earnings expectations) are made to the world.

Leverage

Companies that issue high-yield bonds generally are highly leveraged. Leverage per se is not harmful and in many circumstances is beneficial to growth. However, the degree of leverage should be evaluated in terms of its effect on the financial flexibility of the firm. As pointed out earlier, leverage should be calculated on absolute and market-adjusted bases. The most common approach to market adjustment is to calculate a market value for the equity of the firm. To the extent that the common stock is selling below book value, leverage will be understated by a traditional approach. Some firms also adjust the market value of debt in calculating leverage. This approach is interesting, but a consistent approach must be employed when convertibles are considered in the equity equation. The benefit of adjusting the equity side of the leverage equation is clear. As the market values a company's equity upward, the market is indicating a willingness to support more leverage. A similar increase in the market adjustment of a firm's debt may indicate an upward appraisal of creditworthiness or an overall lowering of interest rates. In either case, the company probably would have the opportunity to refinance at a lower cost and thereby increase profitability.

Care also should be taken to evaluate sources of leverage that are not stated clearly on the balance sheet. These sources arise from increasing use of complicated financings.[8] For example, consider deferred-coupon bonds that are commonly used by high-yield issuers. Deferred-coupon bonds permit the issuer to postpone interest payment to some future year. As a result, the interest burden is placed on future cash flow to meet the interest obligations. Because of this burden, the presence of deferred-coupon bonds may impair the ability of the issuer to improve its credit quality in future periods. Moreover, if senior bonds have

8. William A. Cornish, "Unique Factors in the Credit Analysis of High-Yield Bonds," in Frank K. Reilly (ed.), *High-Yield Bonds: Analysis and Risk Assessment* (Charlottesville, VA: Association for Investment Management and Research, 1990).

deferred-coupon payments, the subordinated bonds will be adversely affected over time as the amount of senior bonds increases over time relative to the amount of subordinated bonds. For example, one type of deferred-coupon bond that was issued commonly at one time was the payment-in-kind (PIK) bond. With this bond structure, a high-yield issuer has the option to either pay interest in cash or pay the equivalent of interest with another bond with the same coupon rate. If the issuer does not have the ability to pay the interest in cash, payment with another bond will increase future interest expense and thereby adversely affect the issuer's future cash flow. If the PIK bonds are senior bonds, subordinated bonds are adversely affected over time as more senior bonds are added to the capital structure and future interest expense is increased further.

Corporate Structure

High-yield issuers usually have a holding-company structure. The assets to pay creditors of the holding company will come from the operating subsidiaries. It is critical to analyze the corporate structure for a high-yield issuer. Specifically, the analyst must understand the corporate structure in order to assess how cash will be passed between subsidiaries and the parent company and among the subsidiaries. The corporate structure may be so complex that the payment structure can be confusing.

For example, in January 1990, Farley, Inc., had the following debt structure: senior subordinated debt, subordinated notes, and junior subordinated debt.[9] Where was Farley, Inc., going to obtain cash flow to make payments to its creditors? One possibility was to obtain funds from its operating subsidiaries. At the time, Farley, Inc., had three operating subsidiaries: Fruit of the Loom, Acme Boot, and West Point Pepperell. An examination of the debt structure of Fruit of the Loom (20% owned by Farley, Inc.) indicated that there was bank debt and that no intercompany loans were permitted. While there were restrictions on dividend payments, none were being paid at the time. An examination of Acme Boot (100% owned by Farley, Inc.) showed that there was bank debt, and while there were restrictions but no prohibitions on intercompany loans, Farley, Inc., had in fact put cash into this operating subsidiary. Finally, West Point Pepperell (95% owned by Farley, Inc.) had bridge loans that restricted asset sales and dividend payments. Moreover, any payments that could be made to Farley, Inc., from West Point Pepperell had to be such that they would not violate West Point Pepperell's financial ratio requirements imposed by its bridge loan. The key point is that an analyst evaluating the ability of Farley, Inc., to meet its obligations to creditors would have to look very closely at the three operating subsidiaries. Just looking at financial ratios for the entire holding-company structure would not be adequate. At the time, it was not likely that the three operating subsidiaries would be able to make any contribution to assist the parent company in paying off its creditors.

9. This illustration is from Cornish, "Unique Factors in the Credit Analysis of High-Yield Bonds."

Covenants

While an analyst, of course, should consider covenants when evaluating any bond issue (investment-grade or high-yield), it is particularly important for the analysis of high-yield issuers. The importance of understanding covenants was summarized by one high-yield portfolio manager as follows:

> Covenants provide insight into a company's strategy. As part of the credit process, one must read covenants within the context of the corporate strategy. It is not sufficient to hire a lawyer to review the covenants because a lawyer might miss the critical factors necessary to make the appropriate decision. Also, loopholes in covenants often provide clues about the intentions of management teams.[10]

Definitions

Great care must be paid to definitions. As discussed earlier with respect to cash flow, definitions can materially skew cash-flow projections. When asked to define certain terms, management often will state that its definitions are "standard." There is no standard definition. Definitions also should be evaluated in covenants. Historically, coverage requirements that determined how many additional bonds could be issued were based on EBIT (earnings before interest and taxes) coverage. For many companies, coverage has evolved based on EBITDA, a less restrictive test. Currently, the use of "adjusted EBITDA" is becoming more frequent.[11]

CREDIT SCORING MODELS

Thus far in this chapter the traditional ratios and other measures that credit analysts use in assessing default risk are described. Several researchers have used these measures as input to assess the default risk of issuers using the statistical technique of multiple discriminant analysis (MDA). This statistical technique is primarily a classification technique that is helpful in distinguishing between or among groups of objects and in identifying the characteristics of objects responsible for their inclusion in one or another group. One of the chief advantages of MDA is that it permits a simultaneous consideration of a large number of characteristics and does not restrict the investigator to a sequential evaluation of each individual attribute. For example, MDA permits a credit

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10. Robert Levine, "Unique Factors in Managing High-Yield Bond Portfolios," in *High-Yield Bonds: Analysis and Risk Assessment*. p. 35.
11. For a discussion of the problems with using EBITDA, see Pamela M. Stumpp, "Critical Failings of EBITDA as a Cash Flow Measure," Chapter 6 in Frank J. Fabozzi (ed.), *Bond Credit Analysis: Framework and Case Studies* (Hoboken, NJ: Wiley, 2001).

analyst studying ratings of corporate bonds to examine, at one time, the total and joint impact on ratings of multiple financial ratios, financial measures, and qualitative factors. Thus the analyst is freed from the cumbersome and possibly misleading task of looking at each characteristic in isolation from the others. MDA seeks to form groups that are internally as similar as possible but that are as different from one another as possible.

From the preceding description of MDA it can be seen why it has been applied to problems of why bonds get the ratings they do and what variables seem best able to account for a bond's rating. Moreover, MDA has been used as a predictor of bankruptcy. While the steps involved in MDA for predicting bond ratings and corporate bankruptcies are a specialist topic, we will discuss the results of the work by Edward Altman, the primary innovator of MDA for predicting corporate bankruptcy.[12] The models of Altman and others involved in this area are updated periodically. Our purpose here is only to show what an MDA model looks like.

In one of Altman's earlier models, referred to as the "Z-score model," he found that the following MDA could be used to predict corporate bankruptcy.[13]

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

where

X_1 = working capital/total assets (in decimal)
X_2 = retained earnings/total assets (in decimal)
X_3 = earnings before interest and taxes/total assets (in decimal)
X_4 = market value of equity/total liabilities (in decimal)
X_5 = sales/total assets (number of times)
Z = Z-score

Given the value of the five variables for a given firm, a *Z*-score is computed. It is the *Z*-score that is used to classify firms with respect to whether or not there is potentially a serious credit problem that would lead to bankruptcy. Specifically, Altman found that *Z*-scores of less than 1.81 indicated a firm with serious credit problems, whereas a *Z*-score in excess of 3.0 indicated a healthy firm.

Subsequently, Altman and his colleagues revised the *Z*-score model based on more recent data. The resulting model, referred to as the "zeta model" found that the following seven variables were important in predicting corporate bankruptcies and were highly correlated with bond rating:[14]

12. See Chapters 8 and 9 in Edward I. Altman, *Corporate Financial Distress and Bankruptcy: A Complete Guide to Predicting and Avoiding Distress and Profiting from Bankruptcy*, 2d ed. (Hoboken, NJ: Wiley, 1993).

13. Edward I. Altman, "Financial Bankruptcies, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance* (September 1968), pp. 589–609.

14. Edward I. Altman, Robert G. Haldeman, and Paul Narayann, "Zeta Analysis: A New Model to Identify Bankruptcy Risk of Corporations," *Journal of Banking and Finance* (June 1977), pp. 29–54.

- Earnings before interest and taxes (EBIT)/total assets
- Standard error of estimate of EBIT/total assets (normalized) for 10 years
- EBIT/interest charges
- Retained earnings/total assets
- Current assets/current liabilities
- Five-year average market value of equity/total capitalization
- Total tangible assets, normalized

While credit scoring models have been found to be helpful to analysts and bond portfolio managers, they do have limitations as a replacement for human judgment in credit analysis. Marty Fridson, for example, provides the following sage advice about using MDA models:

> . . . quantitative models tend to classify as troubled credits not only most of the companies that eventually default, but also many that do not default. Often, firms that fall into financial peril bring in new management and are revitalized without ever failing in their debt service. If faced with a huge capital loss on the bonds of a financially distressed company, an institutional investor might wish to assess the probability of a turnaround—an inherently difficult-to-quantify prospect—instead of selling purely on the basis of a default model.[15]

Fridson then goes on to explain that a credit analyst must bear in mind that "companies can default for reasons that a model based on reported financial cannot pick up" and provides several actual examples of companies that filed for bankruptcy for such reasons.

CONCLUSION

This chapter has emphasized a basic method for analyzing corporate bonds. A format for analysis is essential. However, analysis of securities cannot be totally quantified, and the experienced analyst will develop a second sense about whether to delve into a particular aspect of a company's financial position or to take the financial statements at face value. All aspects of credit analysis, however, have become increasingly important as rapidly changing economic conditions and globalization change the credit quality of companies and industries.

15. Martin S. Fridson, *Financial Statement Analysis: A Practitioner's Guide,* 2d ed. (Hoboken, NJ: Wiley, 1995), p. 195.

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CHAPTER
THIRTY-THREE

CREDIT RISK MODELING

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During the last years we have seen many theoretical developments in the field of credit risk research. In view of the large-scale changes in market conditions, the entry of more sophisticated market participants, and the increase in complexity of investable assets, most of the research has focused on pricing of corporate debts. But many of these models have failed to describe real-world phenomena such as credit spreads realistically. This practitioner-oriented chapter attempts to describe the history and future of modeling credit risk and valuation of credit-risky assets.

Credit risk is the distribution of financial losses owing to unexpected changes in the credit quality of the counterparty in a financial agreement. Examples range from agency downgrades to failure to service debt to liquidation. Credit risk pervades virtually all financial transactions. The distribution of credit losses is complex. At its center is the probability of default, by which we mean any type of failure to honor a financial agreement. To estimate the probability of default, we need to specify

- A model of investor uncertainty
- A model of the available information and its evolution over time
- A model definition of the default event.

However, default probabilities alone are not sufficient to price credit-sensitive securities. We need, in addition,

- A model for the risk-free interest rate
- A model of recovery on default
- A model of the premium investors require as compensation for bearing systematic credit risk

The credit premium maps actual default probabilities to market-implied probabilities that are embedded in market prices. To price securities that are sensitive to the credit risk of multiple issuers and to measure aggregated portfolio credit risk, we also need to specify

- A model that links defaults of different entities

There are three main quantitative approaches to analyzing credit. In the *structural approach,* we make explicit assumptions about the dynamics of a firm's assets, its capital structure, and its debt and share holders. A firm defaults if its assets are insufficient according to some measure. In this situation, a corporate liability can be characterized as an option on the firm's assets. The *reduced-form approach* is silent about why a firm defaults. Instead, the dynamics of default are given exogenously through a default rate, or intensity. In this approach, prices of credit-sensitive securities can be calculated as if they were default-free using an interest rate that is the risk-free rate adjusted by the intensity. The *incomplete-information approach* combines the structural and reduced-form models. While avoiding their difficulties, it picks the best features of both approaches: the economic and intuitive appeal of the structural approach and the tractability and empirical fit of the reduced-form approach.

In this chapter we review the three approaches in the context of the multiple facets of credit modeling that were just mentioned. Our goal is to provide a concise overview and a guide to the large and growing literature on credit risk.[1]

STRUCTURAL CREDIT MODELS

The basis of the structural approach, which goes back to Black and Scholes[2] and Merton,[3] is that corporate liabilities are contingent claims on the assets of a firm. The market value of the firm is the fundamental source of uncertainty driving credit risk.

Classical Approach

Consider a firm with market value V, which represents the expected discounted future cash flows of the firm. The firm is financed by equity and a zero-coupon bond with face value K and maturity date T. The firm's contractual obligation is to repay the amount K to the bond investors at time T. Debt covenants grant bond investors absolute priority: if the firm cannot fulfill its payment obligation, then bondholders immediately will take over the firm.

1. A more mathematical introduction can be found in Kay Giesecke, "Credit Risk Modeling and Valuation: An Introduction," in David Shimko (ed.), *Credit Risk: Models and Management,* Vol. 2 (London: Riskbooks, 2004).
2. Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* 81 (1973), pp. 81–98.
3. Robert C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* 29 (1974), pp. 449–470.

EXHIBIT 33–1

Default Interpretation in the Classical Approach

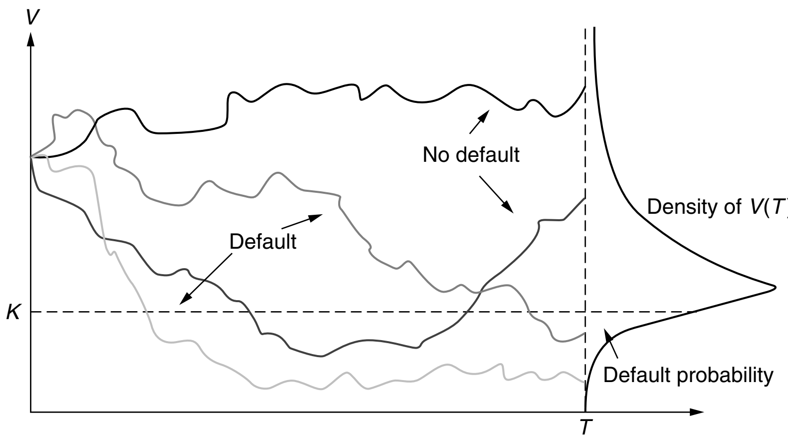


Exhibit 33–1 shows several possible paths of firm value. Default occurs if the firm value at maturity is less than the face value of the debt *K*. The particular path the firm value has taken does not matter here; only the firm value at *T* is important. The probability of default therefore is equal to the probability that firm value is below debt face value at maturity. To calculate this probability, we make assumptions about the distribution of firm value at debt maturity. The standard assumption is that firm value is log-normally distributed. The probability of default then is given as the area under the log-normal firm value density between 0 and face value, as shown in the graph. This probability can be calculated explicitly in terms of *K*, the current firm value $V(0)$, the volatility of firm value, the growth rate of firm value and *T*.

Assuming that the firm can neither repurchase shares nor issue new senior debt, the payoffs to the firm's liabilities at debt maturity *T* are as summarized in Exhibit 33–2. If the asset value $V(T)$ exceeds or equals the face value *K* of the bonds, the bondholders will receive their promised payment *K*, and the shareholders will get the remaining $V(T) - K$. However, if the value of assets $V(T)$ is

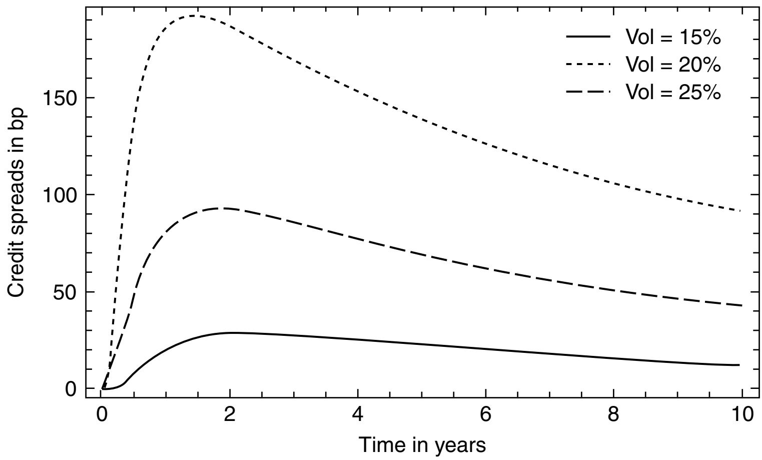
EXHIBIT 33–2

Payoffs at Maturity in the Classical Approach

Event Description	Assets	Debt	Equity
No default	$V(T) \geq K$	K	$V(T) - K$
Default	$V(T) < K$	$V(T)$	0

EXHIBIT 33–3

Term Structure of Credit Spreads, Varying Asset Volatility, in the Classical Approach



less than K, the ownership of the firm will be transferred to the bondholders, who lose the amount $K - V(T)$. Equity is worthless because of limited liability.

Summarizing, the value of the bond is equivalent to that of a portfolio composed of a default-free loan with face value K maturing at time T and a short European put position on the assets of the firm with strike K and maturity T. The value of the equity is equivalent to the payoff of a European call option on the assets of the firm with strike K and maturity T. Pricing equity and credit-risky debt thus reduces to pricing European options.

The credit spread is the difference between the yield on a defaultable bond and the yield on an otherwise equivalent default-free zero bond. It gives the excess return demanded by bond investors to bear the potential default losses. The credit spread is a function of maturity T, asset volatility (the firm's business risk), the initial leverage ratio $K/V(0)$, and risk-free rates.

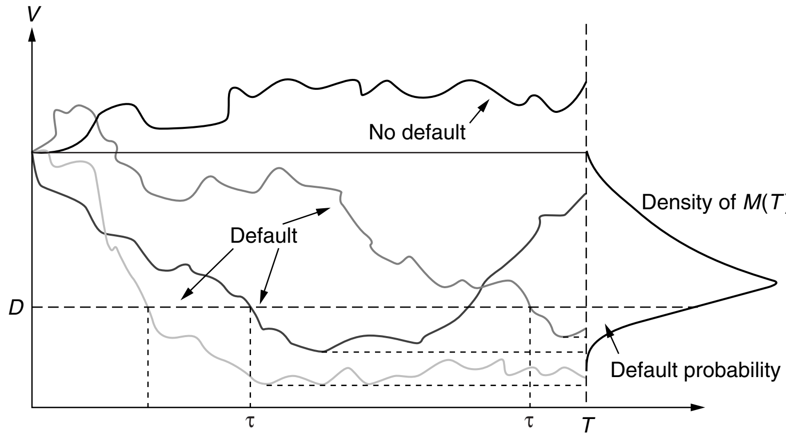
Letting initial leverage be 80% and risk-free rates be 6%, in Exhibit 33–3 we plot the model term structure of credit spreads for varying asset volatilities. We see clearly that as asset volatility (business risk) rises, then so does the spread required by the market to compensate for the risk of default. Other noticeable traits of this graph are the rapid fall to zero spreads at short maturities and the more pronounced hump-shaped curve as volatility rises higher.

First-Passage Approach

In the classical approach, firm value can dwindle to almost nothing without triggering default. This is unfavorable to bondholders, as noted by Black and

EXHIBIT 33–4

Default in the First-Passage Approach



Cox.[4] Bond indenture provisions often include safety covenants that give bond investors the right to reorganize a firm if its value falls below a given barrier.

First-passage time models generalize the classical model such that a default can occur not only at maturity of the debt contract but also at any point of time. They assume that default happens if the firm value V hits a specified default barrier D. The default barrier in general can be a stochastic process, as is the firm value. For tractability reasons, however, one often works with a simple time-dependent, nonstochastic barrier specification, or just a constant barrier.

Suppose that the default barrier D is a constant between zero and the initial firm value—this is reasonable because we would expect liabilities to be nonnegative and less than current assets. Then the default time is more realistically defined as when the value of the firm crosses below the default barrier. In other words, firms can default at times other than debt maturity. This relaxation of the European nature of the default event in the classical approach provides some more realistic behavior.

Exhibit 33–4 shows several possible paths of firm value and a constant default barrier D. Suppose for the moment that D is equal to the face value of the firm's debt. Default occurs if the firm value falls, at any time before the horizon T, below the default barrier. As shown, different firm-value paths correspond to different default times. Unlike the classical model discussed earlier, here the entire path the firm value follows is relevant. Firm-value paths that imply survival in the classical approach can

4. Fischer Black and John C. Cox, "Valuing Corporate Securities: Some Effects of Bond Indenture Provisions," *Journal of Finance* 31 (1976), pp. 351–367.

imply default in the first-passage approach. Therefore, the first-passage approach implies higher probabilities of default than the classical approach.

The probability of default is given by the probability that the minimum firm value at the horizon $M(T)$ is lower than the barrier D. In order to calculate this probability, we make an assumption about the distribution of future firm values, as in the classical approach. This determines also the distribution of the minimum firm value at the horizon. With log-normal firm values, this distribution is inverse gaussian. The default probability is given as the area under the inverse gaussian density curve between 0 and the default barrier D.

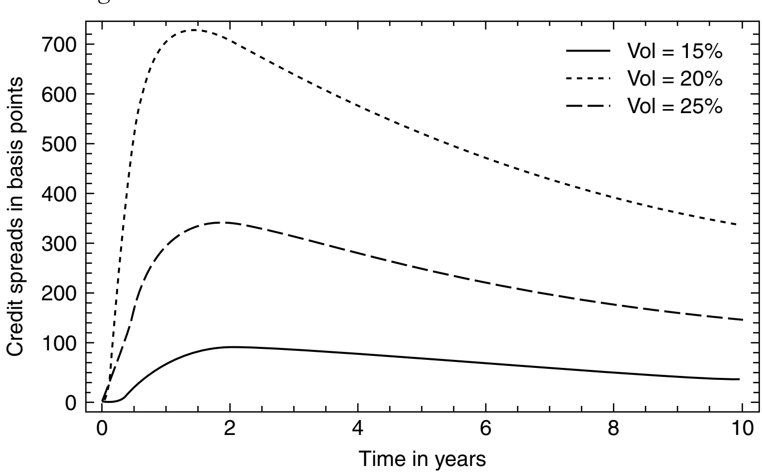
We consider the payoff to investors in the firm's liabilities. For simplicity, we assume that the default barrier is equal to the face value of firm debt. If the firm value never fell below the barrier over the term of the bond, then bond investors receive the bond's face value K and equity investors would receive the remaining $V(T) - K$. However, if the firm falls below the barrier at some point during the bond's term, then the firm defaults. In this case the firm stops operating, bond investors take over its remaining assets, and equity investors receive nothing.

Therefore, the equity position is equivalent to that of a down-and-out call on firm assets with strike equal to the face value of the debt, barrier level equal to the default barrier, and maturity equal to debt maturity. The value of the debt is given as the difference between firm value and equity value. Pricing equity and credit-risky debt thus reduces to pricing European barrier options.

We consider the credit spread implied by a first-passage model in Exhibit 33–5. We assume that the default barrier is constant and equal to the face value of the bonds. We set leverage equal to 60% and risk-free rates to

EXHIBIT 33–5

Term Structure of Credit Spreads, Varying Asset Volatility, in the First-Passage Model



6%, as in Exhibit 33–3. We assume that in the event of default, bond investors recover a fraction of 50% of their initial investment.

With increasing maturity T, the spread asymptotically approaches zero. This is at odds with empirical observation; for many firms, spreads tend to increase with increasing maturity, reflecting the fact that uncertainty is greater in the distant future than in the near term. This discrepancy follows from two model properties: the firm value grows at a positive (risk-free) rate, and the capital structure is constant and assumed known with certainty. We can address this issue by assuming that the total debt grows at a positive rate or that firms maintain some target leverage ratio as in Collin-Dufresne and Goldstein.[5] A critical insight from this plot is that the level of spreads in the first-passage model is much higher and much more realistic than in the classical model. This is due to the fact that default probabilities are higher in the first-passage approach, as we discussed earlier.

Dependent Defaults

Credit spreads of different issuers are correlated through time. Two patterns are found in time series of spreads. The first is that spreads vary smoothly with general macroeconomic factors in a correlated fashion. This means that firms share a common dependence on the economic environment, which results in cyclic correlation between defaults. The second relates to the jumps in spreads: we observe that these are often common to several firms or even entire markets. This suggests that the sudden large variation in the credit risk of one issuer, which causes a spread jump in the first place, can propagate to other issuers as well. The rationale is that economic distress is contagious and propagates from firm to firm. A typical channel for these effects are borrowing and lending chains. Here the financial health of a firm also depends on the status of other firms as well.

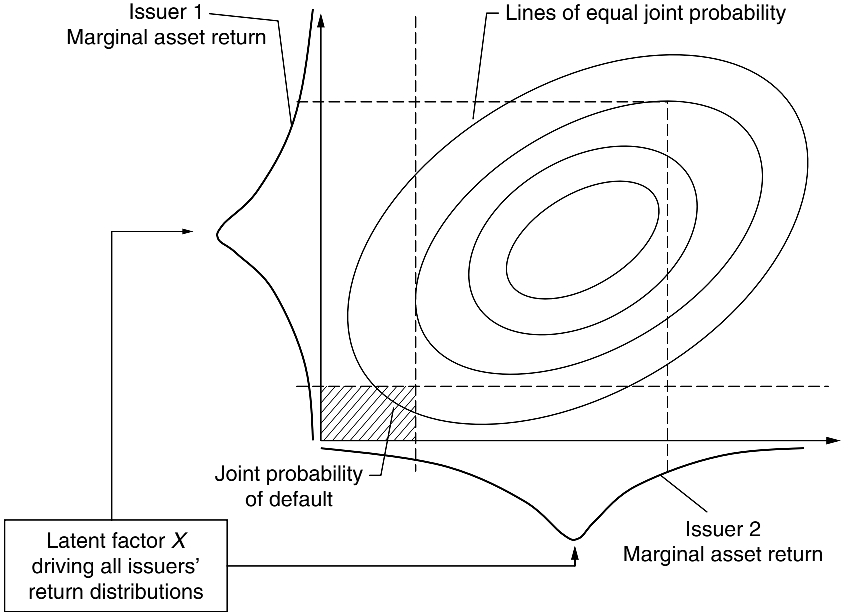
We want to incorporate these two default correlation mechanisms into the structural approach to credit. To introduce cyclic correlation, it is natural to assume that firm values of several firms are correlated through time. This corresponds to common factors driving asset returns. We consider the simplest case with two firms whose firm values are log normal. Our definition of default follows the classical approach.

Exhibit 33–6 illustrates the situation. The axes show the marginal asset return distributions of the two firms. Individual asset returns are normally distributed, hence the bell shape. Individual returns are modeled through a linear factor model, which represents systematic and firm-specific risk. Systematic risk is modeled by a common latent factor X, which drives the systematic variation in the asset returns of both firms. The sensitivity of a firm's return to this common factor controls the asset correlation across firms. This asset correlation drives the default correlation between firms.

5. Pierre Collin-Dufresne and Robert Goldstein, "Do Credit Spreads Reflect Stationary Leverage Ratios?" *Journal of Finance* 56 (2001), pp. 1929–1958.

EXHIBIT 33–6

Illustrative Example of Structural-Based Joint Default Modeling



The elliptical shapes represent lines of equal joint asset value probability. The shaded area on the bottom left illustrates the joint default probability, as defined by the area under which issuer 1's asset value is below its default barrier and issuer 2 is below its default barrier.

Asset correlation captures the dependence of firms on common economic factors in a natural way. Modeling default contagion effects is much more difficult. A straightforward idea is to consider a jump-diffusion model for firm value. We would stipulate that a downward jump in the value of a given firm triggers subsequent jumps in the firm values of other firms with some probability. This would correspond to the propagation of economic distress. This approach is difficult, however, because of the lack of closed-form results on the joint distribution of firms' historical asset lows. This is what we need to calculate the probability of joint default.

A more successful attempt is to introduce interaction effects through the default barriers D_i. Suppose that the barrier is random and depends on the firm's liquidity state, which, in turn, depends on the default status of the firm's counterparties. If a firm's liquidity reserves are stressed owing to a payment default of a counterparty, it finances the loss by issuing more debt. This increases the default, barrier: the firm is now more likely to default, all else being equal. With no counterparty defaults the default barrier remains unaffected. This model allows a closed-form approximation of the credit portfolio loss distribution.

Credit Premium

Issuers of credit-sensitive securities share a common dependence on the economic environment. It follows that aggregated credit risk cannot be diversified away. This undiversifiable or systematic risk commands a premium, which compensates risk-averse investors for assuming credit risk.

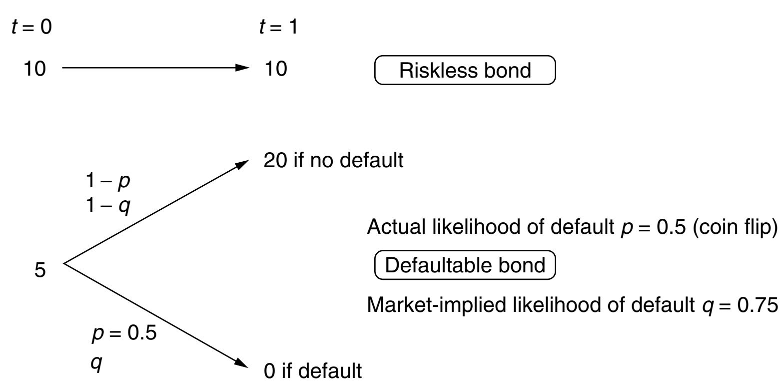
The credit premium is empirically well documented. Its importance relates to the uses of a quantitative credit model. As a default probability forecasting tool, a credit model must reflect the historical default experience. As a tool for pricing credit-sensitive securities, it must fit observed market prices. To make use of both market data and historical default data in the calibration and application of a credit model, we need to understand the relationship between actual defaults and defaultable security prices.

Here the risk premium comes into play: it maps the actual likelihood of default $p(T)$ into the market-implied likelihood of default $q(T)$ that is embedded in security prices.

We examine the difference between the two using a simple example in Exhibit 33–7. We consider a one-period market with two securities, a risk-free bond paying 10 and trading at 10 (risk-free rates are zero) and a defaultable bond trading at 5 that pays 20 in case of no default and zero in case the issuer defaults by the end of the trading period.

EXHIBIT 33–7

Real-World versus Market-Implied Probability of Default



Suppose that the actual probability of default is $p = 0.5$ (50%, or a coin flip). This is, however, not the probability the market uses for pricing the bond: it would lead to a price of $p.20 + (1 - p).0 = 10$, which is double the price at which the bonds are actually trading. At this price, risk-averse investors would rather put their money into the risk-free bond that costs 10 as well, unless they get a discount as compensation for the default risk. The market requires a discount of 5, and the corresponding price reflects the market-implied probability of default q, which satisfies $5 = (1 - q).20$. This yields $q = 0.75$ (75% probability of default), which is bigger than the actual probability of default $p = 0.5$.

To account for risk aversion in calculating the expected payoff of the defaultable bond, the market puts more weight on the unfavorable states of the world in which the firm defaults. In the structural credit models with firm value dynamics as described previously and constant risk-free rates, the situation is only a little more complicated.

In the absence of arbitrage opportunities, the credit risk premium α is uniquely determined through market prices of credit-sensitive securities such as equity or debt and is measured as the excess return on firm assets over the risk-free return per unit of firm risk measured in terms of asset volatility. If the market is risk-averse, then α is positive: investors in credit-risky firm assets require a return that is higher than the risk-free return. The excess return on any credit-sensitive security is given by its volatility times α.

Calibration

The calibration of a quantitative credit model is closely related to its use. To price single-name credit-sensitive securities using a structural model, we need to calibrate the risk-free rate, the asset volatility, the asset value, the face value of the debt, the default barrier, and the maturity of the debt. The default barrier is relevant only in the first-passage approach. To use the model to forecast actual default probabilities, we need to calibrate additionally the growth rate of firm assets or, equivalently, the credit risk premium α. In a multiple-firm setting we need to estimate asset correlations in addition to the single-name parameters.

Firm values are not observable. The goal is to estimate the parameters of the firm-value process based on equity prices, which can be observed for public firms. Risk-free interest rates can be estimated from default-free Treasury bond prices via standard procedures. We bypass estimation of face value and maturity of firm debt from balance-sheet data, which is nontrivial given the complex capital structure of firms. In practice, these parameters often are fixed ad hoc, as some average of short- and long-term debt, for example. We introduce a more reasonable solution to this problem later.

We consider the classical approach, as briefly discussed earlier. Given equity prices and equity volatilities, Jones, Mason, and Rosenfeld and many others suggest to back out asset values and asset volatilities by numerically solving a system of two equations.[6] The first equation relates the equity price to asset value, time, and asset volatility and follows from the Black-Scholes pricing function for a European call with strike K and maturity T. The second equation relates the equity price to asset and equity volatility, the delta of equity, and asset value. This relation is obtained from applying Ito's formula to the first equation.

We can use these two equations to "translate" a time series of equity values into a time series of asset values and volatilities. As for the equity volatility, we can use the empirical standard deviation of equity returns or a true forecasting model such as Barra Equity Risk models. Given a time series of asset returns, the empirical growth rate yields an estimate of the market price of credit risk. The estimate of the firm growth rate, however, is very poor: it is based on two asset-return observations only.

Further, given the asset-return time series of several firms, asset correlation can be estimated. Alternatively, we can introduce a linear-factor model for normally distributed asset returns that expresses the idea that firms share a common dependence on general economic factors. This is similar to the idea we discussed earlier.

Can We Predict the Future?

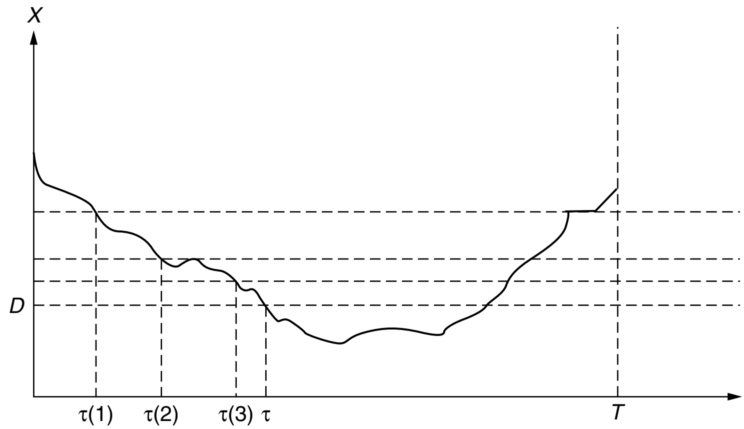
To a certain extent, users of structural models implicitly assume that they can. In structural models, firm value is the single source of uncertainty that drives credit risk. Investors observe the distance of default as it evolves over time. If the firm value has no jumps, this implies that the default event is not a total surprise. There are "predefault events" that announce the default of a firm. In the first-passage approach, we can think of a predefault event as the first time assets fall dangerously close to the default barrier (see Exhibit 33–8).

This has significant implications for the fitting of structural models to market prices. First, since default can be anticipated, the model price of a credit-sensitive security converges continuously to its recovery value. Second, the model credit spread tends to zero with time to maturity going to zero.[7] Quite telling in this regard are the credit spreads implied by the classical and first-passage approaches (see Exhibits 33–3 and 33–5). Both properties are at odds with intuition and market reality. Market prices do exhibit surprise downward jumps on default. Even for very short maturities in the range of weeks, market credit spreads remain positive. This indicates that investors do have substantive short-term uncertainty about defaults, in contrast to the predictions of the structural models.

6. E. Jones, Scott Mason, and Eric Rosenfeld, "Contingent Claims Analysis of Corporate Capital Structures: An Empirical Investigation," *Journal of Finance* 39 (1984), pp. 611–627.
7. See Kay Giesecke, "Default and Information," working paper, Cornell University, 2001.

EXHIBIT 33–8

Announcing the Default Timing by a Sequence of "Predefault" Events in the First-Passage Approach



REDUCED-FORM CREDIT MODELS

Reduced-form models were developed in the 1990s.[8] Here we assume that default occurs without warning. This means that investors face short-term credit risk, which is absent from the structural models discussed previously. This is a desirable model property because it allows us to fit the model to market credit spreads.

Default Intensity

The rate at which default occurs is called the *default intensity,* and we denote it by λ. We can think of the *intensity* at time t as the conditional probability that default will happen immediately, given that the firm has escaped default by t. As such, it describes the short-term credit risk investors face.

The intensity is the central ingredient of all reduced-form models. It is modeled as a (nonnegative) stochastic process under the market-implied probability. The time evolution of the intensity reflects changes in the instantaneous default probability of a firm. The intensity model is calibrated from market prices

8. See Philippe Artzner and Freddy Delbaen, "Default Risk Insurance and Incomplete Markets," *Mathematical Finance* 5 (1995), pp. 187–195; Robert A. Jarrow and Stuart M. Turnbul, "Pricing Derivatives on Financial Securities Subject to Credit Risk," *Journal of Finance* 50 (1995), pp. 53–86; and Darrell Duffie and Kenneth J. Singleton, "Modeling Term Structures of Defaultable Bonds," *Review of Financial Studies* 12 (1999), pp. 687–720.

of credit-sensitive securities issued by the firm. There is a one-to-one relation between the intensity and the corresponding default probabilities.

We give two simple but useful specifications for the intensity and the corresponding default probabilities.

- *Example 1*. Suppose that λ is a constant. Then default is a Poisson arrival, and the default time is exponential with parameter λ. The default probability thus is given by $q(T) = 1 - \exp(-\lambda T)$.
- *Example 2*. Suppose that $\lambda = \lambda(t)$ is a deterministic function of time t. Then default is an inhomogeneous Poisson arrival. A simple but useful parameterization that is frequently used is the assumption that $\lambda(t)$ is stepwise defined over finite periods across the spread curve—these stepwise constants can be calibrated easily from market data.

These examples constitute only a small sample of possible parameterizations of the default intensity. There are many more choices, often borrowed from the classical term-structure models based on the short-term interest rate. This is motivated by the close analogy of defaultable term-structure models and classical, nondefaultable term-structure models to which we turn next.

Valuation

The description of the default dynamics through the market-implied default intensity λ leads to tractable valuation formulas. Below we describe several different specifications of these formulas corresponding to different units for the value recovered by investors at default.

We consider a zero-coupon bond paying 1 at maturity T if there is no default and a fraction $0 < R < 1$ of an equivalent (face value 1, maturity T) but default-free bond at default if default occurs before maturity T. This recovery specification is often called *equivalent recovery.* Given the market-implied probability of default $q(T)$, and assuming that R is a constant, the present value of the bond can be written as $\exp(-rT) - \exp(-rT)(1 - R)q(T)$. Here, r is the constant risk-free rate of interest. Thus the value of the bond is the value of an otherwise equivalent risk-free bond minus the present value of the default loss $(1 - R)$. If the intensity is constant (Example 1) and recovery is zero, we obtain for the bond price today $\exp[-(r + \lambda)T]$. This means that the value of the defaultable bond is calculated as if the bond were risk-free by using a default-adjusted discount rate. The new discount rate is the sum of the risk-free rate r and the intensity λ. This parallel between pricing formulas for defaultable bonds and otherwise equivalent default-free bonds is one of the best features of reduced-form models.

An alternative recovery model is called *fractional recovery of predefault market value*. Here it is assumed that the bond recovers a fraction $0 < R < 1$ of the market value of the bond just prior to default. If the recovery rate and the intensity are constant (Example 1 above), we obtain the following convenient formula for the bond price: $\exp\{-[r + \lambda(1 - R)]T\}$. This is the value of a zero-recovery defaultable bond when the issuer's default intensity is "thinned" to $\lambda(1 - R)$. The intuition behind this is as follows. Suppose that the bond defaults with intensity λ. At default, the bond becomes worthless with probability $(1 - R)$, and its value remains unchanged with probability R. Clearly, the predefault value of the bond is not changed by this way of looking at default. Consequently, for pricing, we can ignore the "harmless" default, which occurs with intensity λR. We then price the bond as if it had zero recovery and a default intensity of $\lambda(1 - R)$. The fractional-recovery pricing formula is then implied by the formula for equivalent recovery.

The results for the valuation of more complex credit-sensitive securities are analogous, and in the general case, a credit-sensitive security can be valued as if it were not sensitive to credit risk by using an adjusted rate for discounting payoffs.

We take a closer look at the credit spreads implied by reduced-form models. In the simple case where recovery is zero and some technical conditions are satisfied, we can show that short-term credit spreads tend to λ and not zero. This should be contrasted with the structural models, where the spread goes to zero with time to maturity going to zero. In the reduced-form models, the default event is unpredictable; it comes without warning. There is always short-term uncertainty about the default event, for which investors demand a premium. This premium, expressed in terms of yield, is given by the intensity.

The unpredictability of default has another important consequence. In line with empirical observation, the model price of a credit-sensitive security will drop abruptly to its recovery value on default. This is in direct conflict with the structural models considered earlier, in which the price converges to its default contingent value and remains there as equity value drops to zero.

Default Correlation

In the reduced-form approach we can introduce cyclical default correlation by assuming that firms' default intensities are correlated through time. Similarly to the structural models of correlated default, we can introduce systematic and firm-specific factors that drive the intensities of firms. The sensitivity of a firm with respect to the systematic factors controls the intensity correlation across firms. This intensity correlation drives the dependence between firm defaults. Joint default probabilities can be calculated by observing that the intensity of the first default in a portfolio of names is the sum of the default intensities of the individual issuers in the portfolio.

Reduced-form models provide a flexible framework for modeling the dynamics of multiple-issuer credit risk. However, calibration of the model to market variables is not trivial because of the scarcity of default data and the need to model a large number of parameters simultaneously. There are also studies that argue that the approach can be problematic for other reasons.

Taking account of contagious default correlation in the reduced-form approach is not an easy exercise. The idea is that there are correlated jumps in firms' default intensities corresponding to the correlated jumps we observe in credit spreads. A variant of this assumes that there are marketwide events that can trigger joint defaults.[9] Another variant assumes that the default intensity of a firm depends explicitly on the default status of related counterparty firms in the market.[10] To avoid running into a circularity problem, one can suppose that only the default of designated "primary" firms has an effect on other "secondary" firms.

While Jarrow and Yu[11] focus on the pricing of credit-sensitive securities in the presence of contagion effects, it is difficult to calculate joint default probabilities and portfolio loss distributions within this approach. As Davis and Lo[12] and Giesecke and Weber[13] show, one can obtain tractable closed-form characterizations of loss distributions at the cost of more restricting assumptions that relate to the homogeneity of firms and the symmetry in their counterparty relations.

Calibration

Reduced-form models typically are formulated directly under the market-implied probability. This suggests that we calibrate directly from market prices of various credit-sensitive securities. One often uses liquid debt prices or credit default swap spreads, although Jarrow argues that equity is a good candidate as well.[14] Depending on the characteristics of the calibration security, it may be necessary to make parametric assumptions about the recovery process as well. With fractional recovery and zero bonds, for example, the problem is to choose the parameters of the adjusted short-rate model $r + \lambda(1 - R)$ such that model bond prices best fit observed market prices.

Here one can either parameterize the adjusted short rate directly or specify the component processes separately. With a separate specification, identification problems may arise because only the product $\lambda(1 - R)$ enters the pricing formula just described. In general, in the estimation problem one can draw from the experience related to nondefaultable term-structure models given the close analogy to reduced-form defaultable models.[15]

9. See Darrell Duffie and Kenneth J. Singleton, "Simulating Correlated Defaults," working paper, GSB, Stanford University, 1998; and Kay Giesecke, "A Simple Exponential Model for Dependent Defaults," *Journal of Fixed Income* 13 (2003), pp. 74–83.
10. This is due to Robert A. Jarrow and Fan Yu, "Counterparty Risk and the Pricing of Defaultable Securities," *Journal of Finance* 56 (2001), pp. 555–576.
11. Jarrow and Yu, "Counterparty Risk and the Pricing of Defaultable Securities."
12. Mark Davis and Violet Lo, "Infectious Defaults," *Quantitative Finance* 1 (2001), pp. 383–387.
13. Kay Giesecke and Stefan Weber, "Cyclical Correlations, Credit Contagion, and Portfolio Losses," *Journal of Banking and Finance* 28 (2004), pp. 3009–3036.
14. Robert A. Jarrow, "Default Parameter Estimation Using Market Prices," *Financial Analysts Journal* 5 (2001), pp. 1–18.
15. Dai and Singleton provide for an overview of available techniques [Qiang Dai and Kenneth Singleton, "Term Structure Dynamics in Theory and Reality," *Review of Financial Studies* 16 (2003), pp. 631–678]. Standard methods include maximum likelihood and least squares.

INCOMPLETE-INFORMATION CREDIT MODELS

For the purpose of measuring default risk, neither the structural nor the reduced-form model explicitly accounts for the fact that investors rely on information that is imperfect. The framework described in this section addresses this issue directly by giving a common perspective on reduced-form and structural models. This perspective leads to previously unrecognized hybrid models that incorporate the best features of both traditional approaches while avoiding their shortcomings.

Incomplete-information credit models were introduced by several researchers.[16] Giesecke and Goldberg[17] describe a structural reduced-form hybrid default model based on incomplete information. This model, hereafter denoted I^2, is a first-passage time model: it assumes that a firm defaults when its value falls below a barrier. All first-passage time models require descriptions of both firm value and a default barrier. What distinguishes the I^2 model from traditional first-passage time models as we described them earlier is that it assumes that investors do not know the default barrier. The importance of modeling uncertainty about the default barrier is highlighted by high-profile scandals at firms such as Enron, Tyco, and WorldCom. In these cases, public information led to poor estimates of the default barrier.

Both the expected default barrier and the uncertainty around it can be calibrated to available information in the I^2 model. Imagine that a firm is believed to be in good financial health but that a particular analyst thinks otherwise. The analyst can increase the forecasts to line up with her views by raising the expected value of the barrier. She also can adjust the variance of the default barrier to the level of her confidence in reported levels of the firm's liability.

Other incomplete-information models can be envisioned. We can think of a situation where we cannot observe firm values or receive noisy or lagged firm-value information. Another situation is when we are uncertain about both firm values and the default barrier.

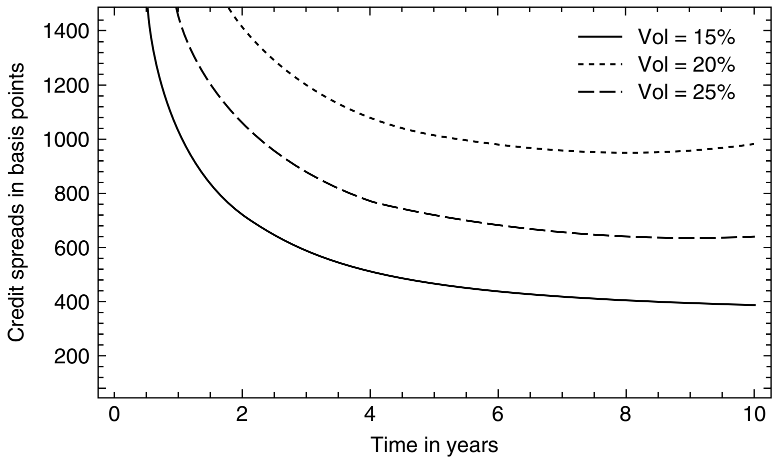
With incomplete information, default becomes a surprise event. It cannot be anticipated any more, as it can in the traditional first-passage models. It follows that investors face short-term credit risk as in the reduced-form models. With short-term uncertainty, the model prices generated by the incomplete-information models provide an excellent fit to market prices. In particular, model prices are consistent with the jumps in prices observed around the default announcement. Model spreads are consistent with the nonzero short-term spreads observed in the credit markets. Exhibit 33–9 shows the term structure of credit spreads implied

16. See Darrell Duffie and David Lando, "Term Structures of Credit Spreads with Incomplete Accounting Information," *Econometrica* 69 (2001), pp. 633–664; Giesecke, "Default and Information"; and Umut Cetin, Robert A. Jarrow, Philip Protter, and Yildiray Yildirim, "Modeling Credit Risk with Partial Information," working paper, Cornell University, 2002. A nontechnical discussion of incomplete-information models is provided in Lisa R. Goldberg, "Investing in Credit: How Good Is Your Information?" *Risk* 17 (2004), pp. S15–S18.

17. Kay Giesecke and Lisa Goldberg, "Forecasting Default in the Face of Uncertainty," *Journal of Derivatives* 12 (2004), pp. 14–25.

EXHIBIT 33–9

Term Structure of Credit Spreads, Varying Asset Volatility, in the I^2 Model



by the I^2 model, assuming risk-free rates of 6%. Strictly positive short spreads reflect the compensation for the short-term credit risk that investors face.

Giesecke and Goldberg calibrate the I^2 model from market data and further analyze its empirical properties. In particular, the I^2 model output is compared empirically with a traditional first-passage model. Two main conclusions can be drawn. The I^2 model reacts more quickly because it takes direct account of the entire history of public information rather than just current values. Furthermore, the I^2 model predicts positive short spreads for firms in distress. The traditional first-passage model always predicts that short spreads are zero.

Dependent Defaults

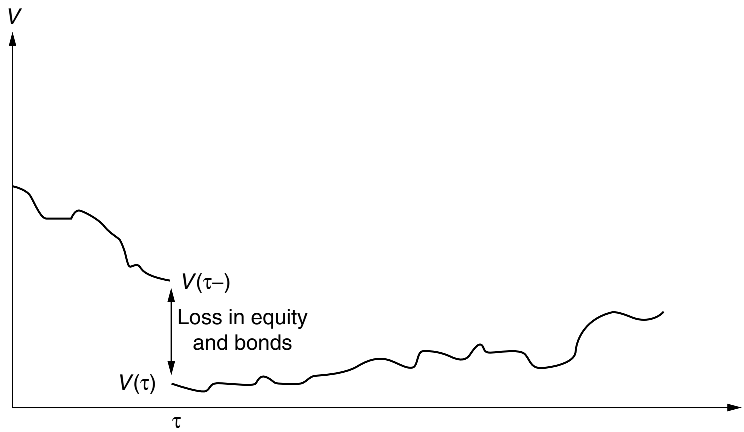
Since incomplete-information models are based on the structural approach, we can model cyclical default correlation through firm-value correlation.

Contagious default correlation arises very naturally with incomplete information. Consider the I^2 model. With defaults of firms arriving over time, we learn about the unobserved default barriers of the surviving firms.[18] This means that we update the distribution we put on a firm's default barrier with the information we extract from the unanticipated defaults of counterparty firms and reassess firms' default probabilities. The situation in which we do

18. This is discussed in detail in Kay Giesecke, "Correlated Default with Incomplete Information," *Journal of Banking and Finance* 28 (2004), pp. 1521–1545.

EXHIBIT 33–10

Firm Value in the Incomplete-Information Model



not directly observe firm values is very similar.[19] In both scenarios, the "contagious" jumps in credit spreads we observe in credit markets are implied by informational asymmetries.

Credit Premium

The credit risk premium is the mapping between the actual probability and the market-implied probability. To understand the structure of the premium, we examine the dynamics of firm value and corporate liabilities in the I^2 model. We argued earlier that thanks to the unpredictability of default, prices of credit-sensitive claims including firm equity and debt drop precipitously at default. Empirical observation shows that equity drops to near zero. This makes sense because equity holders have no stake in the firm after default. The value of the bonds is diminished by bankruptcy costs, which is described by some fractional recovery R.

Consequently, firm value, which is equal to the sum of equity and debt values, also drops at default. This is shown in Exhibit 33–10. Therefore, there are two sources of uncertainty related to firm value:

- The first is the diffusive uncertainty.
- The second is the uncertainty associated with the downward jump at default.

19. This is analyzed in Pierre Collin-Dufresne, Robert Goldstein, and Jean Helwege, "Are Jumps in Corporate Bond Yields Priced: Modeling Contagion via the Updating of Beliefs," working paper, Carnegie Mellon University, 2002.

Giesecke and Goldberg show that in the I^2 model the credit risk premium can be decomposed into two components, which correspond to the two sources of uncertainty[20]:

- The diffusive risk premium α compensates investors for the diffusive uncertainty in firm value. As in the traditional structural models, it is realized as a change to the drift term in firm-value dynamics.
- The default event risk premium β is not present in the traditional structural models. It compensates investors for the jump uncertainty in firm value and is realized as a change to the default probability. Driessen[21] empirically confirms that this event risk premium is a significant factor in corporate bond returns.

Giesecke and Goldberg demonstrate that the assumption of no arbitrage is realized in the mathematical relationships among α, β, the recovery rate assumed by the market, and the coefficients of the price processes of traded securities. The price processes depend explicitly on the leverage ratio, so the premia α and β do as well. As Giesecke and Goldberg discuss,[22] this violates an important condition for the Modigliani and Miller theorem.[23] The I^2 model therefore is not consistent with the Modigliani-Miller theorem. It provides a new way to measure the deviation of real markets from the idealized markets in which the Modigliani-Miller theorem holds.

The structure of the incomplete-information risk premium is analogous to the risk premium in reduced-form models considered in El Karoui and Martellini[24] and Jarrow, Lando, and Yu.[25] The diffusive premium related to the firm-value process corresponds to a premium for diffusive risk in the default intensity process. The event risk premium is analogous to the default event risk premium in intensity-based models. However, in the incomplete-information setting it is defined in the general reduced-form context where an intensity need not exist.

20. Kay Giesecke and Lisa Goldberg, "The Market Price of Credit Risk," working paper, Cornell University, 2003.
21. Joost Driessen, "Is Default Event Risk Priced in Corporate Bonds," working paper, University of Amsterdam, 2002.
22. Kay Giesecke and Lisa Goldberg, "In Search of a Modigliani-Miller Economy," *Journal of Investment Management* 2 (2004), pp. 1–6.
23. Franco Modigliani and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review* 48 (1958), pp. 261–297.
24. Nicole El Karoui and Lionel Martellini, "A Theoretical Inspection of the Market Price for Default Risk," working paper, Marshall School of Business, University of Southern California, 2001.
25. Robert A. Jarrow, David Lando, and Fan Yu, "Default Risk and Diversification: Theory and Applications," working paper, Cornell University, 2003.

Calibration

There is a lively debate in the literature concerning which data should be used to calibrate credit. Jarrow[26] points to a division between structural and reduced-form modelers on this issue. Traditionally, structural models are fit to equity markets and reduced-form models are fit to bond markets. Jarrow argues that the equity and bond data can be used in aggregate to calibrate a credit model, and he gives a recipe for doing this in a reduced-form setting.

Giesecke and Goldberg[27] apply reasoning similar to that of Jarrow to calibrate the I^2 model. The estimation procedure makes use of historical default rates in conjunction with data from equity, bond, and credit default swap markets. Huang and Huang[28] give empirical evidence that structural models yield more plausible results if calibrated to both kinds of data. Importantly, the physical and market-implied probabilities are fit simultaneously. The output of the calibration includes estimates of the risk premium, market-implied recovery, model security prices, and physical probabilities of default.

One issue addressed in Giesecke and Goldberg[29] is the relationship between model and actual capital structures. In the classical setting, equity is a European option, with strike price and date equal to the face value and maturity of a zero bond. This model fits market data only to the extent that firm debt can be represented adequately as a zero bond. Giesecke and Goldberg make use of the flexibility imparted by incomplete information to give a more realistic picture of equity. Specifically, equity is a down-and-out call with a stochastic strike price. This approach sidesteps the intractable problem of describing a complex capital structure in terms of a single face value and maturity date.

26. Jarrow, "Default Parameter Estimation Using Market Prices."
27. Kay Giesecke, and Lisa Goldberg, "Calibrating Credit with Incomplete Information," working paper, Cornell University, 2004.
28. Jay Huang and Ming Huang, "How Much of the Corporate-Treasury Yield Spread Is Due to Credit Risk?" working paper, Stanford University, 2003.
29. Giesecke and Goldberg, "Calibrating Credit with Incomplete Information."

CHAPTER
THIRTY-FOUR

GUIDELINES IN THE CREDIT ANALYSIS OF MUNICIPAL GENERAL OBLIGATION AND REVENUE BONDS

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Historically, the degree of safety of investing in municipal bonds has been considered second only to that of U.S. Treasury bonds, but beginning in the fourth quarter of the last century, ongoing concerns developed among many investors and underwriters about the potential default risks of municipal bonds.

One concern resulted from the well-publicized billion-dollar general obligation note defaults in 1975 of New York City. Not only did specific investors face the loss of their principal, but the defaults sent a loud and clear warning to municipal bond investors in general. The warning was that regardless of the supposedly ironclad legal protections for the bondholder, when issuers have severe budget-balancing difficulties, the political hues, cries, and financial interests of public employee unions, vendors, and community groups may be dominant forces in the initial decision-making process.

This reality was further reinforced by the new federal bankruptcy law that took effect on October 1, 1979, which makes it easier for municipal bond issuers to seek protection from bondholders by filing for bankruptcy. One by-product of the increased investor concern is that since 1975, the official statement, which is the counterpart to a prospectus in an equity or corporate bond offering and is to contain a summary of the key legal and financial security features, has become more comprehensive. As an example, before 1975 it was common for a city of New York official statement for a general obligation bond sale to be only 6 pages long, whereas for a bond sale at the end of 2003 it was 165 pages long.

The second reason for the increased interest in credit analysis was derived from the changing nature of the municipal bond market. It is now characterized by strong buying patterns by private investors and institutions. The patterns were caused in part by high federal, state, and local income tax rates. Tax-exempt bonds increasingly have become an important and convenient way to shelter income. One corollary of the strong buyers' demand for tax exemption has been an erosion of the traditional security provisions and bondholder safeguards that had grown out of the default experiences of the 1930s. General obligation bond issuers with high tax and debt burdens, declining local economies, and chronic budget-balancing problems had little difficulty finding willing buyers. Also, revenue bonds increasingly were rushed to market with legally untested security provisions, modest rate covenants, reduced debt reserves, and weak additional-bond tests. Because of this widespread weakening of security provisions, it has become more important than ever before that the prudent investor carefully evaluate the creditworthiness of a municipal bond before making a purchase.

In analyzing the creditworthiness of a general obligation, tax-backed or pure revenue bond, the investor should cover five categories of inquiry: (1) legal documents and opinions, (2) politics /management, (3) underwriter/financial advisor, (4) general credit indicators and economics, and (5) red flags, or danger signals.

The purpose of this chapter is to set forth the general guidelines that the investor should rely upon in asking questions about specific bonds.

THE LEGAL OPINION

Popular opinion holds that much of the legal work done in a bond issue is boilerplate in nature, but from the bondholder's point of view the legal opinions and document reviews should be the ultimate security provisions because, if all else fails, the bondholder may have to go to court to enforce his or her security rights. Therefore, the integrity and competency of the lawyers who review the documents and write the legal opinions that usually are summarized in the official statements are very important.

The relationship of the legal opinion to the analysis of municipal bonds for both general obligation and revenue bonds is threefold. First, the lawyer should check to determine whether the issuer is indeed legally able to issue the bonds. Second, the lawyer is to see that the issuer has properly prepared for the bond sale by enacting the various required ordinances, resolutions, and trust indentures and without violating any other laws and regulations. This preparation is particularly important in the highly technical areas of determining whether the bond issue is qualified for tax exemption under federal law and whether the issue has been structured in such a way as to violate federal arbitrage regulations. Third, the lawyer is to certify that the security safeguards and remedies provided for the bondholders and pledged by either the bond issuer or third parties (such as banks with letter-of-credit agreements) are actually supported by federal, state, and local government laws and regulations.

General Obligation Bonds

General obligation bonds are debt instruments issued by states, counties, towns, cities, and school districts. They are secured by the issuers' general taxing powers. The investor should review the legal documents and opinion as summarized in the official statement to determine what specific *unlimited* taxing powers, such as those on real estate and personal property, corporate and individual income taxes, and sales taxes, are legally available to the issuer, if necessary, to pay the bondholders. Usually for smaller governmental jurisdictions, such as school districts and towns, the only available unlimited taxing power is on property. If there are statutory or constitutional taxing power limitations, the legal documents and opinion should clearly describe how they affect the security of the bonds.

For larger general obligation bond issuers, such as states and big cities that have diverse revenue and tax sources, the legal opinion should indicate the claim of the general obligation bondholder on the issuer's general fund. Does the bondholder have a legal claim, if necessary, to the first revenues coming into the general fund? This is the case with bondholders of state of New York general obligation bonds. Does the bondholder stand second in line? This is the case with bondholders of state of California general obligation bonds. Or are the laws silent on the question altogether? This is the case for most other state and local governments.

Additionally, certain general obligation bonds, such as those for water and sewer purposes, are secured in the first instance by user charges and then by the general obligation pledge. (Such bonds are popularly known as being "double barreled.") If so, the legal documents and opinion should state how the bonds are secured by revenues and funds outside the issuer's general taxing powers and general fund.

Revenue Bonds

Revenue bonds are issued for project or enterprise financings that are secured by the revenues generated by the completed projects themselves, or for general public-purpose financings in which the issuers pledge to the bondholders tax and revenue resources that were previously part of the general fund. This latter type of revenue bond is usually created to allow issuers to raise debt outside general obligation debt limits and without voter approvals. The trust indenture and legal opinion for both types of revenue bonds should provide the investor with legal comfort in six bond-security areas:

- The limits of the basic security
- The flow-of-funds structure
- The rate, or user-charge, covenant
- The priority of revenue claims
- The additional-bonds test
- Other relevant covenants

Limits of the Basic Security

The trust indenture and legal opinion should explain what the revenues for the bonds are and how they realistically may be limited by federal, state, and local laws and procedures. The importance of this is that although most revenue bonds are structured and appear to be supported by identifiable revenue streams, those revenues sometimes can be negatively affected directly by other levels of government. For example, the Mineral Royalties Revenue Bonds that the state of Wyoming sold in December 1981 had most of the attributes of revenue bonds. The bonds had a first lien on the pledged revenues, and additional bonds could only be issued if a coverage test of 125% was met. Yet the basic revenues themselves were monies received by the state from the federal government as royalty payments for mineral production on federal lands. The U.S. Congress was under no legal obligation to continue this aid program. Therefore, the legal opinion as summarized in the official statement must clearly delineate this shortcoming of the bond security.

Flow-of-Funds Structure

The trust indenture and legal opinion should explain what the bond issuer has promised to do concerning the revenues received. What is the order of the revenue flows through the various accounting funds of the issuer to pay for the operating expenses of the facility, payments to the bondholders, maintenance and special capital improvements, and debt-service reserves? Additionally, the trust indenture and legal opinion should indicate what happens to excess revenues if they exceed the various annual fund requirements.

The flow of funds of most revenue bonds is structured as *net revenues* (i.e., debt service is paid to the bondholders immediately after revenues are paid to the basic operating and maintenance funds, but before paying all other expenses). A *gross revenues* flow-of-funds structure is one in which the bondholders are paid even before the operating expenses of the facility are paid. Examples of gross revenue bonds are those issued by the New York Metropolitan Transportation Authority. However, although it is true that these bonds legally have a claim to the fare-box revenues before all other claimants, it is doubtful that the system could function if the operational expenses, such as wages and electricity bills, were not paid first.

Rate or User-Charge Covenants

The trust indenture and legal opinion should indicate what the issuer has legally committed itself to do to safeguard the bondholders. Do the rates charged only have to be sufficient to meet expenses, including debt service, or do they have to be set and maintained at higher levels to provide for reserves? The legal opinion rarely does but should, also indicate whether or not the issuer has the legal power to increase rates or charges of users without having to obtain prior approvals by other governmental units.

Priority of Revenue Claims

The legal opinion as summarized in the official statement should clearly indicate whether or not others can legally tap the revenues of the issuer even before they start passing through the issuer's flow-of-funds structure. An example would be the highway revenue bonds issued by the Puerto Rico Highway Authority. These bonds are secured by the revenues from the Commonwealth of Puerto Rico gasoline tax. However, under the commonwealth's constitution, the revenues are first applied to the commonwealth government's own general obligation bonds if no other funds are available for them.

Additional-Bonds Test

The trust indenture and legal opinion should indicate under what circumstances the issuer can issue additional bonds that share equal claims to the issuer's revenues. Usually, the legal requirement is that the maximum annual debt service on the new bonds as well as on the old bonds be covered by the projected net revenues by a specified minimum amount. This can be as low as one times coverage. Some revenue bonds have stronger additional-bonds tests to protect the bondholders. For example, the state of Florida Orlando–Orange County Expressway Bonds have an additional-bonds test that is twofold. First, under the Florida constitution the previous year's *pledged historical revenues* must equal at least 1.33 times maximum annual debt service on the outstanding and to-be-issued bonds. Second, under the original trust indenture, *projected revenues* must provide at least 1.50 times the estimated maximum annual debt service on the outstanding and to-be-issued bonds.

Other Relevant Covenants

Lastly, the trust indenture and legal opinion should indicate whether there are other relevant covenants for the bondholder's protection. These usually include pledges by the issuer of the bonds to insure the project (if it is a project-financing revenue bond), to have the accounting records of the issuer annually audited by an outside certified public accountant, to have outside engineers annually review the condition of the capital plant, and to keep the facility operating for the life of the bonds.

In addition to the above aspects of the specific revenue structures of general obligation and revenue bonds, two other developments over the recent past make it more important than ever for the investor to carefully review the legal documents and opinions summarized in the official statements. The first development involves the mushrooming of new financing techniques that may rest on legally untested security structures. The second development is the increased use of legal opinions provided by local attorneys who may have little prior municipal bond experience. (Legal opinions traditionally have been written by experienced municipal bond attorneys.)

Legally Untested Security Structures and New Financing Techniques

In addition to the more traditional general obligation bonds and toll road, bridge, and tunnel revenue bonds, there are now more non-voter-approved, innovative, and legally untested security mechanisms. These innovative financing mechanisms include lease-rental bonds, moral obligation housing bonds, "dedicated tax-backed" and structured "asset-backed" bonds, take-and-pay power bonds with step-up provisions requiring the participants to increase payments to make up for those that may default, commercial bank–backed letter-of-credit "put" bonds, and tax-exempt commercial paper. What distinguishes these newer bonds from the more traditional general obligation and revenue bonds is that they have little history of court decisions and other case law to firmly protect the rights of the bondholders. For the newer financing mechanisms, the legal opinion should include an assessment of the probable outcome if the bond security were challenged in court. Note, however, that most official statements do not provide this to the investor.

The Need for Reliable Legal Opinions

For many years, concern over the reliability of the legal opinion was not as important as it is now. As a result of the numerous bond defaults and related shoddy legal opinions in the nineteenth century, the investment community demanded that legal documents and opinions be written by recognized municipal bond attorneys. As a consequence, over the years, a small group of primarily Wall Street–based law firms and certain recognized firms in other financial centers dominated the industry and developed high standards of professionalism.

Now, however, more and more issuers have their legal work done by local law firms, a few of whom have little experience in municipal bond work. This development, along with the introduction of more innovative and legally untested financing mechanisms, has created a greater need for reliable legal opinions. An example of a specific concern involves the documents the issuers' lawyers must complete so as to avoid arbitrage problems with the Internal Revenue Service.

On negotiated bond issues, one remedy has been for the underwriters to have their own counsels review the documents and to provide separate legal opinions.

THE NEED TO KNOW WHO *REALLY* IS THE ISSUER

Still another general question to ask before purchasing a municipal bond is just what kind of people are the issuers? Are they conscientious public servants with clearly defined public goals? Do they have histories of successful management of public institutions? Have they demonstrated commitments to professional and fiscally stringent operations? Additionally, issuers in highly charged and partisan environments in which conflicts chronically occur between political parties or among political factions or personalities are clearly bond issuers to scrutinize closely and possibly to avoid. Such issuers should be scrutinized regardless of the strength of the surrounding economic environment.

For General Obligation and Tax-Backed Bonds

For general obligation bond issuers, focus on the political relationships that exist among chief executives such as mayors, county executives, and governors, and among their legislative counterparts. Issuers with unstable political elites are of particular concern. Of course, rivalry among politicians is not necessarily bad. What is undesirable is competition so bitter and personal that real cooperation among the warring public officials in addressing future budgetary problems may be precluded. An example of an issuer that was avoided because of such dissension is the city of Cleveland. The political problems of the city in 1978 and the bitter conflicts between Mayor Kucinich and the city council resulted in a general obligation note default in December of that year.

For Revenue Bonds

When investigating revenue bond issuers, it is important to determine not only the degree of political conflict, if any, that exists among the members of the bond-issuing body but also the relationships and conflicts among those who make the appointments to the body. Additionally, the investor should determine whether the issuer of the revenue bond has to seek prior approval from another governmental jurisdiction before the user fees or other charges can be levied. If this is the case, then the stability of the political relationships between the two units of government must be determined.

An important example involves the creditworthiness of the water and electric revenue bonds and notes issued by Kansas City, Kansas. Although the revenue bonds and notes were issued by city hall, it was the six-member board of public utilities, a separately elected body, that had the power to set the water and electricity rates. In the spring of 1981, because of a political struggle between a faction on the board of public utilities and the city commissioners (including the city's finance commissioner), the board refused to raise utility rates as required by the covenant. The situation came under control only when a new election changed the makeup of the board in favor of those supported by city hall.

In addition to the preceding institutional and political concerns, for revenue bond issuers in particular, the technical and managerial abilities of the staff should be assessed. The professional competency of the staff is a more critical factor in revenue bond analysis than it is in the analysis of general obligation bonds. The reason is that unlike general obligation bonds, which are secured in the final instance by the full faith and credit and unlimited taxing powers of the issuers, many revenue bonds are secured by the ability of the revenue projects to be operational and financially self-supporting.

The professional staffs of authorities that issue revenue bonds for the construction of nuclear and other public power-generating facilities, apartment complexes, hospitals, water and sewer systems, and other large public works projects, such as convention centers and sports arenas, should be reviewed carefully. Issuers who have histories of high management turnovers, project cost overruns, or little experience should be avoided by the conservative investor or at least considered higher risks than their assigned commercial credit ratings may indicate. Additionally, it is helpful, although not mandatory, for revenue bond issuers to have their accounting records annually audited by outside certified public accountants so as to provide the investor with a more accurate picture of the issuer's financial health.

ON THE FINANCIAL ADVISOR AND UNDERWRITER

Shorthand indications of the quality of the investment are (1) who the issuer selected as its financial advisor, if any, (2) its principal underwriter if the bond sale was negotiated, and (3) its financial advisor if the bond issue came to market competitively. Additionally, since 1975, many prudent underwriters will not participate if there are significant credit-quality concerns. Therefore, it is also useful to learn who was the underwriter for the bond sales as well.

Identifying the financial advisors and underwriters is important for two reasons.

The Need for Complete, Not Just Adequate, Investment Risk Disclosures

The first reason relates to the quality and thoroughness of information provided to the investor by the issuer. The official statement, or private-placement papers if the issue is placed privately, is usually prepared with the assistance of lawyers and a financial advisor or by the principal underwriter. There are industry-wide disclosure guidelines that generally are adhered to, but not all official statements provide the investor with complete discussions of the risk potentials that may result from either the specific economics of the project or the community settings and the operational details of the security provisions. It is usually the author of this document who decides what to emphasize or downplay in the official statement. The more professional and established the author is in providing unbiased and complete information about the issuer, the more comfortable the investor can be with information provided by the issuer and in arriving at a credit-quality conclusion.

The Importance of Firm Reputation for Thoroughness and Integrity

By itself, the reputation of the issuer's financial advisor and/or underwriter should not be the determinant credit-quality factor, but it is a fact the investor should consider, particularly in the case of marginally feasible bond issues that have complex flow-of-funds and security structures. The securities industry is different from other industries, such as real estate, in that trading and investment commitments are usually made over the phone with a paper trail following days later. Many institutional investors, such as banks, bond funds, and property and casualty insurance companies, have learned to judge issuers by the company they keep. Institutions tend to be conservative, and they are more comfortable with financial information provided by established financial advisors and underwriters who have recognized reputations for honesty. Individual investors and analysts would do well to adopt this approach.

GENERAL CREDIT INDICATORS AND ECONOMIC FACTORS IN THE CREDIT ANALYSIS

The last analytical factor is the economic health or viability of the bond issuer or specific project financed by the bond proceeds. The economic factors cover a variety of concerns. When analyzing general obligation bond issuers, one should look at the specific budgetary and debt characteristics of the issuer, as well as the general economic environment. For project-financing, or enterprise, revenue bonds, the economics are limited primarily to the ability of the project to generate sufficient charges from the users to pay the bondholders. These are known as *pure revenue bonds*.

For revenue bonds that rely not on user charges and fees but instead on general purpose taxes and revenues, the analysis should take basically the same approach as for the general obligation bonds. For these bonds, the taxes and revenues diverted to the bondholders would otherwise go to the state's or city's general fund.

As an example, the bonds of the New York State Municipal Assistance Corporation for the City of New York Bonds (MAC), secured by general New York

City Sales taxes and annual state-aid appropriations, were structured to appear as pure revenue bonds, but in essence they were not. They incorporated a bond structure created to bail out New York City from severe budget deficits. The creditworthiness of the bond is tied to that of the underlying jurisdiction, which has had portions of its taxing powers and general fund revenues diverted to secure this new revenue-type bailout bond. Besides looking at the revenue features, the investor therefore must look at the underlying jurisdiction. These MACs were first issued in 1975 and refunded through the years. It should be noted that in October 2004, the MACs were refunded, now with "Sales Tax Receivable Corporation" bonds and stretched out to 2033 for paying off operating deficits of the 1960s.

For General Obligation Bonds

For general obligation bonds, the economic concerns include questions in four specific areas: debt burden, budget soundness, tax burden, and the overall economy.

Debt Burden

In relation to the debt burden of the general obligation bond issuer, some of the more important concerns include the determination of the total amount of debt outstanding and to be issued that is supported by the general taxing powers of the issuer as well as by earmarked revenues.

For example, general obligation bonds issued by school districts in New York State are general obligations of the issuer and are also secured by state-aid payments due the issuer. If the issuer defaults, the bondholder can go to the state comptroller and be paid from the next state-aid payment due the local issuer. An example of another earmarked-revenue general obligation bond is the State of Illinois General Obligation Transportation, Series A Bond. For these state general obligations, debt service is secured by gasoline taxes in the state's transportation fund.

The debt of the general obligation bond issuer includes, in addition to the general obligation bonds outstanding, leases and "moral obligation" commitments. Additionally, the amount of the unfunded pension liabilities should be determined. Key debt ratios that reveal the burden on local taxpayers include determining the per capita amount of general obligation debt as well as the per capita debt of the overlapping or underlying general obligation bond issuers. Other key measures of debt burden include determining the amounts and percentages of the outstanding general obligation bonds as well as the outstanding general obligation bonds of the overlapping or underlying jurisdictions to real estate valuations. These numbers and percentages can be compared with most recent year medians, as well as with the past history of the issuer, to determine whether the debt burden is increasing, declining, or remaining relatively stable.

Budgetary Soundness

Concerning the budgetary operations and budgetary soundness of the general obligation bond issuer, some of the more important questions include how well the issuer over at least the previous five years has been able to maintain balanced budgets and fund reserves. How dependent is the issuer on short-term debt to finance annual budgetary operations? How have increased demands by residents for costly social services been handled? That is, how frugal is the issuer? How well have the public-employee unions been handled? They usually lobby for higher salaries, liberal pensions, and other costly fringe benefits. Clearly, it is undesirable for the pattern of dealing with the constituent demands and public-employee unions to result in raising taxes and drawing down nonrecurring budget reserves. Last, another general concern in the budgetary area is the reliability of the budget and accounting records of the issuer. Are interfund borrowings reported? Who audits the books?

It should be noted that by the turn of the century, e-commerce and Internet usage were steadily growing among American consumers. Many states, counties, and city governments over the past 50 years have derived substantial revenues from sales taxes that currently are not applied to Internet sales. In some jurisdictions, over 20% of an issuer's revenues may come from local sales taxes. How the growth of the Internet affects this revenue source is uncertain at this time but at some future date could be a significant negative for the budgets of at least some issuers as well as for their bonds secured by these taxes.

Tax Burden

Concerning the tax burden, it is important to learn two things initially. First, what are the primary sources of revenue in the issuer's general fund? Second, how dependent is the issuer on any one revenue source? If the general obligation bond issuer relies increasingly on a property tax, wage and income taxes, or a sales tax to provide the major share of financing for annually increasing budget appropriations, taxes could quickly become so high as to drive businesses and people away. Many larger northern states and cities with their relatively high income, sales, and property taxes appear to be experiencing this phenomenon. Still another concern is the degree of dependency of the issuer on intergovernmental revenues, such as federal or state revenue sharing and grants-in-aid, to finance its annual budget appropriations. Political coalitions on the state and federal levels that support these financial transfer programs are not permanent and could undergo dramatic change very quickly. Therefore, a general obligation bond issuer that currently has a relatively low tax burden but receives substantial amounts of intergovernmental monies should be reviewed carefully by the investor. If it should occur that the aid monies are reduced, as has been occurring under many federal legislative programs, certain issuers primarily may increase their taxes instead of reducing their expenditures to conform to the reduced federal grants-in-aid.

Overall Economy

The fourth and last area of general obligation bond analysis concerns the issuer's overall economy. For local governments, such as counties, cities, towns, and school districts, key items include learning the annual rate of growth of the full value of all taxable real estate for the previous 10 years and identifying the 10 largest taxable properties. What kinds of business or activity occur on the respective properties? What percentage of the total property tax base do the 10 largest properties represent? What has been the building permit trend for at least the previous five years? What percentage of all real estate is tax-exempt, and what is the distribution of the taxable ones by purpose (such as residential, commercial, industrial, railroad, and public utility)? Last, who are the five largest employers? Concerning the final item, communities that have one large employer are more susceptible to rapid adverse economic change than communities with more diversified employment and real estate bases. For additional information that reveals economic health or decline, one must determine whether the population of the community over the previous 10 years has been increasing or declining by age and income and how the monthly and yearly unemployment rates compare with the national averages, as well as with the previous history of the community.

For state governments that issue general obligation bonds, the economic analysis should include many of the same questions applied to local governments. In addition, the investor should determine on the state level the annual rates of growth for the previous five years of personal income and retail sales and how much the state has had to borrow from the Federal Unemployment Trust Fund to pay unemployment benefits. This last item is particularly significant for the long-term economic attractiveness of the state because under current federal law, employers in states with large federal loans in arrears are required to pay increased unemployment taxes to the federal government.

For Revenue Bonds

Airport Revenue Bonds

For airport revenue bonds, the economic questions vary according to the type of bond security involved. There are two basic security structures.

The first type of airport revenue bond is one based on traffic-generated revenues that result from the competitiveness and passenger demand of the airport. The financial data on the operations of the airport should come from audited financial statements going back at least three years. If a new facility is planned, a feasibility study prepared by a recognized consultant should be reviewed. The feasibility study should have two components: (1) a market and demand analysis to define the service area and examine demographic and airport use trends and (2) a financial analysis to examine project operating costs and revenues.

Revenues at an airport may come from landing fees paid by the airlines for their flights, passenger facility charges (PFCs), concession fees paid by restaurants, shops, newsstands, and parking facilities, and from airline apron and fueling fees.

Also, in determining the long-term economic viability of an airport, the investor should determine whether or not the wealth trends of the service area are upward, whether the airport is dependent on tourism or serves as a vital transfer point, whether passenger enplanements and air cargo handled over the previous five years have been growing, whether increased costs of jet fuel and airport safety would make other transportation such as trains and automobiles more attractive in that particular region, and whether the airport is a major domestic hub for an airline, which could make the airport particularly vulnerable to route changes caused by schedule revisions and changes in airline corporate management.

The second type of airport revenue bond is secured by a lease with one or more airlines for the use of a specific facility such as a terminal or hangar. The lease usually obligates them to make annual payments sufficient to pay the expenses and debt service for the facility. For many of these bonds, the analysis of the airline lease is based on the credit quality of the lessee airline. Whether or not the lease should extend as long as the bonds are outstanding depends on the specific airport and facility involved. For major hub airports, it may be better not to have long-term leases because without leases, fees and revenues can be increased as the traffic grows, regardless of which airline uses the specific facility. Of course, for regional or startup airports, long-term leases with trunk (i.e., major airline) carriers are preferred.

After 9/11, air travel suffered a unique temporary downturn. While air travel remains an essential service, after the terrorist attacks, the analysis of the credit quality of airports and airlines with related bankruptcy issues has undergone increased scrutiny.

Dedicated Tax-Backed and Structured/Asset-Backed Bonds

More recently, states and local governments have issued increasing amounts of bonds where the debt service is to be paid from so-called dedicated revenues such as sales taxes, tobacco settlement payments, fees, and penalty payments. Many are structured to mimic the asset-backed bonds that are common in the taxable market. The "assets" providing the security for the municipal bonds are the "dedicated" revenues instead of credit card receivables, home equity loans, and auto loan repayments that are commonly used to secure the taxable asset-backed bonds.

Additionally, the municipal bonds are usually subject to some form of annual legislative appropriation and result from statutes specially created to pledge the identified taxes and revenues and allow for the bond sales. In the good economic times of the late 1990s many investors as well as the rating agencies have tended to blur the credit distinctions between these bonds and the issuer's own general obligation bonds. In fact, many such bonds carry higher credit ratings than the underlying general obligation bonds because the "coverage" on the former appears to be so high. In most instances, the general obligation bonds are legally backed by specific state constitutional provisions, whereas, the dedicated tax and structured/asset-backed bonds are recent legislative creations and have not been tested yet in stressful budgetary, economic, and political environments.

Highway Revenue Bonds

There are generally two types of highway revenue bonds. The bond proceeds of the first type are used to build specific revenue-producing facilities such as toll roads, bridges, and tunnels. For these pure enterprise revenue bonds, the bondholders have claims to the revenues collected through the tolls. The financial soundness of the bonds depends on the ability of the specific projects to be self-supporting. Proceeds from the second type of highway revenue bond generally are used for public highway improvements, and the bondholders are paid by earmarked revenues such as gasoline taxes, automobile registration payments, and driver's license fees.

Concerning the economic viability of a toll revenue bond, the investor should ask a number of questions.

1. What is the traffic history, and how inelastic is the demand? Toll roads, bridges, and tunnels that provide vital transportation links are clearly preferred to those that face competition from interstate highways, toll-free bridges, or mass transit.
2. How well is the facility maintained? Has the issuer established a maintenance reserve fund at a reasonable level to use for such repair work as road resurfacing and bridge painting?
3. Does the issuer have the ability to raise tolls to meet covenant and debt-reserve requirements without seeking approvals from other governmental actors such as state legislatures and governors? In those few cases where such approvals are necessary, the question of how sympathetic these other power centers have been in the past in approving toll-increase requests should be asked.
4. What is the debt-to-equity ratio? Some toll authorities have received substantial nonreimbursable federal grants to help subsidize their costs of construction. This, of course, reduces the amount of debt that has to be issued.
5. What is the history of labor-management relations, and can public-employee strikes substantially reduce toll collections?
6. When was the facility constructed? Generally, toll roads financed and constructed in the 1960s tend now to be in good financial condition because the cost of financing was much less than it is today. Many of these older revenue bond issuers have been retiring their bonds ahead of schedule by buying them at deep discounts to par in the secondary market.
7. If the facility is a bridge that could be damaged by a ship and made inoperable, does the issuer have adequate use-and-occupancy insurance?

Those few toll revenue bonds that have defaulted have done so because of either unexpected competition from toll-free highways and bridges, poor traffic projections, or substantially higher than projected construction costs. An example of one of the few defaulted bonds is the West Virginia Turnpike Commission's Turnpike Revenue Bonds, issued in 1952 and 1954 to finance the construction of an 88-mile expressway from Charleston to Princeton, West Virginia. The initial traffic-engineering estimates were overly optimistic, and the construction costs came in approximately $37 million higher than the original budgeted amount of $96 million. Because of insufficient traffic and toll collections, between 1956 and 1979 the bonds were in default. By the late 1970s with the completion of various connecting cross-country highways, the turnpike became a major link for interstate traffic. The bonds became self-supporting in terms of making interest coupon payments. It was not until 1989 that all the still-outstanding bonds were finally redeemed.

More recently, a new group of start-up toll roads has been financed with municipal bonds. The revenue projections for several roads turned out to be overly optimistic. Some have had to draw on the debt reserves. Others have had to be restructured. Examples include the Santa Rosa Bay Bridge Authority in Florida, the Southern Connector Toll Road in South Carolina, and the San Joaquin Toll Road in California.

Concerning the economics of highway revenue bonds that are not pure enterprise type but instead are secured by earmarked revenues, such as gasoline taxes, automobile registration payments, and driver's license fees, the investor should ask the following questions:

- Are the earmarked tax revenues based on state constitutional mandates, such as the state of Ohio's Highway Improvement Bonds, or are they derived from laws enacted by state legislatures, such as the state of Washington's Chapters 56, 121, and 167 Motor Vehicle Fuel Tax Bonds? A constitutional pledge is usually more permanent and reliable.
- What has been the coverage trend of the available revenues to debt service over the previous 10 years? Has the coverage been increasing, stable, or declining?
- If the earmarked revenue is gasoline tax, is it based on a specific amount per gallon of gasoline sold or as a percentage of the price of each gallon sold? With greater conservation and more efficient cars, the latter tax structure is preferred because it is not as susceptible to declining sales of gasoline and because it benefits directly from any increased gasoline prices at the pumps.
- What has been the history of statewide gasoline consumption through recessions and oil shocks?

Hospital Revenue Bonds

Two unique features of hospitals make the analysis of their debt particularly complex and uncertain. The first concerns their sources of revenue, and the second concerns the basic structure of the institutions themselves.

During the past 35 years, the major sources of revenue for most hospitals have been (1) payments from the federal (Medicare) and combined federal-state

(Medicaid) hospital reimbursement programs and (2) appropriations made by local governments through their taxing powers. It is not uncommon for hospitals to receive at least two-thirds of their annual revenues from these sources. How well the hospital management markets its service to attract more private-pay patients, how aggressive it is in third-party collections, such as from Blue Cross and HMOs, and how conservatively it budgets for the governmental reimbursement payments are key elements for distinguishing weak from strong hospital bonds.

Particularly for community-based hospitals (as opposed to teaching hospitals affiliated with medical schools), a unique feature of their financial structure is that their major financial beneficiaries, physicians, have no legal or financial liabilities if the institutions do not remain financially viable over the long term. An example of the problems that can be caused by this lack of liability is found in the story of the Sarpy County, Nebraska, Midlands Community Hospital Revenue Bonds. These bonds were issued to finance the construction of a hospital three miles south of Omaha, Nebraska, that was to replace an older one located in the downtown area. Physician questionnaires prepared for the feasibility study prior to the construction of the hospital indicated strong support for the replacement facility. Many doctors had used the older hospital in downtown Omaha as a backup facility for a larger nearby hospital. Unfortunately, once the new Sarpy hospital opened in 1976, many physicians found that the new hospital could not serve as a backup because it was 12 miles further away from the major hospital than the old hospital had been. Because these physicians were not referring their patients to the new Sarpy hospital, it was soon unable to make bond principal payments and was put under the jurisdiction of a court receiver.

The preceding factors raise long-term uncertainties about many community-based hospitals, but certain key areas of analysis and trends reveal the relative economic health of hospitals that already have revenue bonds outstanding. The first area is the liquidity of the hospital as measured by the ratio of dollars held in current assets to current liabilities. In general, a five-year trend of high values for the ratio is desirable because it implies an ability by the hospital to pay short-term obligations and thereby avoid budgetary problems. The second indicator is the ratio of long-term debt to equity, as measured in the unrestricted end-of-year fund balance. In general, the lower the long-term debt to equity ratio, the stronger the finances of the hospital. The third indicator is the actual debt service coverage of the previous five years, as well as the projected coverage. The fourth indicator is the annual bed-occupancy rates for the previous five years. The fifth is the percentage of physicians at the hospital who are professionally approved (board certified), their respective ages, and how many of them use the hospital as their primary institution.

For new or expanded hospitals, much of the preceding data are provided to the investor in the feasibility study. One item in particular that should be determined for a new hospital is whether the physicians who plan to use the hospital actually live in the area to be served by the hospital. Because of its importance in providing answers to these questions, the feasibility study must be prepared by reputable, experienced researchers.

Housing Revenue Bonds

For housing revenue bonds, the economic and financial questions vary according to the type of bond security involved. There are two basic types of housing revenue bonds, each with a different type of security structure. One is the housing revenue bond secured by *single-family* mortgages, and the other is the housing revenue bond secured by mortgages on *multifamily* housing projects.

Concerning single-family housing revenue bonds, the strongly secured bonds usually have four characteristics:

- The single-family home loans are insured by the Federal Housing Administration (FHA), Federal Veterans Administration (VA), or an acceptable private mortgage insurer or its equivalent. If the individual home loans are not insured, then they should have a loan-to-value ratio of 80% or less.
- If the conventional home loans have less than 100% primary mortgage insurance coverage, an additional 5% to 10% mortgage-pool insurance policy or its equivalent would be required. The private mortgage insurer should be of high quality in terms of company capitalization and in terms of conservative underwriting standards and limits.
- In addition to a debt reserve with monies equal at least to six months of interest on the single-family housing revenue bonds, there is a mortgage reserve fund equal at least to 1% of the mortgage portfolio outstanding.
- The issuer of the single-family housing revenue bonds is in a region of the country that has stable or strong economic growth as indicated by increased real estate valuations, personal income, and retail sales, as well as low unemployment rates.

In the 1970s, state agency issuers of single-family housing revenue bonds assumed certain prepayment levels in structuring the bond maturities. In recent years, most issuers have abandoned this practice but investors should review the retirement schedule for the single-family mortgage revenue bonds to determine whether or not the issuer has assumed large, lump-sum mortgage prepayments in the early year cash-flow projections. If so, how conservative are the prepayment assumptions, and how dependent is the issuer on the prepayments to meet the annual debt-service requirements? Of course, while the focus of this chapter is on credit analysis, the investor should be aware that extraordinary redemptions of these bonds can occur from prepayments on the mortgages.

It should be noted that over the last 10 years issuers have adopted structures similar to those in the taxable mortgage-backed securities market that incorporate prepayment assumptions. In tax-exempt single-family housing bonds these are usually the Planned Amortization Class (PAC) structures.

State issuing agencies usually have professional in-house staffs that closely monitor the home mortgage portfolios, whereas the local issuers do not. Finally, many state issuing agencies have accumulated substantial surplus funds over the years that can be viewed as an additional source of bondholder protection.

For multifamily housing revenue bonds, there are four specific, though overlapping, security structures. The first type of multifamily housing revenue bond is one in which the bonds are secured by federally insured mortgages. Usually, the federal insurance covers all but the difference between the outstanding bond principal and collectible mortgage amount (usually 1%), and all but the *nonasset* bonds (i.e., bonds issued to cover issuance costs and capitalized interest). The attractiveness of the federal insurance is that it protects the investor against bond default within the limitations outlined. The insurance protects the bondholders regardless of whether the projects are fully occupied and generating rental payments.

The second type of multifamily housing revenue bond is one in which the federal government subsidizes, under the HUD Section 8 program, all annual costs (including debt service) of the project not covered by tenant rental payments. Under Section 8, the eligible low-income and elderly tenants pay only 15% to 30% of their incomes for rent. Because the ultimate security comes from the Section 8 subsidies, which normally escalate annually with the increased cost of living in that particular geographic region, the bondholder's primary risks concern the developer's ability to complete the project, find tenants eligible under the federal guidelines to live in the project, and then maintain high occupancy rates for the life of the bonds. The investor should carefully review the location and construction standards used in building the project, as well as the competency of the project manager in selecting tenants who will take care of the building and pay their rents. In this regard, state agencies that issue Section 8 bonds usually have stronger in-house management experience and resources for dealing with problems than do the local development corporations that have issued Section 8 bonds. It should be noted that the federal government has eliminated appropriations for new Section 8 projects. Since 1995, the federal government has restricted automatic rent increases under the Section 8 program. This has introduced financial pressure.

The third type of multifamily housing revenue bond is one in which the ultimate security for the bondholder is the ability of the project to generate sufficient monthly rental payments from the tenants to meet the operating and debt-service expenses. Some of these projects may receive governmental subsidies (such as interest-cost reductions under the federal Section 236 program and property tax abatements from local governments), but the ultimate security is the economic viability of the project. Key information includes the location of the project, its occupancy rate, whether large families or the elderly will primarily live in the project, whether or not the rents necessary to keep the project financially sound are competitive with others in the surrounding community, and whether or not the project manager has a proven record of maintaining good service and of establishing careful tenant selection standards.

A fourth type of multifamily housing revenue bond is one that includes some type of private credit enhancement to the underlying real estate. These credit enhancements can include guarantees or sureties of an insurance company, securitization by the Federal National Mortgage Association (FNMA), or a bank letter of credit.

Other financial features desirable in all multifamily housing bonds include a debt-service reserve fund, which should contain an amount of money equal to the maximum annual debt service on the bonds, a mortgage reserve fund, and a capital repair and maintenance fund.

Another feature of many multifamily housing revenue bond programs, particularly those issued by state housing agencies, is the state moral obligation pledge. Several state agencies have issued housing revenue bonds that carry a potential state liability for making up deficiencies in their one-year debt-service reserve funds, should any occur. In most cases, if a drawdown of the debt reserve occurs, the state agency must report the amount used to its governor and state budget director. The state legislature, in turn, may appropriate the requested amount, although there is no legally enforceable obligation to do so. Bonds with this makeup provision are called *moral obligation bonds*.

The moral obligation provides a state legislature with permissive authority—*not mandatory authority*—to make an appropriation to the troubled state housing agency. Therefore, the analysis should determine (1) whether the state has the budgetary surpluses for subsidizing the housing agency's revenue bonds and (2) whether there is a consensus within the executive and legislative branches of that particular state's government to use state general fund revenues for subsidizing multifamily housing projects.

Industrial Revenue Bonds

Generally, industrial revenue bonds are issued by state and local governments on behalf of individual corporations and businesses. The security for the bonds usually depends on the economic soundness of the particular corporation or business involved. If the bond issue is for a subsidiary of a larger corporation, one question to ask is whether or not the parent guarantees the bonds. Is it obligated only through a lease, or does it not have any obligation whatsoever for paying the bondholders? If the parent corporation has no responsibility for the bonds, then the investor must look very closely at the operations of the subsidiary in addition to those of the parent corporation.

For companies that have issued publicly traded common stock, operating data are readily available in the quarterly (10-Q) and annual (10-K) financial reports that must be filed with the Securities and Exchange Commission. For privately held companies, financial data are more difficult to obtain.

In assessing the economic risk of investing in an industrial revenue bond, another question to ask is whether the bondholder or the trustee holds the mortgage on the property. Although holding the mortgage is not an important economic factor in assessing either hospital or low-income multifamily housing bonds where the properties have very limited commercial value, it can be an important strength for the holder of industrial development revenue bonds. If the bond is secured by a mortgage on a property of a retailer such as Kmart, or an industrial facility such as a warehouse, the property location and resale value of the real estate may provide some protection to the bondholder, regardless of what happens to the company that issued the bonds. Of course, the investor always should avoid possible bankruptcy situations regardless of the economic attractiveness of the particular piece of real estate involved. The reason is that the bankruptcy process usually involves years of litigation and numerous court hearings, which no investor should want to be concerned about.

Lease-Rental Bonds

Lease-rental bonds usually are structured as revenue bonds, and annual payments, paid by a state or local government, cover all costs including operations, maintenance, and debt service. It should be noted that many Certificate of Participation Bonds, or COPs, are similar in security structure in that they too are dependent on the annual legislative appropriation process. The public purposes financed by these bond issues include public office buildings, fire houses, police stations, university buildings, mental health facilities, and highways, as well as office equipment and computers. In some instances, the payments may come from student tuition, patient fees, and earmarked tax revenues, and the state or local government is not legally obligated to make lease-rental payments beyond the amount of available earmarked revenues. However, for many lease-rental bonds, the underlying lessee state, county, or city is to make payment from its general fund subject to annual legislative appropriation. For example, the Albany County, New York, Lease Rental South Mall Bonds were issued to finance the construction of state office buildings. Although the bonds were technically general obligations of Albany County, the real security came from the annual lease payments made by the State of New York. These payments were appropriated annually. For such bonds, the basic economic and financial analysis should follow the same guidelines as for general obligation bonds.

Public Power Revenue Bonds

Public power revenue bonds are issued to finance the construction of electrical generating plants. An issuer of the bonds may construct and operate one power plant, buy electric power from a wholesaler and sell it retail, construct and operate several power plants, or join with other public and private utilities in jointly financing the construction of one or more power plants. This last arrangement is known as a joint-power financing structure. Although there are revenue bonds that can claim the revenues of a federal agency (e.g., the Washington Public Power Supply System's Nuclear Project No. 2 Revenue Bonds, which if necessary can claim the revenues of the Bonneville Power Administration) and many others that can require the participating underlying municipal electric systems to pay the bondholders whether or not the plants are completed and operating (i.e., the Michigan Public Power Agency Revenue Bonds), the focus here is how the investor determines which power projects will be financially self-supporting without these backup security features.

There are at least five major questions to ask when evaluating the investment soundness of a public power revenue bond:

- Does the bond issuer have the authority to raise its electric rates in a timely fashion without going to any regulatory agencies? This is particularly important if substantial rate increases are necessary to pay for new construction or plant improvements.
- How diversified is the customer base among residential, commercial, and industrial users?
- Is the service area growing in terms of population, personal income, and commercial/industrial activity so as to warrant the electrical power generated by the existing or new facilities?
- Are rates competitive with neighboring IOUs? This is a significant credit factor resulting from the competitive provisions contained in the Energy Policy Act of 1992.
- What are the projected and actual costs of power generated by the system, and how competitive are they with other regions of the country? Power rates are particularly important for determining the long-term economic attractiveness of the region for industries that are large energy users.
- How diversified is the fuel mix? Is the issuer dependent on one energy source such as hydro dams, oil, natural gas, coal, or nuclear fuel?

Concerning electrical generating plants fueled by nuclear power, the aftermath of the Three Mile Island nuclear accident in 1979 has resulted in greater construction and maintenance reviews and costly safety requirements prompted by the Federal Nuclear Regulatory Commission (NRC). The NRC oversees this industry. In the past, although nuclear power plants were expected to cost far more to build than other types of power plants, it also was believed that once the generating plants became operational, the relatively low fuel and maintenance costs would more than offset the initial capital outlays. However, with the increased concern about public safety brought about by the Three Mile Island accident, repairs and design modifications are now expected to be made even after plants begin to operate. Of course, this increases the ongoing costs of generating electricity and reduces the attractiveness of nuclear power as an alternative to the oil, gas, and coal fuels.

Resource-Recovery Revenue Bonds

A resource-recovery facility converts refuse (solid waste) into commercially salable energy, recoverable products, and a residue to be landfilled. The major revenues for a resource-recovery bond usually are the tipping fees per ton paid by those who deliver the garbage to the facility for disposal; revenues from steam, electricity, or refuse-derived fuel sold to an electric power company or another energy user; and revenues from the sale of recoverable materials such as aluminum and steel scrap.

Resource-recovery bonds are secured in one of two ways or a combination thereof. The first security structure is one in which the cost of running the resource-recovery plant and paying the bondholders comes from the sale of the energy produced (steam, electricity, or refuse-derived fuel), as well as from fees paid by the haulers, both municipal and private, who bring the garbage to the facility. In this financing structure, the resource-recovery plant usually has to be operational and self-supporting for the bondholders to be paid. The second security structure involves an agreement with a state or local government, such as a county or municipality, that contractually obligates the government to haul or to have hauled a certain amount of garbage to the facility each year for the life of the facility and to pay a tipping fee sufficient to operate the facility. The tipping fee must include amounts sufficient to pay bondholders whether or not the resource-recovery plant has become fully operational.

When deciding to invest in a resource-recovery revenue bond, one should ask the following questions. First, how proven is the system technology used in the plant? *Mass burning* is the simplest method, and it has years of proven experience. In mass burning, the refuse is burned with very little processing. Prepared fuels and shredding, the next most proven method, requires the refuse to be prepared by separation or shredding so as to produce a higher-quality fuel for burning. More innovative approaches require the most detailed engineering evaluations by qualified specialists. Second, how experienced and reliable are the construction contractors and facility operators (vendors)? Third, are there adequate safeguards and financial incentives for the contractor/vendor to complete and then maintain the facility? Fourth, what are the estimated tipping fees that will have to be charged, and how do they compare with those at nearby landfills? In 1994 the U.S. Supreme Court in the *Carbone* decision struck down "flow control" ordinances that had been used to require all garbage within a local region to be delivered to designated plants regardless of economically attractive alternatives. As a result of *Carbone,* the competitiveness of the tipping fee will be a critical credit factor. Fifth, is the bondholder protected during the construction stage by reserves and by fixed-price construction contracts? Sixth, are the prices charged for the generated energy fixed, or are they tied to the changing costs of the fuel sources such as oil and gas in that particular marketplace?

Because of the uniqueness of the resource-recovery technology, there are additional questions that should be asked. First, even if the plant-system technology is a proven one, is the plant either the same size as others already in operation or a larger scale model that would require careful investor review? Second, if the system technology used is innovative, is there sufficient redundancy or low-utilization assumptions in the plant design to absorb any unforeseen problems once the plant begins production? Last, in addition to the more routine reserves (such as debt, maintenance, and special capital improvement reserves) and covenants (such as covenants that commercial insurance be placed on the facility and that the contractor pledge to maintain the plant for the life of the bonds), there also should be required yearly plant reviews by independent consulting engineers. The vendor should be required to make the necessary repairs so that the facility will be operational for the life of the bonds.

For resource-recovery revenue bonds that have a security structure involving an agreement with a local government, additional questions for the investor to ask are the following: Is the contractual obligation at a fixed rate, or is the tipping fee elastic enough to cover all the increasing costs of operations, maintenance, and debt service? Would strikes or other *force majeure* events prevent the contract from being enforceable or preclude the availability of an adequate supply of garbage? Last, the investor should determine the soundness of the budgetary operations and general fund reserves of the local government that is to pay the tipping or service fee. For these bonds, the basic economic analysis should follow the same guidelines as for general obligation bonds.

Student Loan Revenue Bonds

Student loan revenue bonds usually are issued by state agencies or not-for-profit organizations and are used for purchasing new guaranteed student loans for higher education or existing guaranteed student loans from local banks.

The student loans are 100% guaranteed. They are guaranteed either directly by the federal government—under the Federal Insured Student Loan (FISL) program for 100% of principal and interest—or by a state guaranty agency under a more recent federal insurance program, the Federal Guaranteed Student Loan (GSL) program. This latter program provides federal reimbursement for a state guaranty agency on an annual basis for 100% of the payment on defaulted loans up to approximately 5% of the amount of loans being repaid, 90% for claims in excess of 5% but less than 9%, and 80% for claims exceeding 9%. The federal commitments are not dependent on future congressional approvals. Loans made under the FISL and GSL programs are contractual obligations of the federal government.

Although most student loans have federal government support, the financial soundness of the bond program that issues the student loan revenue bonds and monitors the loan portfolio is of critical importance to the investor because of the unique financial structure of a student loan portfolio. Although loan repayments from the student or, in the event of student default, repayments from the guaranty agency are contractually insured, it is difficult to precisely project the actual loan repayment cash flows. The reason is that the student does not begin repaying the loan until he or she leaves college or graduate school and all other deferments, such as military service, have ended. Before the student begins the loan repayments, the federal government pays the interest on the loans under prescribed formulas. Therefore, the first general concern of the investor should be to determine the strength of the cash-flow protection.

The second general concern is the adequacy of the loan guaranty. Under all economic scenarios short of a depression, in which the student loan default rate could be 20% or greater, the GSL sliding federal reinsurance scale of 100–90–80 should provide adequate cash-flow and bond default protection as long as the student loan revenue bond issuer effectively services the student loan repayments, has established and adequately funded loan-guaranty and debt reserve funds, employs conservative loan-repayment assumptions in the original bond-maturity schedule, and is required to call the bonds at par if the student loan repayments are accelerated. This latter factor presents a reinvestment risk for the bondholder.

There are eight specific questions for the investor to ask:

- What percentage of the student loans are FISL- and GSL-backed?
- Has a loan-guarantee fund been established and funded? Usually, a fund that is required to have an amount equal to at least 2% of the loan principal outstanding is desirable.
- Is the issuer required to maintain a debt reserve fund? Usually, for notes, a fund with at least six-months interest, and for bonds, a fund with a one-year maximum annual debt service, are desirable.
- If the bond issuer has purchased portfolios of student loans from local banks, are the local lenders required to repurchase any loans if there are either defaults or improperly originated loans?
- What in-house capability does the issuer have for monitoring and servicing the loan repayments?
- What is the historical loan-default rate?
- How are the operating expenses of the agency met? If federal operating subsidies are received under the "Special Allowance Payment Rate" program, what are the rate assumptions used? In this program, the issuer receives a supplemental subsidy, which fluctuates with the 91-day U.S. Treasury bill rate.
- If a state agency is the issuer, is it dependent on appropriations for covering operating expenses and reserve requirements?

Water and Sewer Revenue Bonds

Water and sewer revenue bonds are issued to provide for a local community's basic needs and as such are not usually subject to general economic changes. Because of the vital utility services performed, their respective financial structures are usually designed to have the lowest possible user charges and still remain financially viable. Generally, rate covenants requiring that user charges cover operations, maintenance, and approximately 1.2 times annual debt service and reserve requirements are most desirable. On the one hand, a lower rate covenant provides a smaller margin for unanticipated slow collections or increased operating and plant maintenance costs caused by inflation. On the other hand, rates that generate revenues more than 1.2 times the annual debt service and reserve requirements could cause unnecessary financial burdens on the users of the water and sewer systems.

A useful indication of the soundness of an issuer's operations is to compare the water or sewer utility's average quarterly customer billings to those of other water or sewer systems. Assuming that good customer service is given, the water or sewer system that has a relatively low customer billing charge generally indicates an efficient operation and therefore strong bond-payment prospects.

Key questions for the investor to ask include the following:

- Has the bond issuer, through local ordinances, required mandatory water or sewer connections? Also, local board of health directives against well water contamination and septic tank usage can often accomplish the same objective as the mandatory hookups.
- Does the issuer have to comply with an EPA consent decree and thereby issue significant amounts of bonds?
- What is the physical condition of the facilities in terms of plant, lines, and meters, and what capital improvements are necessary for maintaining the utilities as well as for providing for anticipated community growth?
- For water systems in particular, it is important to determine if the system has water supplies in excess of current peak and projected demands. An operating system at less than full utilization is able to serve future customers and bring in revenues without having to issue additional bonds to enlarge its facilities.
- What is the operating record of the water or sewer utility for the previous five years?
- If the bond issuer does not have its own distribution system but instead charges other participating local governments that do, are the charges or fees based on the actual water flow drawn (for water revenue bonds) and sewage treated (for sewer revenue bonds) or on gallonage entitlements?
- For water revenue bonds issued for agricultural regions, what crop is grown? An acre of oranges or cherries in California will provide the grower with more income than will an acre of corn or wheat in Iowa.
- For expanding water and sewer systems, does the issuer have a record over the previous two years of achieving net income equal to or exceeding the rate covenants, and will the facilities to be constructed add to the issuer's net revenues?
- Has the issuer established and funded debt and maintenance reserves to deal with unexpected cash-flow problems or system repairs?
- Does the bond issuer have the power to place tax liens against the real estate of those who have not paid their water or sewer bills? Although the investor would not want to own a bond for which court actions of this nature would be necessary, the legal existence of this power usually provides an economic incentive for water and sewer bills to be paid promptly by the users.

Additional bonds should be issued only if the need, cost, and construction schedule of the facility have been certified by an independent consulting engineer and if the past and projected revenues are sufficient to pay operating expenses and debt service. Of course, for a new system that does not have an operating history, the quality of the consulting engineer's report is of the uppermost importance.

RED FLAGS FOR THE INVESTOR

In addition to the areas of analysis just described, certain red flags, or negative trends, suggest increased credit risks.

For General Obligation Bonds

For general obligation bonds, the signals that indicate a decline in the ability of a state, county, town, city, or school district to function within fiscally sound parameters include the following:

- Declining property values and increasing delinquent taxpayers
- An annually increasing tax burden relative to other regions
- An increasing property tax rate in conjunction with a declining population
- Declines in the number and value of issued permits for new building construction
- Actual general fund revenues consistently falling below budgeted amounts
- Increasing end-of-year general fund deficits
- Budget expenditures increasing annually in excess of the inflation rate
- The unfunded pension liabilities are increasing
- General obligation debt increasing while property values are stagnant
- Declining economy as measured by increased unemployment and declining personal income

For Revenue Bonds

For revenue bonds, the general signals that indicate a decline in credit quality include the following:

- Annually decreasing coverage of debt service by net revenues
- Use of debt reserve and other reserves by the issuer

- Growing financial dependence of the issuer on unpredictable federal and state-aid appropriations for meeting operating budget expenses
- Chronic lateness in supplying investors with annual audited financials
- Unanticipated cost overruns and schedule delays on capital construction projects
- Frequent or significant rate increases
- Deferring capital plant maintenance and improvements
- Excessive management turnovers
- Shrinking customer base
- New and unanticipated competition

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CHAPTER
THIRTY-FIVE

RATING AGENCY APPROACH TO STRUCTURED FINANCE

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There are four major areas of focus in rating a structured-finance securitization. These are (1) collateral analysis, where the credit of the underlying assets is evaluated, (2) financial analysis of the structure, which may include cash-flow modeling, (3) legal review of the structure and documentation, and (4) review of the respective parties such as the seller/servicer. These four areas of focus are presented and explained in a committee forum by the primary analyst. All rating decisions, including rating actions on existing transactions, are made via an internal committee process. This chapter will describe the committee process and address each of the four major areas of focus in turn.

CREDIT COMMITTEE PROCESS

Most transactions are rated by an analytical team consisting of a primary and a secondary analyst. The primary analyst, most often the senior of the two, is responsible for managing the rating process, including meeting the appropriate timeline for rating the particular transaction. The secondary analyst works with the primary analyst to analyze the collateral and structure of the transaction. The team formulates a rating recommendation and prepares supporting documentation for presentation to a credit rating committee. A minimum quorum is necessary for a committee to make a rating decision. The quorum usually consists of the primary analyst, the secondary analyst, two senior directors, and analysts from other groups as needed.

Most structured finance rating committees contain at least the following information:

- Proposed deal structure and comparison structures of issuer's prior securitizations, as well as peer group comparisons

- Collateral stratifications provided by banker/issuer
- Underwriting guidelines (if applicable)
- Originator and/or servicer reviews or ratings
- Collateral pool analysis and comparison pool analysis of issuer's prior securitizations, as well as peer group comparisons
- Performance of prior securitizations
- Default and recovery assumptions
- Cash-flow results, including prepayment, interest rate, and/or currency stresses or hedge terms

The rationale behind the recommended rating will be discussed, including any positive credit characteristics and analysts' concerns. The credit rating committee then will officially determine the rating. The credit rating committee considers all the relevant quantitative and qualitative issues to arrive at the appropriate rating that reflects both the current information and the prospective performance. If there are no unresolved issues, a rating is assigned. If there are unresolved issues, the committee meeting may be suspended until the issues are resolved and a rating can be determined subsequently.

COLLATERAL ANALYSIS

Assets that have been securitized include but are not limited to residential and commercial mortgage loans, credit card receivables, auto loans, future trade receivables, and other securities such as corporate bonds. Each of these asset types has its own unique characteristics and performance drivers. The major drivers of virtually all asset performance are defaults, whether they be borrower defaults (such as mortgage loans) or corporate defaults (such as bonds) and recovery values should the asset default. The primary objective of collateral analysis is to answer the question, "What is the probability of default, and if the asset defaults, how much will be recovered?" In the ideal situation, this question should be asked and answered for each asset in a portfolio of assets to be securitized.

Default and recovery drivers are relatively asset-specific. For example, default drivers for a residential mortgage loan include the ratio of the amount of the loan to the value of the home, or "LTV," and the borrower's credit history, job stability, and regional economics. Recovery drivers of a residential mortgage loan include the value of the home at the time of default, as well as the time and expense associated with the foreclosure and sale process. Examples of default and recovery drivers for three other types of assets (commercial mortgage-backed securites, auto loan ABS, and credit card ABS) are listed in Exhibit 35–1.

EXHIBIT 35–1

Examples of Default and Recovery Drivers for Securities Backed by Commercial Mortgage Loans, Auto Loans, and Credit Card Receivables

For the commercial mortgage loans backing CMBS:

- Lease terms
- Property income verifications
- Credit approvals
- Principal/borrower reviews
- Expense reimbursements
- Regional vacancy rate assumptions
- Management fees
- Historical expenses
- Insurance
- Taxes
- Utilities
- Maintenance costs
- Capital expenditures
- Debt service on mortgage
- Environmental/engineering reports

For automobile loan ABS*:

- Vehicle age
- Downpayment
- Advance rate
- Depreciation
- Term
- Pricing
- Geographic diversification
- Loan type

For credit card ABS†:

- Underwriting guidelines
- Cardholder credit scores
- Card type—retail, low-price, affinity, cobranded
- Fixed or floating card annual percentage rate
- Flexibility of issuer to reprice card rates
- Frequency of floating-rate resets
- Use of teaser rates
- Geographic and demographic diversification
- Seasoning
- Competitive positioning

*See Fitch research, “A Road Map to Rating Auto Loan-Backed Securitizations,” March 13, 2002, p. 3.

†See Fitch research, “ABCs of Credit Card ABS,” April 4, 2001, p. 9.

FINANCIAL REVIEW OF STRUCTURE

Virtually all deal structures within structured finance contain some type of credit protection or credit enhancement that supports a class or several classes of bonds. The most common forms of credit enhancement are

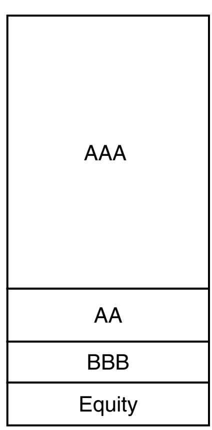
- Senior/subordinate structure
- Overcollateralization
- Excess spread
- Reserve fund
- Letter of credit
- Monoline bond insurance

These forms of credit enhancement may be used on their own or in combination in a particular transaction. The rating agency approach to each of these will be discussed in this section.

The most common type of credit enhancement within the structured-finance arena is the senior/subordinate structure. In this structure, there are multiple classes of bonds that are rated based on the amount of bond support or subordination underneath the respective bond class. A typical senior/subordinate structure is shown in Exhibit 35–2. In this structure, the AAA-rated bonds comprise the largest portion of the issued bonds because AAA-rated bonds represent the cheapest cost of funding. Other rated bonds and equity absorb losses on the collateral before payments to AAA bondholders are withheld. Likewise, each rated class of securities has a certain amount of lower-rated securities or some other type of credit enhancement to support its respective rating. The rating agency's collateral and

EXHIBIT 35–2

Typical Senior/Subordinate Structure



structural analyses determine how much credit enhancement is required at each rating level.

Overcollateralization refers to the amount of cushion available to absorb losses created when there is more collateral than securities issued. Rating agencies generally are indifferent between subordination and overcollateralization as long as the required credit-enhancement threshold is met. *Excess spread* refers to the difference between the coupons received on the assets less the coupons paid to the bondholders and deal expenses. This additional interest coverage may be used to pay down notes, thus building overcollateralization, or may be captured via some other mechanism that would create credit protection for the transaction. Because of the reliance on interest coverage in transactions that feature excess spread used as credit enhancement, variables that might affect the amount of excess spread in a given payment period must be factored into the cash-flow analysis. The most common variables are interest-rate movements, prepayments, and collateral defaults. Interest-rate mismatches such as the one created between fixed-rate collateral and floating-rate notes often are hedged via a swap or cap provided by a rated counterparty.

A *reserve fund* is a specified amount of cash that is set aside to absorb losses in the event that it is needed. Letters of credit and monoline bond insurance are forms of credit enhancement that are provided by different types of rated financial institutions. From a rating agency perspective, the rating for one of these forms of credit enhancement is based on the credit rating of the respective institution providing the letter of credit or guarantee.

LEGAL REVIEW OF STRUCTURE

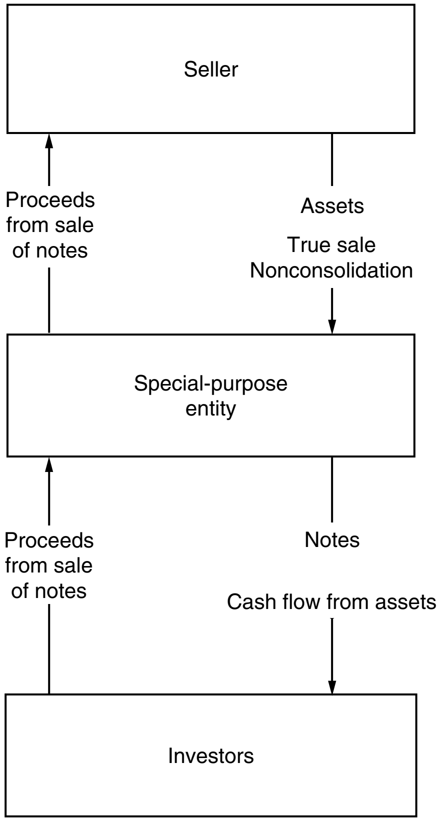
A legal review of a structured-finance transaction structure involves a review of the transfer of assets, securities, and cash with respect to each of the parties involved. The issuer of the securities must be independent from the seller (usually the originator) in order for the securities issued to receive a higher rating than the long-term financial rating of the seller. As a result, the issuer is most often a bankruptcy-remote special-purpose entity (SPE), as verified by an opinion of legal counsel. The SPE is established strictly to own the assets and issue securities to finance the assets, and it is not allowed to enter into any other types of transactions. Additional legal opinions state that the sale of the assets to the SPE constitutes a "true sale" and that no substantive consolidation of the assets would occur in the event of a bankruptcy of the seller. These opinions are referred to as "true sale" and "nonconsolidation" opinions, respectively.

A typical structured-finance legal structural diagram is shown in Exhibit 35–3. In this structure, the assets are sold from the seller or originator into a SPE, which then issues rated notes to investors. Proceeds from the sale of the notes are passed through to the seller, and in turn, all future cash flows from the assets are passed on to the investors in the form of note payments.

The mix of legal documentation in a structured-finance transaction depends on the structure of each transaction. Although the rating agency generally is not

EXHIBIT 35–3

Typical Structured-Finance Legal Structure



a party to any of the legal agreements, the agency is identified in the legal documents and reviews the documents to make sure that they reflect the correct terms and structure of the transaction. In addition, the legal documents contain the rating agency's form of surveillance that needs to be received to monitor the credit quality of the transaction.

Various legal documents dictate the terms of a particular securitization. These may include

- Organizational documents of the special-purpose entity
- Loan agreements
- Mortgages/deeds of trust
- Sale agreements
- Pooling and servicing agreements

- Third-party servicing agreements
- Trust agreements
- Liquidity agreements
- Indentures of trust
- Legal opinions
- Offering circular/prospectus
- Custodial agreements
- Credit support agreements
- Swap agreements
- Collateral/intercreditor agreements
- Investment/portfolio management agreements

PARTIES REVIEW

Another important component of the rating agency analysis for most structured finance transactions is a thorough review of the different parties involved. The review of these parties may be factored into the rating of a structured-finance transaction. FitchRatings, for example, provides separate ratings for the different types of parties that are quantitatively factored directly into the credit-enhancement and cash-flow analysis for some asset types. The most common of these entities within the structured-finance arena are servicers, originators, and asset managers.

Servicers

Servicers play an important role in virtually all mortgage-related structured-finance transactions and many asset-backed deals as well. Servicers are responsible for the processing of payments from borrowers in a particular loan pool, as well as collection efforts for delinquent borrowers. Servicer reviews have been an important component of structured-finance ratings since the inception of these markets. Fitch began rating commercial mortgage loan servicers in 1992 and residential mortgage loan servicers in 1999. Fitch servicer ratings generally consider the following elements[1]:

- Financial condition
- Company and management experience
- Staffing and training

1. See Fitch research, "Residential Mortgage Servicer Ratings," February 21, 2003, and "Commercial Mortgage Servicer Rating Criteria," April 11, 2002.

- Stability of operations
- Servicing/loan administration
- Policies, procedures, and controls
- Current and projected volume capacity
- Performance history
- Technology

Originators

Another important party in most structured-finance transactions is the originator of the assets. In residential mortgage transactions, the originator is often the same party as the servicer. Fitch, for example, has been working with and reviewing originators since the inception of its structured-finance ratings. The following factors are considered in the review of a mortgage originator[2]:

- Financial condition
- Company and management experience
- Staffing and training
- Production and sourcing
- Loan processing
- Credit underwriting
- Property valuation/appraisals
- Closing/postclosing process
- Stability of operations
- Policies, procedures, and controls
- Performance history
- Technology

Asset Managers

Asset managers are a key player in collateralized debt obligation (CDO) transactions, where a portfolio of debt securities is pooled and securitized to issue notes. The portfolio manager or asset manager usually is responsible for the initial asset selection, as well as the ongoing monitoring and trading, if

2. See Fitch research, "Reviewing Residential Mortgage Originators," July 23, 2001, p. 12.

any, of the portfolio. Fitch, for example, rates CDO asset managers in each of the following nine categories[3]:

- Company and management experience
- Financial condition
- Staffing
- Procedures and controls
- Credit underwriting/asset selection
- Portfolio management
- CDO administration
- Technology
- Portfolio performance

Servicer, originator, and asset manager reviews typically are held at the company's facilities to allow the rating agency's analytical team to meet a broad spectrum of company management and to enhance the team's understanding of the company and its operations. The site visit typically lasts one to two days and consists of interviews with senior management, as well as servicing, credit analysis, or portfolio management teams depending on the type of review or rating. Meetings are wide-ranging, covering both quantitative and qualitative issues.

Other parties that the rating agency interacts with on a regular basis in the course of rating and monitoring structured-finance transactions are trustees who are responsible for carrying out the terms of the transaction once it has closed, underwriters, and attorneys.

3. See Fitch research, "Rating CDO Asset Managers," September 24, 2002, p. 1.

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PART

FIVE

VALUATION AND ANALYSIS

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CHAPTER
THIRTY-SIX

FIXED INCOME RISK MODELING

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Many years ago, bonds were boring. Returns were small and steady. Fixed income risk monitoring consisted of watching duration and avoiding low qualities. But as interest-rate volatility has increased and the variety of fixed income instruments has grown, both opportunities and dangers have flourished. Accurate fixed income risk measurement has become more important and more difficult. The sources of fixed income risk have proliferated and intensified. Exposures to these risks are subtle and complex. Today's fixed income environment requires advanced multifactor techniques to adequately model the many sources of risk influencing the market, and powerful tools to compute exposures to those risks.

Duration is the traditional fixed income risk factor, and measures exposure to the risk of parallel term-structure movements. But term structures not only shift in parallel, they also twist and bend, and these movements tend to increase in magnitude as interest rates rise. In addition to interest-rate volatility, most issues are exposed to various sources of default risk, assessed by marketwide sector and quality spreads. These spreads can depend on maturity and move unpredictably over time. Beyond marketwide sources of default risk, individual issues face specific sources of default risk.

Nominal cash flows and quality ratings no longer suffice to measure risk exposures. Call and put options and sinking-fund provisions can significantly alter an instrument's risk exposures in intricate ways. Mortgage-backed securities are subject to uncertain prepayments, which influence the risk exposures of those instruments. When they are packaged as IOs, POs, or CMOs, the risk exposure accounting becomes even more difficult.

There is no question that building a fixed income risk model is complicated business. Forecasting risk factor covariance and analyzing the Byzantine provisions of today's fixed income instruments require sophisticated methods.

Using a fixed income risk model, however, should be intuitive and straightforward. Bond investors should find the risk factors sensible. Risk analysis results should be precise, but still conform to investor instincts. A good risk model actually should simplify the investment process, quantify risks, and increase investor insight.

Fixed income risk modeling plays a critical role in bond portfolio management, benchmark tracking, immunization, active strategy implementation, and performance measurement and analysis. Benchmark tracking involves comparing the risk exposures of an investment portfolio and a benchmark. Matching those exposures should lead to investment returns that accurately track benchmark returns. Immunization involves comparing the risk exposures of a portfolio and a liability stream. Matching those exposures should immunize the portfolio's liability coverage against market changes. Active strategies involve deliberate risk exposures relative to a benchmark, aimed at exceeding benchmark returns. Performance measurement and analysis involves identifying active bets and studying their past performance so as to measure bond manager skill.

This chapter describes a multifactor approach to risk modeling. This approach consists of two basic components. First, a valuation model identifies and values the many risk factors in the market. The valuation model requires the machinery to estimate exposures to these risk factors, including an option simulation to handle the wide variety of optionable fixed income securities. Second, a risk model examines the historical behavior of these risk factors to estimate their variances and covariances. The presentation here will be general, but this chapter will conclude with evidence of the performance of multifactor risk models based on their specific application to the U.S. bond market.[1]

THE VALUATION MODEL

The following multifactor valuation model is designed to identify and value risk factors in the market. This model estimates bond prices as

$$\mathrm{PM}_n(t) = \sum_T \frac{\mathrm{cf}_n(T) \cdot \mathrm{PDB}(t, T)}{\exp[\kappa_n(t) \cdot T]} + \xi_n(t) \qquad (36\text{–}1)$$

$$= \mathrm{PF}_n(t) + \xi_n(t) \qquad (36\text{–}2)$$

with

$$\kappa_n(t) = \sum_j x_{n,j} \cdot s_j(t) \qquad (36\text{–}3)$$

1. For a more detailed description of this application to the U.S. bond market, see Ronald N. Kahn, "Risk and Return in the U.S. Bond Market: A Multifactor Approach," in Frank J. Fabozzi (ed.), *Advances and Innovations in the Bond and Mortgage Markets* (Chicago: Probus Publishing, 1980). For further discussion of important risk factors, especially factors affecting mortgage investors, see Ronald N. Kahn, "Fixed-Income Risk Modeling in the 1990s," *Journal of Portfolio Management* (Fall 1995), pp. 95–101.

where

$PM_n(t)$ = bond n market price at time t
$Pf_n(t)$ = bond n fitted price at time t
$cf_n(T)$ = bond n option-adjusted cash flow at time T
$PDB(t, T)$ = price at t of default-free pure discount bond maturing at T
$x_{n,j}$ = bond n exposure to factor j
$s_j(t)$ = yield spread due to factor j at time t
$\xi_n(t)$ = bond n price error at time t
$\kappa_n(t)$ = bond n total yield spread at time t

The characteristics of the market as a whole are the term structure, represented here by the default-free pure discount bond prices $PDB(t, T)$, and the marketwide factor yield spreads $s_j(t)$. The bond-specific exposures include the option-adjusted cash flows $cf_n(T)$ and the exposures $x_{n,j}$. These depend on any call or put options or sinking-fund provisions embedded in bond n. The final bond-specific component of this model is the price error $\xi_n(t)$. This model clearly enumerates how a bond's total exposure to the various factors determines its price. The estimated values [$PDB(t, T)$, $s_j(t)$, $\xi_n(t)$] result from fitting this model to actual trading prices at time t.[2] All these values change unpredictably over time.

The yield-spread factors s_j correspond to the non-term-structure sources of risk and return identified by the model. Most of these are sources of default risk. For example, each corporate bond sector might have its own yield spread, measuring the default risk common to all AAA-rated members of the sector. Each quality rating also would have its own yield spread, measuring the additional default risk common to issues rated lower than AAA.

Beyond the factors that measure default risk, there are other factors that capture risk and return in bond markets. Benchmark factors measure the uncertain liquidity premiums afforded heavily traded issues. A current-yield factor measures the market's assessment at time t of the advantage of receiving return in the form of capital gains instead of interest, providing a possible tax advantage. A perpetual factor, appearing in markets containing perpetual bonds, measures the market's assessment at time t of the advantage or disadvantage of owning perpetual bonds.

Observed corporate bond yield spreads tend to increase with maturity, quantifying the market's perception of the increase in default risk over time. For investors, any change in the dependence of spreads upon maturity constitutes a source of return risk. Because these spreads appear to increase linearly with duration, a duration spread can measure the extent of this increase with duration at any given time. A risk model then can measure how this dependence changes over time.

2. For more details, see Ronald N. Kahn, "Estimating the U.S. Treasury Term Structure of Interest Rates," in Frank J. Fabozzi (ed.), *The Handbook of U.S. Treasury and Government Agency Securities: Instruments, Strategies and Analysis,* Revised Edition. (Chicago: Probus Publishing, 1990).

So far this analysis has concentrated on the estimated marketwide factors of value. Estimates of these factors rely on option-adjusted cash flows, however. Hence the next section will describe the option-adjustment procedure in more detail.

Option Adjustments

Estimating the values [PDB(t, T), $s_j(t)$, $\xi_n(t)$] requires market prices, cash flows, and yield-spread factor exposures. However, because embedded options alter the nominal cash flows, the final step in the valuation model involves adjusting the nominal bond cash flows accordingly.

Bonds can include call and put options and sinking-fund provisions. Mortgage-backed securities include prepayment options. These securities are portfolios containing a nonoptionable security and an option. For callable and sinkable bonds and mortgages, the issuer retains the option, and so the portfolio is long a nonoptionable security and short the option:

$$\text{Optionable bond} = \text{nonoptionable bond} - \text{option} \qquad (36\text{–}4)$$

and

$$\text{PF}_n(t) = \text{PFN}_n(t) - \text{PFO}_n(t) \qquad (36\text{–}5)$$

where

PFN_n = bond n nominal fitted price
PFO_n = bond n option fitted price

For putable bonds, the purchaser owns the put option, so the portfolio is long both the nonoptionable security and the option.

Viewed in this portfolio framework, the key aspect of option adjustment involves modeling the embedded option. A detailed description of option modeling is beyond the scope of this chapter, but basically it is a three-step procedure.

First, choose a model that describes the stochastic evolution of future interest rates. This model will describe the drift and, more important, the interest rate volatility, of either the short interest rate or the entire term structure. It will describe a set of possible future interest-rate paths.

Second, impose a no-arbitrage condition to fairly price bonds of different maturities. This step will determine the probability weight, for valuation purposes, of each possible future interest-rate path and generate a current set of bond prices. A properly tuned model will generate prices consistent with observed bond prices.

Third, impose relevant option decision rules to apply the model to the particular option of interest. These decision rules will depend on the specific option covenants as well as the behavioral model governing the corporation or the individual mortgage holder. Imposing these rules will lead to estimated cash flows and a price for the option. The portfolio property described in Eq. (36–4) dictates how the option cash flows adjust the optionable bond cash flows.

Option Adjustment Example[3]

To see this work in practice, consider a simple example of a callable zero-coupon bond. The bond nominally pays V dollars at maturity M:

$$\text{PFN}_n(t) = V \cdot \text{PDB}(t, M) \tag{36–6}$$

However, the traded security includes an embedded option for the issuer to call the bond at strike price K and time T, with $t < T < M$. The option model estimates the call option value as

$$\text{PFO}_n(t) = -K \cdot Y \cdot \text{PDB}(t, T) + V \cdot X \cdot \text{PDB}(t, M) \tag{36–7}$$

where X and Y are cumulative distribution functions.[4] Equation (36–7) resembles the Black-Scholes stock option formula,[5] although X and Y are not necessarily cumulative normal distributions. They do, however, act as probabilities and range between zero and one.

Now consider the interpretation of Eq. (36–7): The option involves paying the amount KY at time T, to receive VX at the later time M. With this interpretation, and with the portfolio property (Eq. 36–4), the adjusted price and cash flows for the callable security are

$$\begin{aligned} \text{PF}_n(t) &= V \cdot \text{PDB}(t, M) - [-K \cdot Y \cdot \text{PDB}(t, T) \\ &\quad + V \cdot X \cdot \text{PDB}(t, M)] \\ &= K \cdot Y \cdot \text{PDB}(t, T) + V \cdot (1 - X) \cdot \text{PDB}(t, M) \end{aligned} \tag{36–8}$$

$$\text{cf}_n(T) = K \cdot Y \tag{36–9}$$

$$\text{cf}_n(M) = V \cdot (1 - X) \tag{36–10}$$

As Eqs. (36–9) and (36–10) show, the probabilities X and Y adjust the nominal cash flows. An out-of-the-money option has X, Y, and PFO all equal to zero, and the option-adjusted cash flows reduce to the nominal cash flows. For this callable bond example, as X and Y increase, the option will shorten the nominal cash flows. More complicated options involve more cash flows (a set of $T_1, \ldots, T_N$), more probabilities, and perhaps even more complicated numerical procedures to estimate the probabilities, but in principle, the adjustment procedure is the same.

Remember that the true option-adjusted cash flows are still not certain. The option model chooses cash flows $-KY$ and VX to replicate the value and duration of the modeled security. Unfortunately, it is impossible to choose these cash flows to also replicate the convexity of the modeled security. The discrepancy between the

3. This section covers more details of the option-adjustment process for the benefit of mathematically inclined readers.

4. These cumulative distribution functions correspond to the valuation probability—the martingale probability associated with the stochastic interest-rate model.

5. Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy,* May–June 1973.

convexity of the modeled security and the convexity of the replicating cash flow—the "excess convexity" of the option—is greatest when the option is at-the-money and approaches zero elsewhere. Fortunately, this discrepancy affects risk modeling only in second order, at worst—it affects only convexity, not duration. An additional yield-spread factor—an additional s_j—can account for the discrepancy.

Given a procedure for estimating these option-adjusted cash flows at time t, a set of market prices at time t will lead to estimates of PDB(t, T) and $s_j(t)$, according to a procedure designed to minimize overall pricing error. The historical behavior of these market variables then will lead to the risk model itself.

THE RISK MODEL

Bond prices change over time in response to three general phenomena: shortening bond maturities, shifting term structures, and changing yield spreads. Bonds are risky because the last two phenomena are uncertain. The core of a bond risk model is therefore an estimate of the variances and covariances of the term structure and the yield-spread factor excess returns. The next two sections describe how to estimate these marketwide factor excess returns, and a third section describes how to estimate bond-specific risk.

Term-Structure Factor Returns

Building the risk model requires a history of the behavior of all relevant market factors, which the valuation model provides. How exactly does this work? Consider first the term-structure risk factors: the default-free pure discount bond prices. The price PDB(t, T) represents the price at time t of \$1.00 paid at time T. The return to this factor between $t - \Delta t$ and t is the return to the following strategy:

> Invest \$1.00 at time $t - \Delta t$ in PDB($t - \Delta t$, T), a default-free pure discount bond. This bond has a maturity of $T - (t - \Delta t)$. Hold for a period Δt. Then sell the bond, now with a maturity $T - t$, for price PDB(t, T).

The excess return to this factor follows by subtracting the risk-free rate of return. This risk-free rate is the return to the strategy:

> Invest \$1.00 at time $t - \Delta t$ in the default-free pure discount bond PDB($t - \Delta t$, t) maturing at time t. This bond has a maturity of Δt. Hold for a period Δt. Then redeem the bond, which has now matured.

The fixed holding period Δt is a defining constant of the risk model.

Yield-Spread Factor Returns

Now consider the returns associated with the yield-spread factors. The excess return to factor j at time t is the return to the following artificial strategy:

> Invest \$1.00 at time $t - \Delta t$ in a portfolio exposed only to factor j and to term-structure risk. The portfolio duration is set to the average market duration over the risk model history. Hold for a period Δt, *and roll down the term structure over this period.* Sell the portfolio at time t.

This strategy is artificial because it assumes a fixed term structure. The excess return to this strategy is the change in yield spread s_j over the holding period, multiplied by the average bond market duration, plus the yield spread multiplied by the holding period Δt. Duration, the fractional change in price accompanying a change in yield, enters into this formula to convert a change in yield spread into a price return.

Specific Return

Beyond the general, marketwide sources of risk discussed, individual issues also face specific risk. Factors that influence only one particular issue, or only the bonds of a particular company, generate specific risk and return. For example, LBO event risk constitutes a source of specific risk.[6] In the context of the risk model, specific returns arise because the bond pricing error $\xi_n(t)$ can change randomly over time.

The specific return to bond n at time t is the return to the following strategy:

> Invest \$1.00 at time $t - \Delta t$ in a portfolio long bond n, but with all marketwide sources of risk hedged. Hold for a period Δt, and then sell. The difference in pricing error will generate the specific return $[\xi_n(t) - \xi_n(t - \Delta t)] / [PM_n(t - \Delta t)]$.

The distinction between marketwide sources of risk and specific risk is important because investors can hedge marketwide sources of risk through other instruments exposed to those same risk sources. Specific risk is uncorrelated with marketwide risk.[7]

Integration

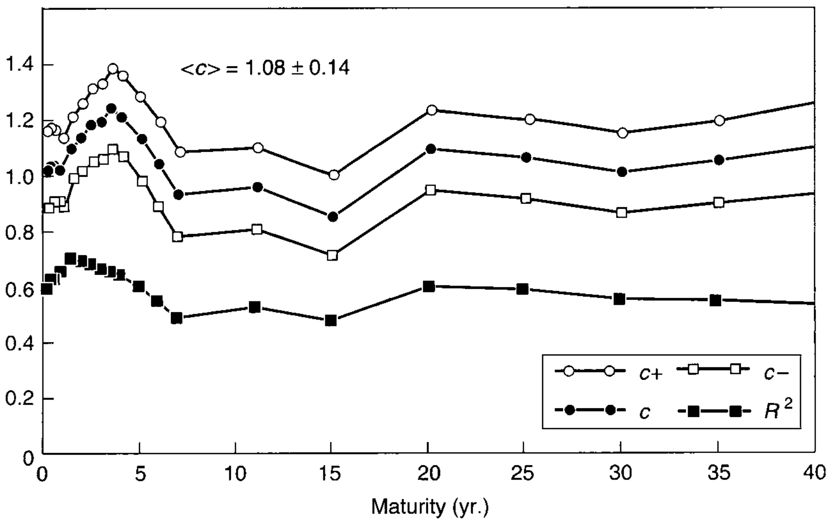
A multifactor risk model identifies the risk factors operating in a given market and then estimates their risk. Each factor generates excess returns over the model's estimation period. The risk model analyzes those return histories to forecast their variances and covariances.

Several difficult questions arise during the course of this analysis. What historical estimation period works best for covariance forecasting? Is covariance

6. Ronald N. Kahn, "LBO Event Risk," in Frank J. Fabozzi (ed.), *Managing Institutional Assets* (New York: Ballinger, 1990).
7. The specific risk of two different issues may be correlated, for example, if one company issued them both.

EXHIBIT 36–1

Risk versus Level of Rates



stable over time, or does it cycle or trend? These basic questions remain the subject of continual debate.

One particular question about forecasting bond market covariance concerns whether or not covariance depends on the level of rates. Does bond market risk increase as rates increase? Is volatility higher when rates are 16% than when rates are 8%? Academics have speculated that the answer is yes, and historical investigation confirms it for the U.S. bond market.

John Cox, Jonathan Ingersoll, and Stephen Ross[8] have developed a widely accepted model of the term structure, which prices bonds and bond options based on equilibrium arguments. Their model posits the stochastic evolution of the term structure, with interest-rate standard deviation and bond return standard deviation both proportional to the square root of the level of rates. When rates double from 8% to 16%, volatility rises by a factor of 1.4: the square root of 2.0.

Historical investigation can probe the dependence of bond market risk on the level of rates. Exhibit 36–1 illustrates the results of a test comparing the standard deviation of monthly pure discount bond excess returns each year from 1948 to 1988 to the mean five-year spot rate observed each year. This test determined the exponent c of the relationship

$$\text{Volatility} \propto (\text{rate})^c$$

8. John C. Cox, Jonathan E. Ingersoll, Jr., and Stephen A. Ross, "A Theory of the Term Structure of Interest Rates," *Econometrica,* 53 (March 1985), pp. 385–407.

If $c = 1$, then volatility is directly proportional to rates; when rates double, volatility doubles. The Cox, Ingersoll, Ross model assumes that $c = 1/2$. The empirical results illustrated in Exhibit 36–1 demonstrate that $c = 1.08 \pm 0.14$. Within the standard errors shown in Exhibit 36–1, volatility is directly proportional to rate level. Moreover, as the R^2 statistic reveals, the level of rates explains 61% of the observed difference in risk from year to year. The effect is more pronounced in high-rate periods than in low-rate periods. Further study examined the dependence of yield-spread factor risk on the level of the five-year spot rate. Results were mixed, though generally consistent with direct proportionality.

Given the broad empirical and theoretical evidence supporting the dependence of covariance on rates, forecasts of covariance based on historical data should take this effect into account.

With all this sophisticated risk model machinery now in place and integrated, how well does the resulting risk model perform?

PERFORMANCE

Multifactor risk modeling involves significant effort. Is this effort justified? Does it significantly differ from the duration approach? How well does the multifactor approach to fixed income risk modeling actually work?

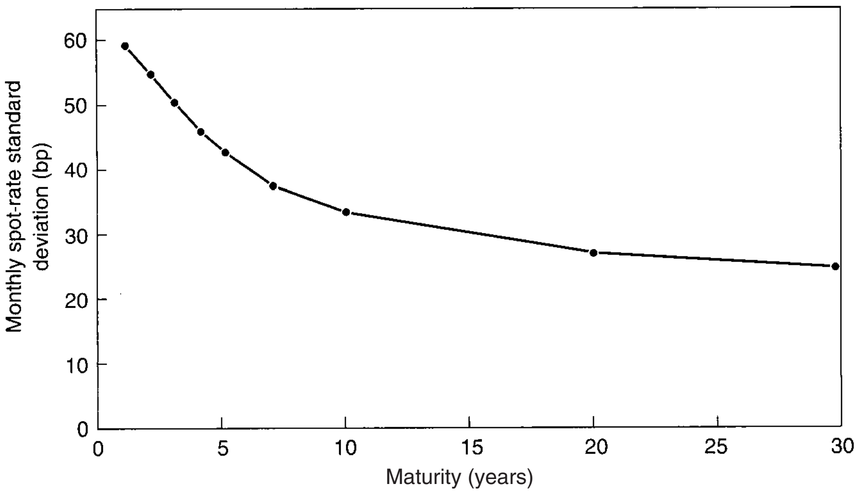
To see how the multifactor approach differs from the duration and convexity approach, consider the performance of a multifactor model in the U.S. bond market. Remember that duration and convexity are both parallel yield-shift concepts. They measure the risk of parallel yield shifts. However, the term structure does not move in parallel.

The risk model views the term structure as a set of pure discount bonds of different maturities, each allowed to move independently. The covariance matrix then describes the extent to which they actually do move together. Exhibits 36–2 and 36–3 illustrate the two predominant, coherent movements of the term structure, as forecast in September 1989 based on the observed term-structure history throughout the 1980s. These *principal components* are the independent, uncorrelated collective movements of the term structure. Exhibit 36–2 illustrates the primary term-structure movement: a nonparallel shift, with short rates more volatile than long rates. A duration-based risk model would assume that a parallel shift completely specified term-structure risk. This nonparallel shift accounts for 95.4% of modeled term-structure risk. Exhibit 36–3 illustrates the secondary term-structure movement: a twist, with short and long rates moving in opposite directions. This twist accounts for an additional 4.1% of modeled term-structure risk. These shapes specifically apply to the September 1989 forecast, but they have remained relatively stable from the 1950s into the 1990s, taking the level of rates into account.

To further examine how well multifactor risk modeling performs, the following test compared a simple duration model and a duration plus convexity

EXHIBIT 36–2

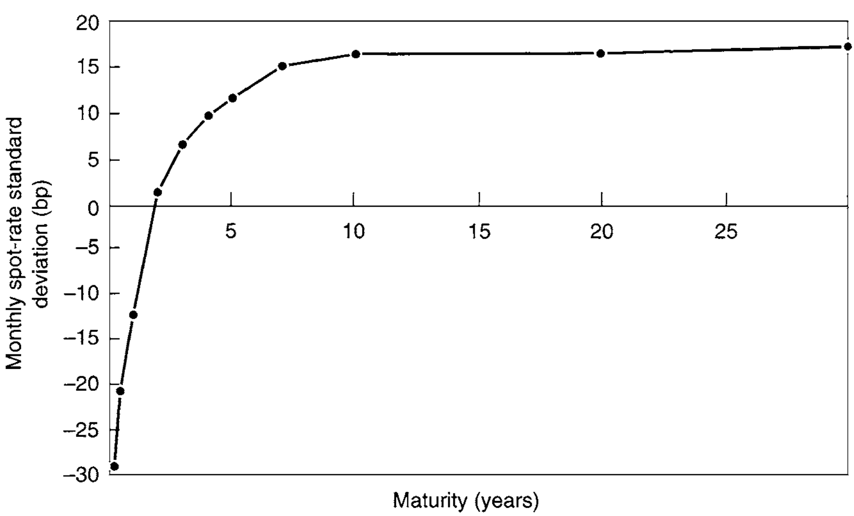
First Principal Component



model with a 10-factor model (pure discount bonds with maturities of 0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 10, and 30 years) in modeling noncallable U.S. Treasury security returns between January 1980 and October 1986. The noncallable U.S. Treasury market should be the simplest market to model because it requires no factors to account for default risk and no option simulation model. For demonstrating the

EXHIBIT 36–3

Second Principal Component



significant enhancement resulting from the multifactor approach, this is the most difficult test. The results are as follows:

Model	Number of Factors	Percent of Explained Variance
Duration	1	75.8
Duration and convexity	2	81.1
First principal component	1	82.4
First two principal components	2	87.0
Full multifactor model	10	88.0

The full multifactor model explains significantly more of the observed variance than the simple duration model or even the duration and convexity model. The first two principal components are the optimized first two risk factors. The first principal component model employs just one factor, a nonparallel shift, and outperforms the two-factor duration and convexity model. Of course, one must construct the full multifactor risk model to identify this optimal one-factor model.

This chapter so far has described the construction of a risk model and a test of its overall performance measuring fixed income risk. How, though, does the risk model apply to a particular investment portfolio?

PORTFOLIO RISK CHARACTERIZATION

Historical analysis captures the inherent riskiness of the factors of value present in the bond market. The riskiness of a particular bond portfolio depends on its exposure to these sources of risk.

The fraction of a portfolio's present value at each vertex measures the portfolio's exposure to term-structure risk. Two portfolios with identical distributions of present value along the vertices face identical term-structure risk. Of course, these two portfolios have identical durations. However, two portfolios can have identical durations without having identical distributions across the entire set of vertices. Such portfolios will not face identical term-structure risk.

What about yield-spread factor risk? Consider for example the risk associated with the sector yield spread. The fraction of the portfolio in each sector, multiplied by the duration of the bonds in that sector compared with bond market average duration, measures the portfolio's sector risk exposure. Risk exposures for quality factors and other factors follow analogously.

Beyond the marketwide factors of value the model identifies, there are also risk factors associated solely with individual issues. By definition, the specific risk for each issue is uncorrelated with all marketwide factor risk. It may be correlated, though, with the specific risk of other bonds of the same issuer. We can estimate this specific issue risk historically as the realized excess return risk of each specific issue not explained by the model.

Total risk follows from combining the risk exposures that characterize a given portfolio with the variances and covariances of the underlying risk factors that characterize the market, and adding in specific issue risk. This number is the predicted total variance of the portfolio excess return.

Portfolio risk analysis usually involves comparing the portfolio against a benchmark (or liability stream). Comparing risk exposures will quantify the manager's bets in relation to the benchmark. The risk model then can predict how well the portfolio will track the benchmark. For active managers, an optimizer can implement common factor and specific issue bets while still controlling risk. An active manager's utility usually will increase with expected excess return and decrease with expected tracking error. An optimizer can maximize this utility.

SUMMARY

Today's fixed income markets are characterized by complex instruments and increased volatility. In this environment, bond portfolio management increasingly must rely on sophisticated models to gauge fixed income risk accurately. Building these models requires considerable sophistication. Using them, however, should be straightforward. A good model should simplify the investment process and increase investor insight.

CHAPTER

THIRTY-SEVEN

VALUATION OF BONDS WITH EMBEDDED OPTIONS

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The complication in building a model to value bonds with embedded options and option-type derivatives is that cash flows will depend on interest rates in the future. Academicians and practitioners have attempted to capture this interest-rate uncertainty through various models, often designed as one- or two-factor models. These models attempt to capture the stochastic behavior of rates.

In practice, these elegant mathematical models must be converted to numeric applications. Here we focus on one such model—a single-factor model that assumes a stationary variance or, as it is more often called, volatility. We demonstrate how to move from the yield curve to a valuation lattice. Effectively, the lattice is a representation of the model, capturing the distribution of rates over time. In our illustration we will reduce the lattice to a binomial tree, the most simple lattice form.

The lattice holds all the information required to perform the valuation of certain option-like interest-rate products. First, the lattice is used to generate the cash flows across the life of the security. Next, the interest rates on the lattice are used to compute the present value of those cash flows.

There are several interest-rate models that have been used in practice to construct an interest-rate lattice. These are described in other chapters. In each case, interest rates can realize one of several possible rates when we move from one period to the next. A lattice model where it is assumed that only two rates are possible in the next period is called a *binomial model*. A lattice model where it is assumed that interest rates can take on three possible rates in the next period is called a *trinomial model*. There are even more complex models that assume more than three possible rates in the next period can be realized.

Regardless of the underlying assumptions, each model shares a common restriction. The interest-rate tree generated must produce a value for an on-the-run optionless issue that is consistent with the current par yield curve. In effect, the value output from the model must be equal to the observed market price for the optionless instrument. Under these conditions, the model is said to be "arbitrage free." A lattice that produces an arbitrage-free valuation is said to be "fair." The lattice is used for valuation only when it has been calibrated to be fair. More on calibration below.

In this chapter we show how to value bonds with embedded options using the lattice methodology. We begin by demonstrating how an interest-rate lattice is constructed. Then we use the model to value bonds with an embedded option. The lattice methodology also can be used to value floating-rate securities with option-type derivatives, options on bonds, caps, floors, swaptions, and forward-start swaps.[1]

THE INTEREST-RATE LATTICE

Exhibit 37–1 provides an example of a binomial interest-rate tree, which consists of a number of "nodes" and "legs." Each leg represents a one-year interval over time. A simplifying assumption of one-year intervals is made to illustrate the key principles. The methodology is the same for smaller time periods. In fact, in practice, the selection of the length of the time period is critical, but we need not be concerned with this nuance here.

The distribution of future interest rates is represented on the tree by the nodes at each point in time. Each node is labeled as N and has a subscript, a combination of L's and H's. The subscripts indicate whether the node is lower or higher on the tree, respectively, relative to the other nodes. Thus node N_{HH} is reached when the one-year rate realized in the first year is the higher of the two rates for that period, then the highest of the rates in the second year.

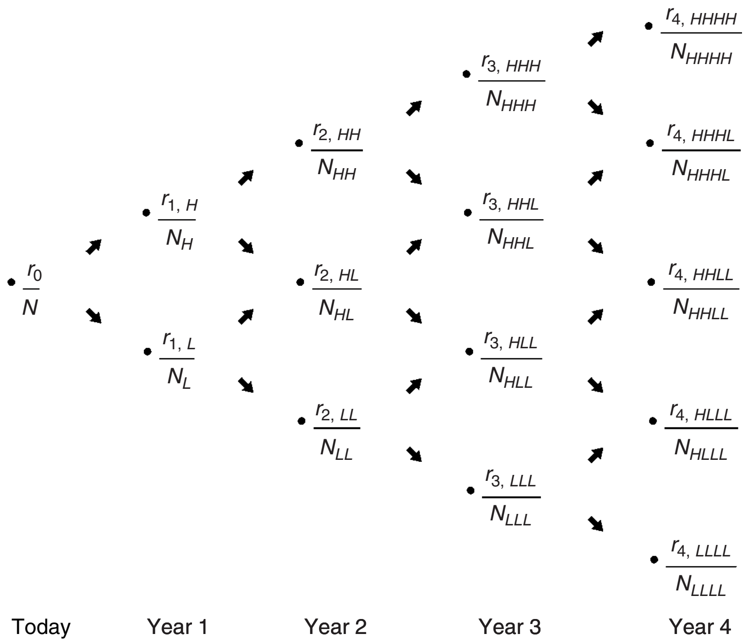
The root of the tree is N, the only point in time at which we know the interest rate with certainty. The one-year rate today (i.e., at N) is the current one-year spot rate, which we denote by r_0.

We must make an assumption concerning the probability of reaching one rate at a point in time. For ease of illustration, we have assumed that rates at any point in time have the same probability of occurring; in other words, the probability is 50% on each leg.

1. These applications of the lattice methodology are presented in Frank J. Fabozzi, Andrew Kalotay, and Michael Dorigan, "Yield Curves and Valuation Lattices" and "Using the Lattice Model to Value Bonds with Embedded Options, Floaters, Options, and Caps/Floors," Chapters 13 and 14 in Frank J. Fabozzi (ed.), *Interest Rate, Term Structure, and Valuation Modeling* (Hoboken, NJ: Wiley, 2002).

EXHIBIT 37–1

Four-Year Binomial Interest-Rate Tree



The interest-rate model we will use to construct the binomial tree assumes that the one-year rate evolves over time based on a log-normal random walk with a known (stationary) volatility. Technically, the tree represents a one-factor model. Under the distributional assumption, the relationship between any two adjacent rates at a point in time is calculated via the following equation:

$$r_{1,H} = r_{1,L} e^{2\sigma\sqrt{t}}$$

where σ is the assumed volatility of the one-year rate, t is time in years, and e is the base of the natural logarithm. Since we assume a one-year interval, that is, $t = 1$, we can disregard the calculation of the square root of t in the exponent.

For example, suppose that $r_{1,L}$ is 4.4448% and σ is 10% per year, then

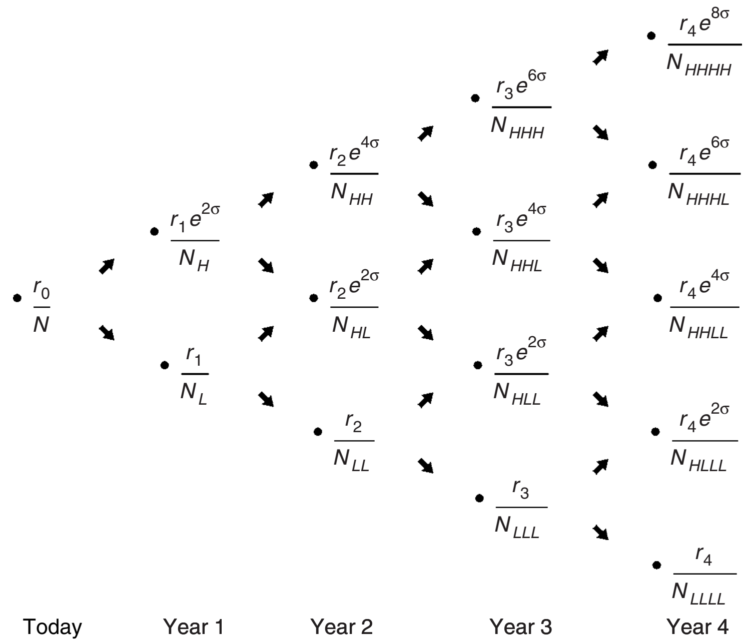
$$r_{1,H} = 4.4448\%(e^{2\times 0.10}) = 5.4289\%$$

In the second year, there are three possible values for the one-year rate. The relationship between $r_{2,LL}$ and the other two one-year rates is as follows:

$$r_{2,HH} = r_{2,LL}\,(e^{4\sigma}) \qquad \text{and} \qquad r_{2,HL} = r_{2,LL}(e^{2\sigma})$$

EXHIBIT 37–2

Four-Year Binomial Interest-Rate Tree with One-Year Rates*



*r_t is the lowest one-year rate at each point in time.

Thus, for example, if $r_{2,LL}$ is 4.6958%, and assuming once again that σ is 10%, then

$$r_{2,HH} = 4.6958\%(e^{4\times0.10}) = 7.0053\%$$

and

$$r_{2,HL} = 4.6958\%(e^{2\times0.10}) = 5.7354\%$$

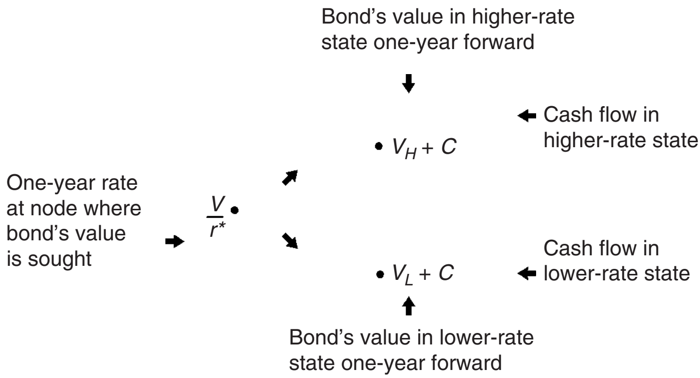
This relationship between rates holds for each point in time. Exhibit 37–2 shows the interest rate tree using this new notation.

Determining the Value at a Node

In general, to get a security's value at a node, we follow the fundamental rule for valuation: The value is the present value of the expected cash flows. The appropriate discount rate to use for cash flows one year forward is the one-year rate at the node where we are computing the value. Now there are two present values in this case: the present value of the cash flows in the state where the one-year rate is the higher rate and one where it is the lower-rate state. We have assumed that the probability of

EXHIBIT 37–3

Calculating a Value at a Node



both outcomes is equal. Exhibit 37–3 provides an illustration for a node assuming that the one-year rate is r^* at the node where the valuation is sought and letting

V_H = the bond's value for the higher one-year rate state

V_L = the bond's value for the lower one-year rate state

C = coupon payment

From where do the future values come? Effectively, the value at any node depends on the future cash flows. The future cash flows include (1) the coupon payment one year from now and (2) the bond's value one year from now, both of which may be uncertain. Starting the process from the last year in the tree and working backwards to get the final valuation resolves the uncertainty. At maturity, the instrument's value is known with certainty—par. The final coupon payment can be determined from the coupon rate or from prevailing rates to which it is indexed. Working back through the tree, we realize that the value at each node is calculated quickly. This process of working backward is often referred to as *recursive valuation.*

Using our notation, the cash flow at a node is either

$V_H + C$ for the higher one-year rate

$V_L + C$ for the lower one-year rate

The present value of these two cash flows using the one-year rate at the node, r^*, is

$$\frac{V_H + C}{(1 + r^*)} = \text{present value for the higher one-year rate}$$

$$\frac{V_L + C}{(1 + r^*)} = \text{present value for the lower one-year rate}$$

Then the value of the bond at the node is found as follows:

$$\text{Value at a node} = \frac{1}{2}\left[\frac{V_H + C}{(1+r^*)} + \frac{V_L + C}{(1+r^*)}\right]$$

CALIBRATING THE LATTICE

We noted earlier the importance of the no-arbitrage condition that governs the construction of the lattice. To ensure that this condition holds, the lattice must be calibrated to the current par yield curve, a process we demonstrate here. Ultimately, the lattice must price optionless par bonds at par.

Assume the on-the-run par yield curve for a hypothetical issuer as it appears in Exhibit 37–4. The current one-year rate is known, 3.50%. Hence the next step is to find the appropriate one-year rates one year forward. As before, we assume that volatility σ is 10% and construct a two-year tree using the two-year bond with a coupon rate of 4.2%, the par rate for a two-year security.

Exhibit 37–5 shows a more detailed binomial tree with the cash flow shown at each node. The root rate for the tree r_0 is simply the current one-year rate, 3.5%. At the beginning of year 2, there are two possible one-year rates, the higher rate and the lower rate. We already know the relationship between the two. A rate of 4.75% at N_L has been chosen arbitrarily as a starting point. An iterative process determines the proper rate (i.e., trial-and-error). The steps are described and illustrated below. Again, the goal is a rate that, when applied in the tree, provides a value of par for the two-year 4.2% bond.

Step 1. Select a value for r_1. Recall that r_1 is the lower one-year rate. In this first trial, we arbitrarily selected a value of 4.75%.

Step 2. Determine the corresponding value for the higher one-year rate. As explained earlier, this rate is related to the lower one-year rate as follows: $r_1 e^{2\sigma}$. Since r_1 is 4.75%, the higher one-year rate is 5.8017% (= 4.75% $e^{2\times 0.10}$). This value is reported in Exhibit 37–5 at node N_H.

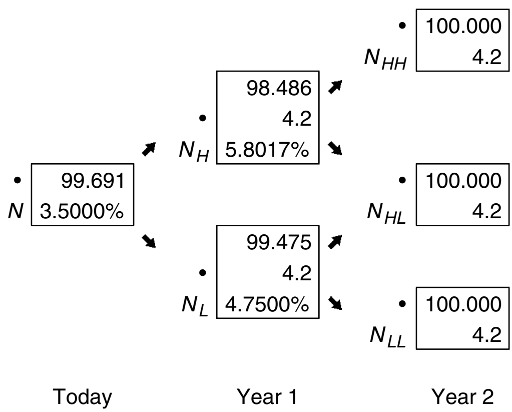
EXHIBIT 37–4

Issuer Par Yield Curve

Maturity	Par Rate	Market Price
1 year	3.50%	100
2 years	4.20%	100
3 years	4.70%	100
4 years	5.20%	100

EXHIBIT 37–5

The One-Year Rates for Year 1 Using the Two-Year 4.2% On-the-Run Issue: First Trial



Step 3. Compute the bond value's one year from now. This value is determined as follows:

a. Determine the bond's value two years from now. In our example, this is simple. Since we are using a two-year bond, the bond's value is its maturity value ($100) plus its final coupon payment ($4.2). Thus it is $104.2.

b. Calculate V_H. Cash flows are known. The appropriate discount rate is the higher one-year rate, 5.8017% in our example. The present value is $98.486 (= $104.2/1.058017).

c. Calculate V_L. Again, cash flows are known—the same as those in step 3b. The discount rate assumed for the lower one-year rate is 4.75%. The present value is $99.475 (= $104.2/1.0475).

Step 4. Calculate *V*.

a. Add the coupon to both V_H and V_L to get the cash flow at N_H and N_L, respectively. In our example we have $102.686 for the higher rate and $103.675 for the lower rate.

b. Calculate *V*. The one-year rate is 3.50%. (*Note:* At this point in the valuation, r^* is the root rate, 3.50%). Therefore, $99.691 = 1/2($99.214 + $100.169)

Step 5. Compare the value in step 4 to the bond's market value. If the two values are the same, then the r_1 used in this trial is the one we seek. If, instead, the value found in step 4 is not equal to the market value of the bond, this means that the value r_1 in this trial is not the one-year rate that is consistent with the current yield curve. In this case, the five steps are repeated with a different value for r_1.

When r_1 is 4.75%, a value of \$99.691 results in step 4, which is less than the observed market price of \$100. Therefore, 4.75% is too large, and the five steps must be repeated trying a lower rate for r_1.

Let's jump right to the correct rate for r_1 in this example and rework steps 1 through 5. This occurs when r_1 is 4.4448%. The corresponding binomial tree is shown in Exhibit 37–6. The value at the root is equal to the market value of the two-year issue (par).

We can "grow" this tree for one more year by determining r_2. Now we will use the three-year on-the-run issue, the 4.7% coupon bond, to get r_2. The same five steps are used in an iterative process to find the one-year rates in the tree two years from now. Our objective is now to find the value of r_2 that will produce a bond value of \$100. Note that the two rates one year from now of 4.4448% (the lower rate) and 5.4289% (the higher rate) do not change. These are the fair rates for the tree one-year forward.

The problem is illustrated in Exhibit 37–7. The cash flows from the three-year 4.7% bond are in place. All we need to perform a valuation are the rates at the start of year 3. In effect, we need to find r_2 such that the bond prices at par. Again, an arbitrary starting point is selected, and an iterative process produces the correct rate.

The completed version of Exhibit 37–7 is found in Exhibit 37–8. The value of r_2, or equivalently $r_{2,LL}$, that will produce the desired result is 4.6958%. The corresponding rates $r_{2,HL}$ and $r_{2,HH}$ would be 5.7354% and 7.0053%, respectively.

EXHIBIT 37–6

The One-Year Rates for Year 1 Using the Two-Year 4.2% On-the-Run Issue

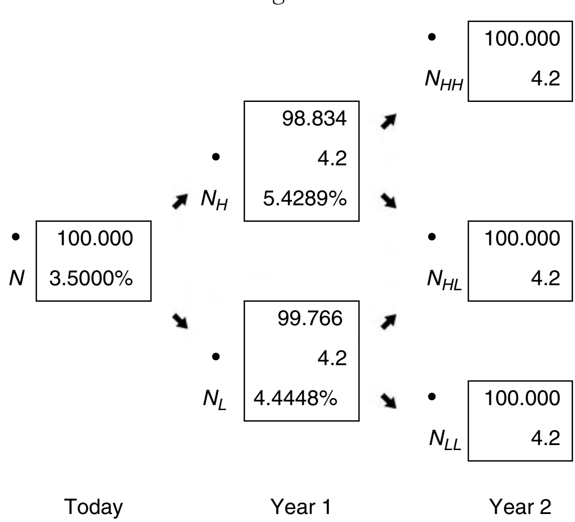


EXHIBIT 37–7

Information for Deriving the One-Year Rates for Year 2 Using the Three-Year 4.7% On-the-Run Issue

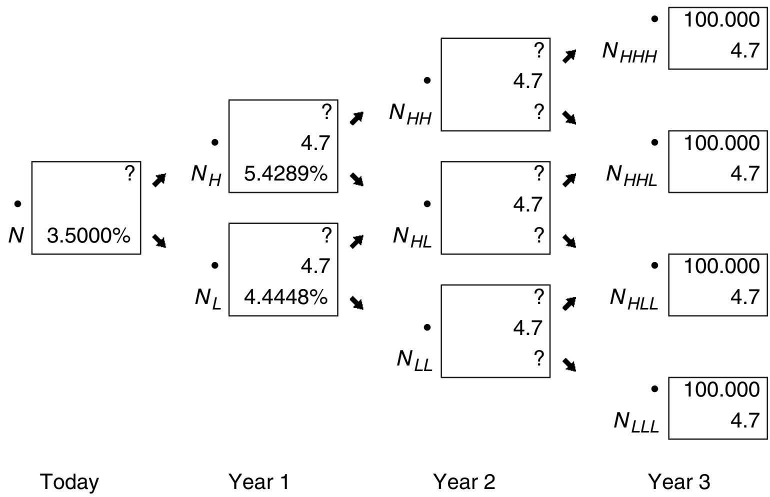
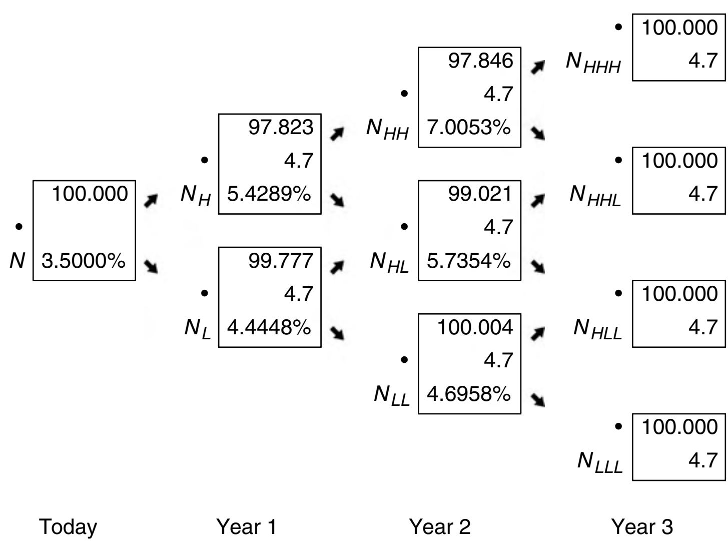


EXHIBIT 37–8

The One-Year Rates for Year 2 Using the Three-Year 4.7% On-the-Run Issue



To verify that these are the correct one-year rates two years from now, work backwards from the four nodes at the right of the tree in Exhibit 37–8. For example, the value in the box at N_{HH} is found by taking the value of \$104.7 at the two nodes to its right and discounting at 7.0053%. The value is \$97.846. Similarly, the value in the box at N_{HL} is found by discounting \$104.70 by 5.7354% and at N_{LL} by discounting at 4.6958%.

USING THE LATTICE FOR VALUATION

To illustrate how to use the lattice for valuation purposes, consider a 6.5% option-free bond with four years remaining to maturity. Since this bond is option-free, it is not necessary to use the lattice model to value it. All that is necessary to obtain an arbitrage-free value for this bond is to discount the cash flows using the spot rates obtained from bootstrapping the yield curve shown in Exhibit 37–4. The spot rates are as follows:

1-year	3.5000%
2-year	4.2147%
3-year	4.7345%
4-year	5.2707%

Discounting the 6.5% four-year option-free bond with a par value of \$100 at the above spot rates would give a bond value of \$104.643.

Exhibit 37–9 contains the fair tree for a four-year valuation. Exhibit 37–10 shows the various values in the discounting process using the lattice in Exhibit 37–9. The root of the tree shows the bond value of \$104.643, the same value found by discounting at the spot rate. This demonstrates that the lattice model is consistent with the valuation of an option-free bond when using spot rates.

FIXED-COUPON BONDS WITH EMBEDDED OPTIONS

The valuation of bonds with embedded options proceeds in the same fashion as in the case of an option-free bond. However, the added complexity of an embedded option requires an adjustment to the cash flows on the tree depending on the structure of the option. A decision on whether to call or put must be made at nodes on the tree where the option is eligible for exercise. Examples for both callable and putable bonds follow.

Valuing a Callable Bond

In the case of a call option, the call will be made when the present value (PV) of the future cash flows is greater than the call price at the node where the decision to exercise is being made. Effectively, the following calculation is made:

$$V_t = \min[\text{call price, PV(future cash flows)}]$$

EXHIBIT 37–9

Binomial Interest-Rate Tree for Valuing Up to a Four-Year Bond for Issuer (10% Volatility Assumed)

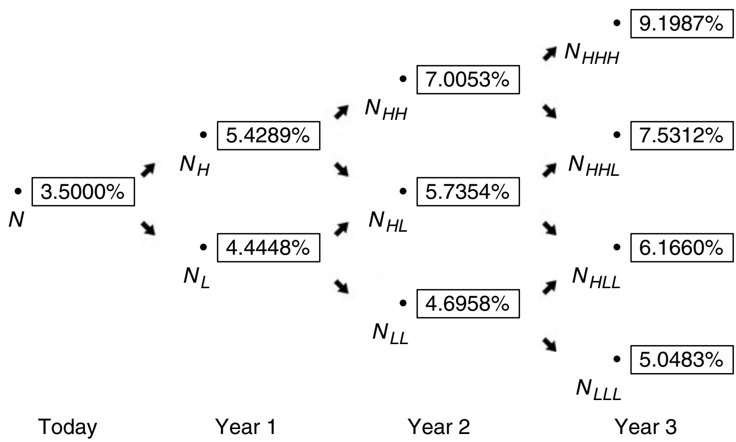


EXHIBIT 37–10

Valuing an Option-Free Bond with Four Years to Maturity and a Coupon Rate of 6.5% (10% Volatility Assumed)

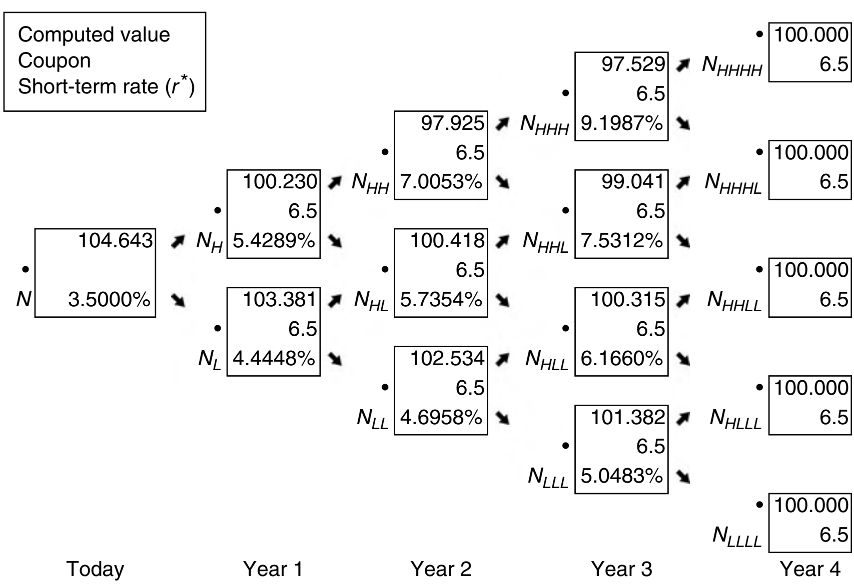
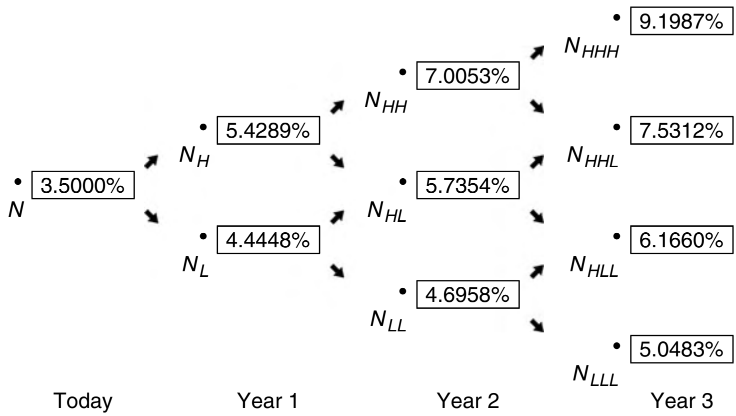


EXHIBIT 37–11

Binomial Interest-Rate Tree for Valuing Up to a Four-Year Bond for Issuer (10% Volatility Assumed)



where V_t represents the PV of future cash flows at the node. This operation is performed at each node where the bond is eligible for call.

For example, consider a 6.5% bond with four years remaining to maturity that is callable in one year at $100. We will value this bond, as well as the other instruments in this chapter, using a binomial tree. Exhibit 37–11 is the binomial interest-rate tree that was derived earlier in this chapter and then used to value an option-free bond. In constructing the binomial tree in Exhibit 37–11, it is assumed that interest-rate volatility is 10%. This binomial tree will be used throughout this chapter.

Exhibit 37–12 shows that two values are now present at each node of the binomial tree. The discounting process explained earlier is used to calculate the first of the two values at each node. The second value is the value based on whether the issue will be called. Again, the issuer calls the issue if the PV of future cash flows exceeds the call price. This second value is incorporated into the subsequent calculations.

In Exhibit 37–13, certain nodes from Exhibit 37–12 are highlighted. Panel *a* of the exhibit shows nodes where the issue is not called (based on the simple call rule used in the illustration) in year 2 and year 3.[2] The values reported in this case are the same as in the valuation of an option-free bond. Panel *b* of the exhibit shows some nodes where the issue is called in year 2 and year 3. Notice how the methodology changes the cash flows. In year 3, for example, at node N_{HLL} the recursive valuation process produces a PV of 100.315. However, given the call rule, this issue would be called. Therefore, 100 is shown as the second value at the node, and it is this value that is then used as the valuation process continues. Taking the process to its end, the value for this callable bond is 102.899.

2. We assume cash flows occur at the end of the year.

EXHIBIT 37–12

Valuing a Callable Bond with Four Years to Maturity, a Coupon Rate of 6.5%, and Callable after the First Year at 100 (10% Volatility Assumed)

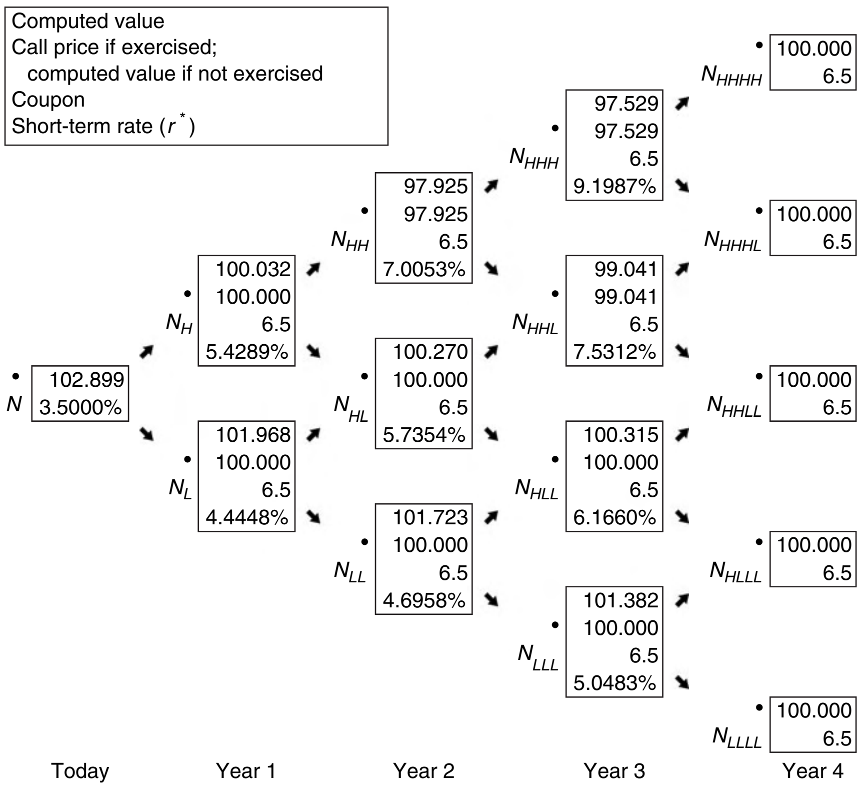


EXHIBIT 37–13

Highlighting Nodes in Years 2 and 3 for a Callable Bond

a. Nodes Where Call Option Is Not Exercised

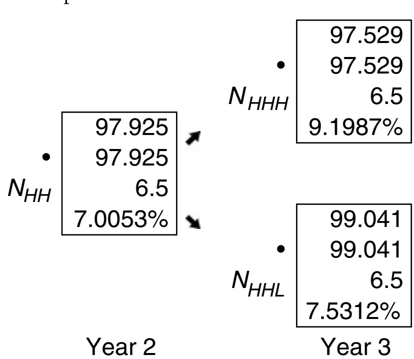
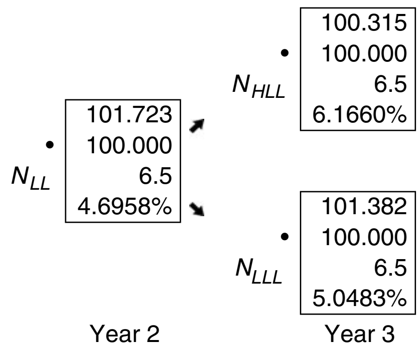


EXHIBIT 37–13 (*Continued*)

b. Selected Nodes Where the Call Option Is Exercised



The value of the call option is computed as the difference between the value of an optionless bond and the value of a callable bond. In our illustration, the value of the option-free bond is 104.643 (calculated earlier in this chapter). The value of the callable bond is 102.899. Hence the value of the call option is 1.744 (=104.634 – 102.899).

Valuing a Putable Bond

A putable bond is one in which the bondholder has the right to force the issuer to pay off the bond prior to the maturity date. The analysis of the putable bond follows closely that of the callable bond. In the case of the putable, we must establish the rule by which the decision to put is made. The reasoning is similar to that for the callable bond. If the PV of the future cash flows is less than the put price (i.e., par), then the bond will be put. In equation form,

$$V_t = \max[\text{put price}, \text{PV(future cash flows)}]$$

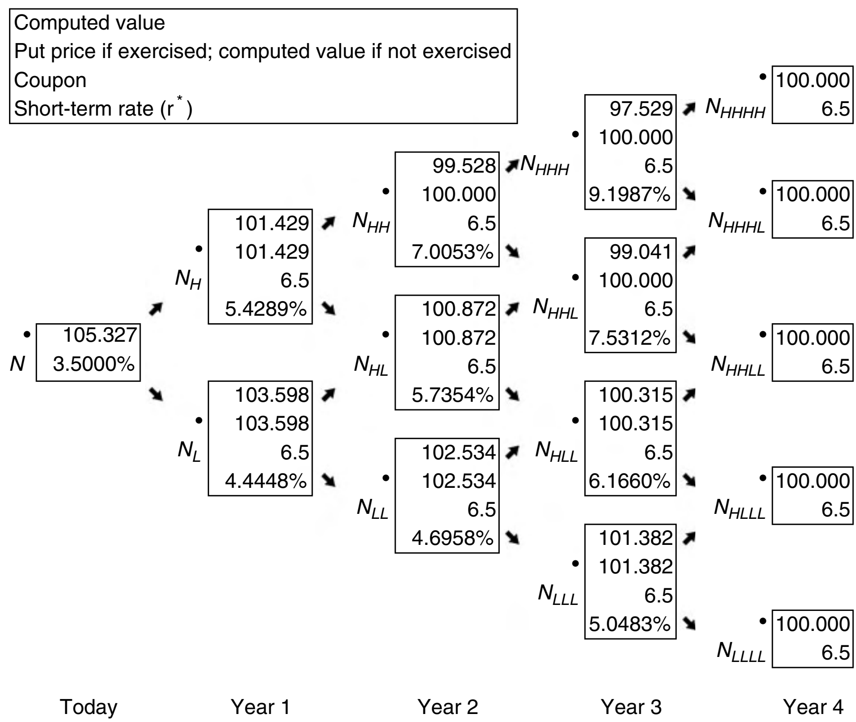
Exhibit 37–14 is analogous to Exhibit 37–3. It shows the binomial tree with the values based on whether or not the investor exercises the put option at each node. The bond is putable any time after the first year at par. The value of the bond is 105.327. Note that the value is greater than the value of the corresponding option-free bond.

With the two values in hand, we can calculate the value of the put option. Since the value of the putable bond is 105.327 and the value of the corresponding option-free bond is 104.643, the value of the embedded put option purchased by the investor is effectively 0.684.

Suppose that a bond is both putable and callable. The procedure for valuing such a structure is to adjust the value at each node to reflect whether the issue would be put or called. Specifically, at each node there are two decisions about the exercising of an option that must be made. If it is called, the value at the node is replaced by the call price. The valuation procedure then continues using the call

EXHIBIT 37–14

Valuing a Putable Bond with Four Years to Maturity, a Coupon Rate of 6.5%, and Putable after the First Year at 100 (10% Volatility Assumed)



price at that node. If the call option is not exercised at a node, it must be determined whether or not the put option will be exercised. If it is exercised, then the put price is substituted at that node and is used in subsequent calculations.

VALUATION OF TWO MORE EXOTIC STRUCTURES

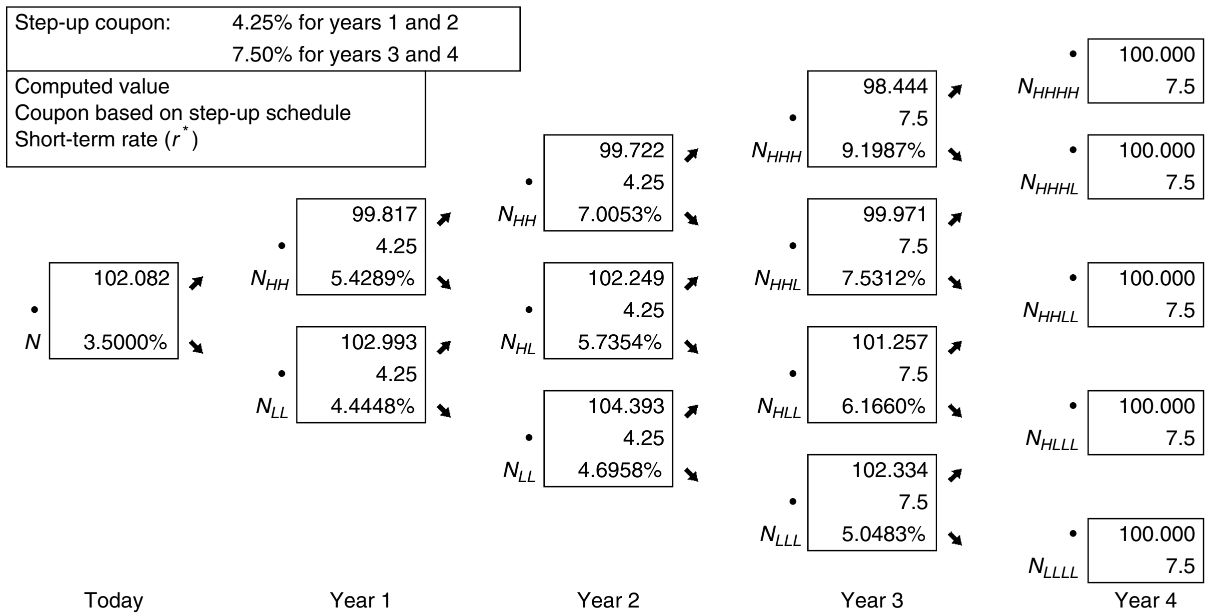
The lattice-based recursive valuation methodology is robust. To further support this claim, we address the valuation of two more exotic structures—the step-up callable note and the range floater.

Valuing a Step-Up Callable Note

Step-up callable notes are callable instruments whose coupon rate is increased (i.e., "stepped up") at designated times. When the coupon rate is increased only once over the security's life, it is said to be a *single step-up callable note*. A *multiple step-up callable note* is a step-up callable note whose coupon is increased more than one

EXHIBIT 37–15

Valuing a Single Step-Up Noncallable Note with Four Years to Maturity (10% Volatility Assumed)



time over the life of the security. Valuation using the lattice model is similar to that for valuing a callable bond described earlier except that the cash flows are altered at each node to reflect the coupon characteristics of a step-up note.

Suppose that a four-year step-up callable note pays 4.25% for two years and then 7.5% for two more years. Assume that this note is callable at par at the end of year 2 and year 3. We will use the binomial tree given in Exhibit 37–11 to value this note.

Exhibit 37–15 shows the value of the note if it were not callable. The valuation procedure is the now familiar recursive valuation from Exhibit 37–13. The coupon in the box at each node reflects the step-up terms. The value is 102.082. Exhibit 37–16 shows that the value of the single step-up callable note is 100.031. The value of the embedded call option is equal to the difference in the optionless step-up note value and the step-up callable note value, 2.051.

Now we move to another structure where the coupon floats with a reference rate but is restricted. In this next case, a range is set in which the bond pays the reference rate when the rate falls within a specified range, but outside the range no coupon is paid.

Valuing a Range Note

A *range note* is a security that pays the reference rate only if the rate falls within a band. If the reference rate falls outside the band, whether the lower or upper boundary, no coupon is paid. Typically, the band increases over time.

To illustrate, suppose that the reference rate is, again, the one-year rate and the note has three years to maturity. Suppose further that the band (or coupon schedule) is defined as in Exhibit 37–17. Exhibit 37–18 holds our tree and the cash flows expected at the end of each year. Either the one-year reference rate is paid, or nothing. In the case of this three-year note, there is only one state in which no coupon is paid. Using our recursive valuation method, we can work back through the tree to the current value, 98.963.

EXTENSIONS

We next demonstrate how to compute the option-adjusted spread, effective duration, and the convexity for a fixed income instrument with an embedded option.

Option-Adjusted Spread

We have concerned ourselves with valuation to this point. However, financial market transactions determine the actual price for a fixed income instrument, not a series of calculations on an interest-rate lattice. If markets are able to provide a meaningful price (usually a function of the liquidity of the market in which the instrument trades), this price can be translated into an alternative measure of value, the option-adjusted spread (OAS).

EXHIBIT 37–16

Valuing a Single Step-Up Callable Note with Four Years to Maturity, Callable in Two Years at 100 (10% Volatility Assumed)

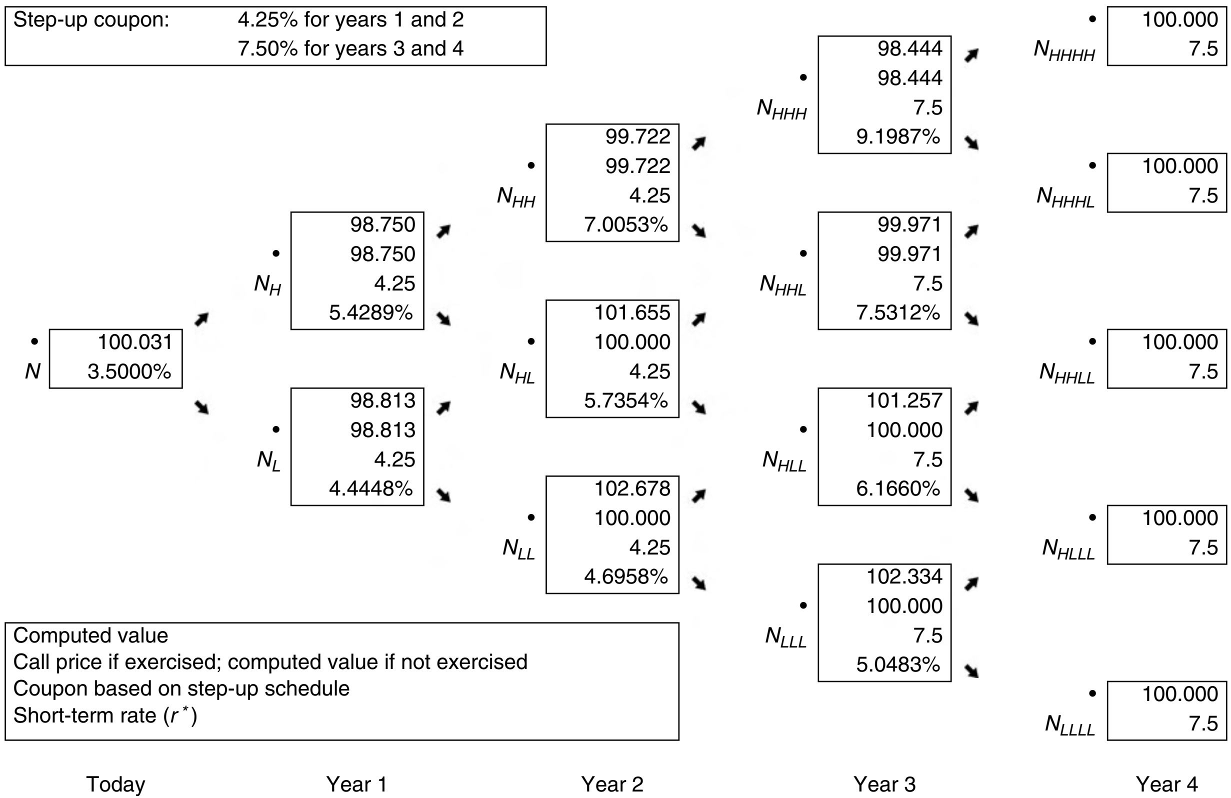


EXHIBIT 37–17

Coupon Schedule (Bands) for a Range Note

	Year 1	Year 2	Year 3
Lower limit	3.00%	4.00%	5.00%
Upper limit	5.00%	6.25%	8.00%

The OAS for a security is the fixed spread (usually measured in basis points) over the benchmark rates that equates the output from the valuation process with the actual market price of the security. For an optionless security, the calculation of OAS is a relatively simple, iterative process. The process is much more analytically challenging with the added complexity of optionality. And just as the value of the option is volatility-dependent, the OAS for a fixed income security with embedded options or an option-like interest-rate product is volatility-dependent.

Recall our illustration in Exhibit 37–12, where the value of a callable bond was calculated as 102.899. Suppose that we had information from the market that the price is actually 102.218. We need the OAS that equates the value from the lattice with the market price. Since the market price is lower than the valuation, the OAS is a positive spread to the rates in the exhibit, rates that we assume to be benchmark rates.

The solution in this case is 35 basis points, which is incorporated into Exhibit 37–19 that shows the value of the callable bond after adding 35 basis

EXHIBIT 37–18

Valuation of a Three-Year Range Floater

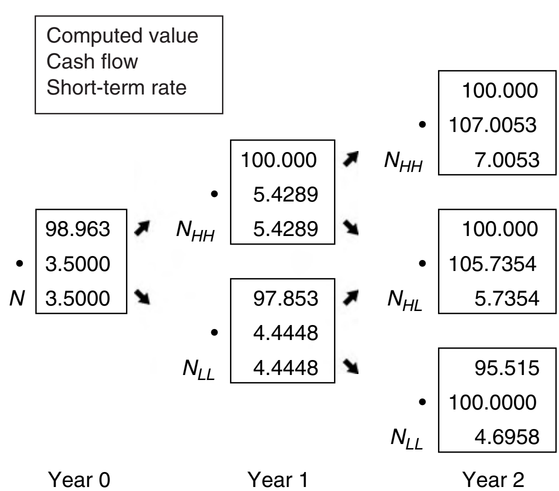
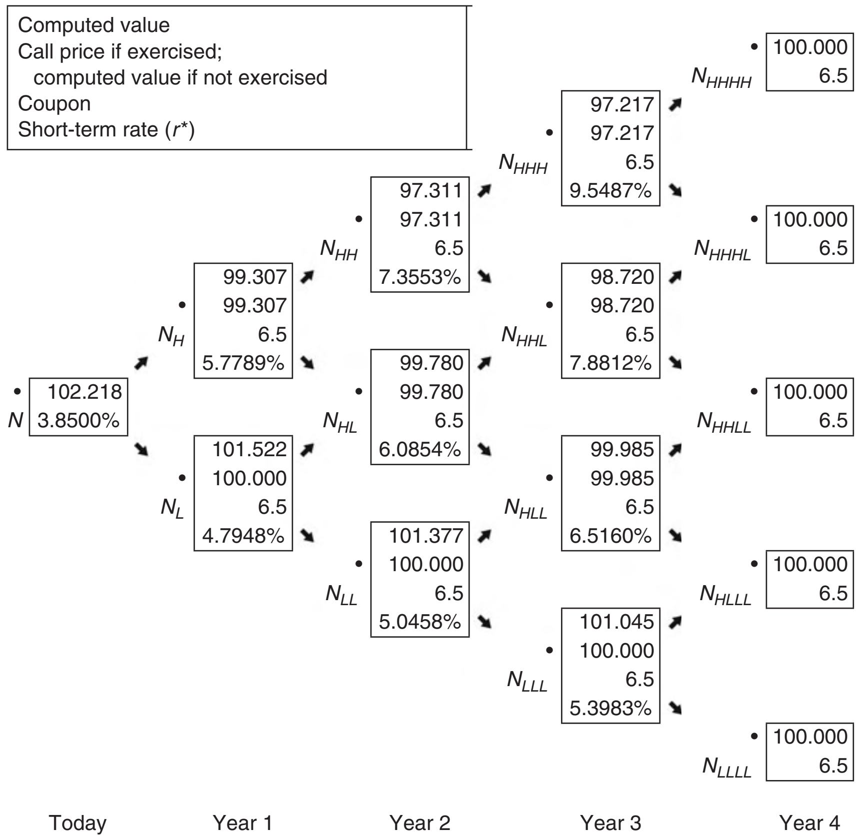


EXHIBIT 37–19

Demonstration that the Option-Adjusted Spread Is 35 Basis Points for a 6.5% Callable Bond Selling at 102.218 (Assuming 10% Volatility)*



*Each one-year rate is 35 basis points greater than in Exhibit 37–12.

points to each rate. The simple binomial tree provides evidence of the complex calculation required to determine the OAS for a callable bond. In Exhibit 37–12, the bond is called at N_{HLL}. However, once the tree is shifted 35 basis points in Exhibit 37–19, the PV of future cash flows at N_{HLL} falls below the call price to 99.985, so the bond is not called at this node. Hence, as the lattice structure grows in size and complexity, the need for computer analytics becomes obvious.

Effective Duration and Effective Convexity

Duration and convexity provide a measure of the interest-rate risk inherent in a fixed income security. We rely on the lattice model to calculate the effective duration and effective convexity of a bond with an embedded option and other option-like securities. The formulas for these two risk measures are given below:

$$\text{Effective duration} = \frac{V_- - V_+}{2V_0(\Delta r)}$$

$$\text{Effective convexity} = \frac{V_+ + V_- - 2V_0}{2V_0(\Delta r)^2}$$

where V_- and V_+ are the values derived following a parallel shift in the yield curve down and up, respectively, by a fixed spread. The model adjusts for the changes in the value of the embedded call option that result from the shift in the curve in the calculation of V_- and V_+.

Note that the calculations must account for the OAS of the security. Below we provide the steps for the proper calculation of V_+. The calculation for V_- is analogous.

Step 1. Given the market price of the issue, calculate its OAS.

Step 2. Shift the on-the-run yield curve up by a small number of basis points (Δr).

Step 3. Construct a binomial interest-rate tree based on the new yield curve from step 2.

Step 4. Shift the binomial interest-rate tree by the OAS to obtain an "adjusted tree." That is, the calculation of the effective duration and convexity assumes a constant OAS.

Step 5. Use the adjusted tree in step 4 to determine the value of the bond, V_+.

We can perform this calculation for our four-year callable bond with a coupon rate of 6.5%, callable at par selling at 102.218. We computed the OAS for this issue as 35 basis points. Exhibit 37–20 holds the adjusted tree following a shift in the yield curve up by 25 basis points and then adding 35 basis points (the OAS) across the tree. The adjusted tree is then used to value the bond. The resulting value V_+ is 101.621.

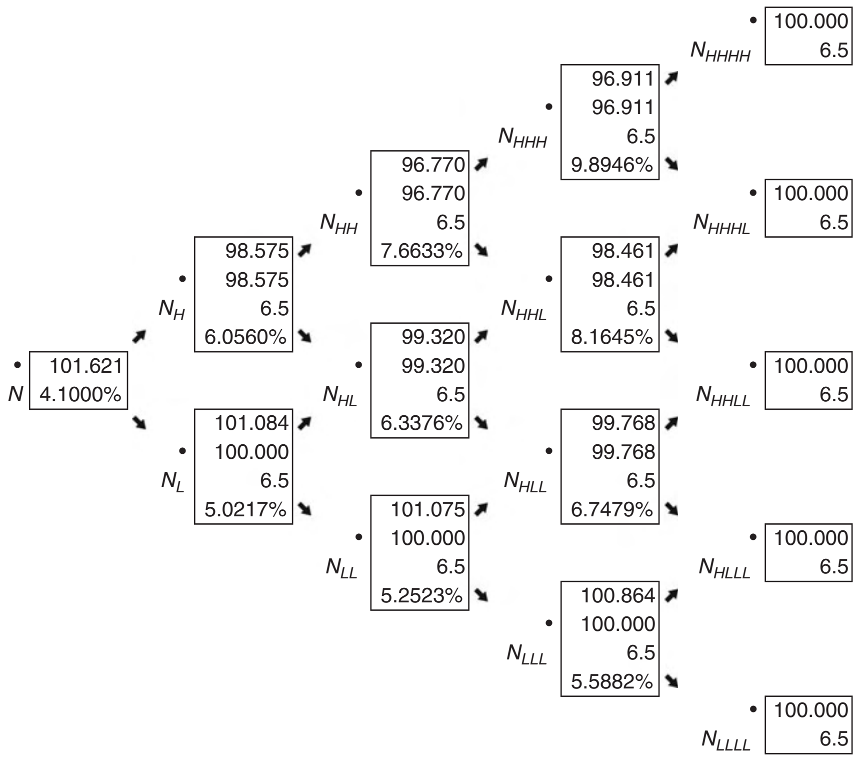
To determine the value of V_-, the same five steps are followed except that in step 2, the on-the-run yield curve is shifted down by a small number of basis points (Δr). It can be demonstrated that for our callable bond, the value for V_- is 102.765.

The results are summarized below:

$$\Delta r = 0.0025$$
$$V_+ = 101.621$$
$$V_- = 102.765$$
$$V_0 = 102.218$$

EXHIBIT 37–20

Determination of V_+ for Calculating Effective Duration and Convexity*



*+25 basis point shift in on-the-run yield curve.

Therefore,

$$\text{Effective duration} = \frac{102.765 - 101.621}{2(102.218)(0.0025)} = 2.24$$

$$\text{Effective convexity} = \frac{101.621 + 102.765 - 2(102.218)}{2(102.218)(0.0025)^2} = -39.1321$$

Notice that this callable bond exhibits negative convexity.

CONCLUSION

In this chapter we explained how an interest-rate lattice can be constructed. The lattice provides a robust means for the valuation of a number of fixed income securities and derivatives. This chapter demonstrated how the lattice can be used to value a variety of bonds with an embedded option. We extend the application of the lattice to calculation of the option-adjusted spread (OAS) and effective duration and effective convexity.

CHAPTER

THIRTY-EIGHT

VALUATION OF MORTGAGE-BACKED SECURITIES

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The traditional approach to the valuation of fixed income securities is to calculate yield—the yield-to-maturity, the yield-to-call for a callable bond, and the cash-flow yield for a mortgage-backed security. A superior approach is the option-adjusted spread (OAS) method. Our objective in this chapter is to describe the OAS method as applied to mortgage-backed securities. At the end of the chapter, we apply the method to three collateralized mortgage obligation (CMO) deals.

In this chapter we describe the theoretical foundations of this technique, the input and assumptions that go into the development of an OAS model, and the output of an OAS model, which in addition to the OAS value includes the option-adjusted duration and option-adjusted convexity. Because the user of an OAS model is exposed to *modeling risk,* it is necessary to test the sensitivity of these numbers to changes in the assumptions.

Valuation modeling for CMOs is similar to valuation modeling for pass-throughs, although the difficulties are amplified because the issuer has sliced and diced both the prepayment risk and the interest-rate risk into smaller pieces called *tranches*. The sensitivity of the pass-through securities from which the CMO is created to these two risks is not transmitted equally to every tranche. Some of the tranches wind up more sensitive to prepayment risk and interest-rate risk than the collateral, whereas some of them are much less sensitive.

The objective of the money manager is to figure out how the OAS of the collateral or, equivalently, the value of the collateral gets transmitted to the CMO tranches. More specifically, the objective is to find out where the value goes and where the risk goes so that the money manager can identify the tranches with low risk and high value: the ones he wants to buy. The good news is that this combination usually exists in every deal. The bad news is that in every deal there are usually tranches with low OAS, low value, and high risk.

STATIC VALUATION

Using OAS to value mortgages is a dynamic technique in that many scenarios for future interest rates are analyzed. Static valuation analyzes only a single-interest-rate scenario, usually assuming that the yield curve remains unchanged. Static valuation results in two measures, average life and static spread, which we review below.

Average Life

The *average life* of a mortgage-backed security is the weighted average time to receipt of principal payments (scheduled payments and projected prepayments). The formula for the average life is

$$\frac{1(\text{principal at time 1}) + \cdots + T(\text{principal at time } T)}{12(\text{total principal received})}$$

where T is the number of months.

In order to calculate average life, an investor must either assume a prepayment rate for the mortgage security being analyzed or use a prepayment model. By calculating the average life at various prepayment rates, the investor can gain some feeling for the stability of the security's cash flows. For example, a PAC bond's average life will not change within the PAC bands but may shorten significantly if the prepayment rate exceeds the upper band. By examining the average life at prepayment rates greater than the upper band, an investor can judge some of the PAC's risks. With a prepayment model available, the average life of a mortgage security can be calculated by changing the mortgage refinancing rate. As the refinancing rate rises, the prepayment model will slow the prepayment rate and thus cause the bond's average life to extend. Conversely, if the refinancing rate is lowered, the model will cause prepayments to rise and shorten the average life.

Static Spread

One of the standard measures in evaluating any mortgage-backed security is the cash-flow yield, or simply "yield." The yield spread, sometimes called the *nominal spread,* is found by spreading the yield to the average life on the interpolated Treasury yield curve. This practice is improper for an amortizing bond even in the absence of interest rate volatility.

What should be done instead is to calculate what is called the *static spread*. This is the yield spread in a static scenario (i.e., no volatility of interest rates) of the bond over the entire theoretical Treasury spot-rate curve, not a single point on the Treasury yield curve. The magnitude of the difference between the nominal spread and the static yield depends on the steepness of the yield curve: The steeper the curve, the greater the difference between the two values. In a relatively flat interest-rate environment, the difference between the nominal spread and the static spread will be small.

There are two ways to compute the static spread. One way is to use today's yield curve to discount future cash flows and keep the mortgage refinancing rate fixed at today's mortgage rate. Since the mortgage refinancing rate is fixed, the investor usually can specify a reasonable prepayment rate for the life of the security. Using this prepayment rate, the bond's future cash flow can be estimated. Use of this approach to calculate the static spread recognizes different prices today of dollars to be delivered at future dates. This results in the proper discounting of cash flows while keeping the mortgage rate fixed. Effectively, today's prices indicate what the future discount rates will be, but the best estimates of future rates are today's rates.

The second way to calculate the static spread allows the mortgage rate to go up the curve as implied by the forward interest rates. This procedure is sometimes called the *zero-volatility OAS*. In this case, a prepayment model is needed to determine the vector of future prepayment rates implied by the vector of future refinancing rates. A money manager using static spread should determine which approach is used in the calculation.

DYNAMIC VALUATION MODELING

Because CMOs are simply a regrouping of the cash flows from the underlying pass-through securities, the valuation of CMO tranches follows directly from the valuation of pass-through securities.

Using Simulation to Generate Interest-Rate Paths and Cash Flows

A technique known as *simulation* is used to value complex securities such as mortgage-backed securities. Simulation is used because the monthly cash flows are path-dependent. This means that the cash flows received this month are determined not only by the current and future interest-rate levels but also by the path that interest rates took to get to the current level.

There are typically two sources of path dependency in a CMO tranche's cash flows. First, collateral prepayments are path-dependent because this month's prepayment rate depends on whether there have been prior opportunities to refinance since the underlying mortgages were issued. Second, the cash flow to be received this month by a CMO tranche depends on the outstanding balances of the other tranches in the deal. We need the history of prepayments to calculate these balances.

Conceptually, the valuation of pass-through securities using the simulation method is simple. In practice, however, it is very complex. The simulation involves generating a set of cash flows based on simulated future mortgage refinancing rates, which, in turn, imply simulated prepayment rates.

The typical model that Wall Street firms and commercial vendors use to generate these random interest-rate paths takes as input today's term structure of interest rates and a volatility assumption. The term structure of interest rates is the theoretical spot-rate (or zero-coupon) curve implied by today's Treasury securities. The volatility assumption determines the dispersion of future interest rates in the simulation. The simulations should be normalized so that the average simulated price of a zero coupon Treasury bond equals today's actual price.

Each OAS model has its own model of the evolution of future interest rates and its own volatility assumptions. Until recently, there have been few significant differences in the interest-rate models of dealer firms and OAS vendors, although their volatility assumptions can be significantly different.

The random paths of interest rates should be generated from an arbitrage-free model of the future term structure of interest rates. By arbitrage-free it is meant that the model replicates today's term structure of interest rates, an input of the model, and that for all future dates there is no possible arbitrage within the model.[1]

The simulation works by generating many scenarios of future interest-rate paths. In each month of the scenario, a monthly interest rate and a mortgage refinancing rate are generated. The monthly interest rates are used to discount the projected cash flows in the scenario. The mortgage refinancing rate is needed to determine the cash flow because it represents the opportunity cost the mortgagor is facing at that time.

If the refinancing rates are high relative to the mortgagor's original coupon rate, the mortgagor will have less incentive to refinance or even a disincentive (i.e., the homeowner will avoid moving in order to avoid refinancing). If the refinancing rate is low relative to the mortgagor's original coupon rate, the mortgagor has an incentive to refinance.

Prepayments are projected by feeding the refinancing rate and loan characteristics, such as age, into a prepayment model. Given the projected prepayments, the cash flow along an interest-rate path can be determined.

To make this more concrete, consider a newly issued mortgage pass-through security with a maturity of 360 months. Exhibit 38–1 shows N simulated interest-rate path scenarios. Each scenario consists of a path of 360 simulated one-month future interest rates. Just how many paths should be generated is explained later. Exhibit 38–2 shows the paths of simulated mortgage refinancing rate corresponding to the scenarios shown in Exhibit 38–1. Assuming these mortgage refinancing rates, the cash flow for each scenario path is shown in Exhibit 38–3.

1. A risk-neutral, arbitrage-free model of Treasury yields means that at all future dates the price of any long-term bond equals the expected value of rolling short-term to maturity. For more details, see Fischer Black, Emmanuel Derman, and William Toy, "A One-Factor Model of Interest Rates and its Application to Treasury Bond Options," *Financial Analyst Journals* (January–February 1990), pp. 33–39.

EXHIBIT 38–1

Simulated Paths of One-Month Future Interest Rates

	Interest-Rate Path Number						
Month	**1**	**2**	**3**	**. . .**	***n***		***N***
1	$f_1(1)$	$f_1(2)$	$f_1(3)$	. . .	$f_1(n)$	. . .	$f_1(N)$
2	$f_2(1)$	$f_2(2)$	$f_2(3)$	. . .	$f_2(n)$	. . .	$f_2(N)$
3	$f_3(1)$	$f_3(2)$	$f_3(3)$	. . .	$f_3(n)$	. . .	$f_3(N)$
t	$f_t(1)$	$f_t(2)$	$f_t(3)$	. . .	$f_t(n)$	. . .	$f_t(N)$
358	$f_{358}(1)$	$f_{358}(2)$	$f_{358}(3)$	. . .	$f_{358}(n)$	. . .	$f_{358}(N)$
359	$f_{359}(1)$	$f_{359}(2)$	$f_{359}(3)$	. . .	$f_{359}(n)$	. . .	$f_{359}(N)$
360	$f_{360}(1)$	$f_{360}(2)$	$f_{360}(3)$	. . .	$f_{360}(\mathrm{n})$	. . .	$f_{360}(\mathrm{N})$

Notation:

$f_t(n)$ = one-month future interest rate for month *t* on path *n*

N = total number of interest-rate paths

Calculating the Present Value for a Scenario Interest-Rate Path

Given the cash flow on an interest-rate path, its present value can be calculated. The discount rate for determining the present value is the simulated spot rate for each month on the interest-rate path plus an appropriate spread. The spot rate on a path can be determined from the simulated future monthly rates. The relationship that holds between the simulated spot rate for month *T* on path *n*

EXHIBIT 38–2

Simulated Paths of Mortgage Refinancing Rates

	Interest-Rate Path Number						
Month	**1**	**2**	**3**	**. . .**	***n***		***N***
1	$r_1(1)$	$r_1(2)$	$r_1(3)$	. . .	$r_1(n)$	. . .	$r_1(N)$
2	$r_2(1)$	$r_2(2)$	$r_2(3)$	. . .	$r_2(n)$	. . .	$r_2(N)$
3	$r_3(1)$	$r_3(2)$	$r_3(3)$	. . .	$r_3(n)$	. . .	$r_3(N)$
t	$r_t(1)$	$r_t(2)$	$r_t(3)$	. . .	$r_t(n)$	. . .	$r_t(N)$
358	$r_{358}(1)$	$r_{358}(2)$	$r_{358}(3)$	. . .	$r_{358}(n)$	. . .	$r_{358}(N)$
359	$r_{359}(1)$	$r_{359}(2)$	$r_{359}(3)$	. . .	$r_{359}(n)$	. . .	$r_{359}(N)$
360	$r_{360}(1)$	$r_{360}(2)$	$r_{360}(3)$	. . .	$r_{360}(n)$	. . .	$r_{360}(N)$

Notation:

$r_t(n)$ = mortgage refinancing rate for month *t* on path *n*

N = total number of interest-rate paths

EXHIBIT 38–3

Simulated Cash Flow on Each of the Interest-Rate Paths

	Interest-Rate Path Number						
Month	**1**	**2**	**3**	**. . .**	***n***		***N***
1	$C_1(2)$	$C_1(2)$	$C_1(3)$	. . .	$C_1(n)$	. . .	$C_1(N)$
2	$C_2(1)$	$C_2(2)$	$C_2(3)$	. . .	$C_2(n)$	. . .	$C_2(N)$
3	$C_3(1)$	$C_3(2)$	$C_3(3)$	. . .	$C_3(n)$	. . .	$C_3(N)$
t	$C_t(1)$	$C_t(2)$	$C_t(3)$	. . .	$C_t(n)$	. . .	$C_t(N)$
358	$C_{358}(1)$	$C_{358}(2)$	$C_{358}(3)$	. . .	$C_{358}(n)$	. . .	$C_{358}(N)$
359	$C_{359}(1)$	$C_{359}(2)$	$C_{359}(3)$	. . .	$C_{359}(n)$	. . .	$C_{359}(N)$
360	$C_{360}(1)$	$C_{360}(2)$	$C_{360}(3)$	. . .	$C_{360}(n)$	. . .	$C_{360}(N)$

Notation:

$C_t(n)$ = cash flow for month t on path n
N = total number of interest-rate paths

and the simulated future one-month rates is

$$z_T(n) = \{[1 + f_1(n)][1 + f_2(n)] \ldots [1 + f_T(n)]\}^{1/T} - 1$$

where

$z_T(n)$ = simulated spot rate for month T on path n
$f_j(n)$ = simulated future one-month rate for month j on path n

Consequently, the interest-rate path for the simulated future one-month rates can be converted to the interest-rate path for the simulated monthly spot rates, as shown in Exhibit 38–4. Therefore, the present value of the cash flow for month T on interest-rate path n discounted at the simulated spot rate for month T plus some spread is

$$\text{PV}[C_T(n)] = \frac{C_T(n)}{[1 + z_T(n) + K]^{1/T}}$$

where

$\text{PV}[C_T(n)]$ = present value of cash flow for month T on path n
$C_T(n)$ = cash flow for month T on path n
$z_T(n)$ = spot rate for month T on path n
K = spread

The present value for path n is the sum of the present value of the cash flow for each month on path n. That is,

$$\text{PV}[\text{path}(n)] = \text{PV}[C_1(n)] + \text{PV}[C_2(n)] + \cdots + \text{PV}[C_{360}(n)]$$

where PV[path(n)] is the present value of interest-rate path n.

EXHIBIT 38–4

Simulated Paths of Monthly Spot Rates

	Interest-Rate Path Number						
Month	**1**	**2**	**3**	**. . .**	***n***		***N***
1	$z_1(1)$	$z_1(2)$	$z_1(3)$	. . .	$z_1(n)$	. . .	$z_1(N)$
2	$z_2(1)$	$z_2(2)$	$z_2(3)$	. . .	$z_2(n)$	. . .	$z_2(N)$
3	$z_3(1)$	$z_3(2)$	$z_3(3)$	. . .	$z_3(n)$	. . .	$z_3(N)$
t	$z_t(1)$	$z_t(2)$	$z_t(3)$	. . .	$z_t(n)$	. . .	$z_t(N)$
358	$z_{358}(1)$	$z_{358}(2)$	$z_{358}(3)$	. . .	$z_{358}(n)$	. . .	$z_{358}(N)$
359	$z_{359}(1)$	$z_{359}(2)$	$z_{359}(3)$	. . .	$z_{359}(n)$	. . .	$z_{359}(N)$
360	$z_{360}(1)$	$z_{360}(2)$	$z_{360}(3)$	. . .	$z_{360}(n)$	. . .	$z_{360}(N)$

Notation:

$z_t(n)$ = spot rate for month t on path n

N = total number of interest-rate paths

The option-adjusted spread is the spread K that when added to all the spot rates on all interest-rate paths will make the average present value of the paths equal to the observed market price (plus accrued interest). Mathematically, OAS is the spread K that will satisfy the following condition:

$$\text{Market price} = \frac{\text{PV[path(1)]} + \text{PV[path(2)]} + \cdots + \text{PV[path}(N)]}{N}$$

where N is the number of interest-rate paths.

This procedure for valuing a pass-through is also followed for a CMO tranche. The cash flow for each month on each interest-rate path is found according to the principal repayment and interest distribution rules of the deal. In order to do this, a CMO structuring model is needed.

Selecting the Number of Interest-Rate Paths

Let's now address the question of the number of scenario paths or repetitions N needed to value a CMO tranche. A typical OAS run will be done for 512 to 1,024 interest-rate paths. The scenarios generated using the simulation method look very realistic and furthermore reproduce today's Treasury curve. By employing this technique, the money manager is effectively saying that Treasuries are fairly priced today and that the objective is to determine whether a specific tranche is rich or cheap relative to Treasuries.

The number of interest-rate paths determines how "good" the estimate is, not relative to the truth but relative to the OAS model used. The more paths, the more average spread tends to settle down. It is a statistical sampling problem.

Most OAS models employ some form of *variance reduction* to cut down on the number of sample paths necessary to get a good statistical sample.[2] Variance reduction techniques allow us to obtain price estimates within a tick. By this we mean that if the OAS model is used to generate more scenarios, price estimates from the model will not change by more than a tick. Thus, for example, if 1,024 paths are used to obtain the estimated price for a tranche, there is little more information to be had from the OAS model by generating more than that number of paths. (For some very sensitive CMO tranches, more paths may be needed to estimate prices within one tick.)

Interpretation of the OAS

The procedure for determining the OAS is straightforward, although time-consuming. The next question, then, is how to interpret the OAS. Basically, the OAS is used to reconcile value with market price. On the left-hand side of the last equation is the market's statement: The price of a mortgage-backed security or mortgage derivative. The average present value over all the paths on the right-hand side of the equation is the model's output, which we refer to as *value*.

What a money manager seeks to do is to buy securities whose value is greater than their price. A valuation model such as the one described earlier allows a money manager to estimate the value of a security, which at this point would be sufficient to determine whether to buy a security. That is, the money manager can say that this bond is 1 point cheap or 2 points cheap, and so on. The model does not stop here, however. Instead, it converts the divergence between price and value into a yield spread measure because most market participants find it more convenient to think about yield spread than about price differences.

The OAS was developed as a measure of the yield spread that can be used to reconcile dollar differences between value and price. But what is it a "spread" over? In describing the preceding model, we can see that the OAS is measuring the average spread over the Treasury spot-rate curve, not the Treasury yield curve. It is an average spread because the OAS is found by averaging over the interest-rate paths for the possible spot-rate curves.

Option Cost

The implied cost of the option embedded in any mortgage-backed security can be obtained by calculating the difference between the OAS at the assumed volatility

2. For a discussion of variance reduction, see Phelim P. Boyle, "Options: A Monte Carlo Approach," *Journal of Financial Economics* 4 (1977), pp. 323–338.

of interest rates and the static spread. That is,

$$\text{Option cost} = \text{static spread} - \text{option-adjusted spread}$$

The reason that the option cost is measured in this way is as follows: In an environment of no interest-rate changes, the investor would earn the static spread. When future interest rates are uncertain, the spread is less, however, because of the homeowner's option to prepay; the OAS reflects the spread after adjusting for this option. Therefore, the option cost is the difference between the spread that would be earned in a static interest-rate environment (the static spread) and the spread after adjusting for the homeowner's option.

In general, a tranche's option cost is more stable than its OAS in the face of market movements. This interesting feature is useful in reducing the computational expensive costs of calculating the OAS as the market moves. For small market moves, the OAS of a tranche may be approximated by recalculating the static spread (which is relatively cheap and easy to calculate) and subtracting its option cost.

Other Products of the OAS Models

Other products of the valuation model are option-adjusted duration, option-adjusted convexity, and simulated average life.

Option-Adjusted Duration

In general, duration measures the price sensitivity of a bond to a small change in interest rates. Duration can be interpreted as the approximate percentage change in price for a 100 basis point parallel shift in the yield curve. For example, if a bond's duration is 4, this means a 100 basis point increase in interest rates will result in a price decrease of approximately 4%. A 50 basis point increase in yields will decrease the price by approximately 2%. The smaller the change in basis points, the better the approximated change in price will be.

The duration for any security can be approximated as follows:

$$\text{Duration} = \frac{P_- - P_+}{2P_0 \Delta y}$$

where

P_- = price if yield is decreased (per $100 of par value) by Δy
P_+ = price if yield is increased (per $100 of par value) by Δy
P_0 = initial price (per $100 of par value)
Δy = number of basis points change used to calculate P_- and P_+

The standard measure of duration is modified duration. The limitation of modified duration is that it assumes that if interest rates change, the cash flow does not change. While modified duration is fine for option-free securities such as Treasury bonds, it is inappropriate for mortgage-backed securities because projected cash flows change as interest rates and prepayments change. When prices in the duration formula are calculated assuming that the cash flow changes when interest rates change, the resulting duration is called *effective duration*.

Effective duration can be computed using an OAS model as follows: First, the bond's OAS is found using the current term structure of interest rates. Next, the bond is repriced holding OAS constant but shifting the term structure. Two shifts are used; in one, yields are increased, and in the second, they are decreased. This produces the two prices, P_- and P_+, used in the preceding formula. Effective duration calculated in this way is often referred to as *option-adjusted duration,* or *OAS duration*.

The assumption in using modified or effective duration to project the percentage price change is that all interest rates change by the same number of basis points; that is, there is a parallel shift in the yield curve. If the term structure does not change by a parallel shift, then effective duration will not correctly predict the change in a bond's price.

Option-Adjusted Convexity

The convexity measure of a security is the approximate change in price that is not explained by duration. *Positive convexity* means that if yields change by a given number of basis points, the percentage increase in price will be greater than the percentage decrease in price. *Negative convexity* means that if yield changes by a given number of basis points, the percentage increase in price will be less than the percentage decrease in price. That is, for a 100 basis point change in yield:

Type of Convexity	Increase in Price	Decrease in Price
Positive convexity	*X*%	Less than *X*%
Negative convexity	*X*%	More than *X*%

Obviously, positive convexity is a desirable property of a bond. A pass-through security can exhibit either positive or negative convexity depending on the prevailing mortgage rate relative to the rate on the underlying mortgage loans. When the prevailing mortgage rate is much higher than the mortgage rate on the underlying mortgage loans, the pass-through usually exhibits positive convexity. It usually exhibits negative convexity when the underlying coupon rate is near or above prevailing mortgage refinancing rates.

The convexity of any bond can be approximated using the formula

$$\frac{P_+ + P_- - (P_0)}{2P_0(\Delta y)^2}$$

When the prices used in this formula assume that the cash flows do not change when yields change, the resulting convexity is a good approximation of the standard convexity for an option-free bond. When the prices used in the formula are derived by changing the cash flows (by changing prepayment rates) when yields change, the resulting convexity is called *effective convexity*. Once again, when an OAS model is used to obtain the prices, the resulting value is referred to as the *option-adjusted convexity,* or *OAS convexity*.

Simulated Average Life

The average life reported in an OAS model is the average of the average lives along the interest-rate paths. That is, for each interest-rate path, there is an average life. The average of these average lives is the average life reported in an OAS model.

Additional information is conveyed by the distribution of the average life. The greater the range and standard deviation of the average life, the more uncertainty there is about the tranche's average life.

ILLUSTRATIONS

We use three deals to show how CMOs can be analyzed using the OAS methodology: a plain-vanilla structure, a PAC/support structure, and a reverse-pay structure.

Plain-Vanilla Structure

The plain-vanilla sequential-pay CMO bond structure in our illustration is FHLMC 1915. A diagram of the principal allocation structure is given in Exhibit 38–5. The structure includes eight tranches, A, B, C, D, E, F, G, and S, and two residual classes. Tranche F is a floating-rate bond, and tranche S is an inverse floating-rate IO. Tranches D, E, and G are special "exchangeable bonds" that allow for the combination of tranches F and S. The focus of our analysis is on tranches A, B, and C.

EXHIBIT 38–5

Diagram of Principal Allocation Structure of FHLMC 1915

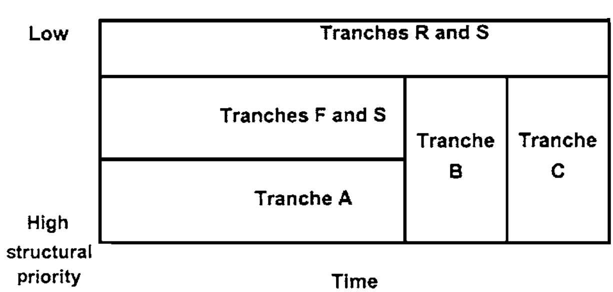


EXHIBIT 38–6

OAS Analysis of FHLMC 1915 Classes A, B, and C (as of 3/10/98)

Base Case (assumes 13% interest-rate volatility)

	OAS (in basis points)	Option Cost (in basis points)	Effective Duration
Collateral class	51	67	1.2
A	32	51	0.9
B	33	82	2.9
C	46	70	6.7

Prepayments at 80% and 120% of Prepayment Model (assumes 13% interest rate volatility)

	New OAS (in basis points)		*Change in Price per $100 par (holding OAS constant)*		*Effective Duration*	
	80%	**120%**	**80%**	**120%**	**80%**	**120%**
Collateral class	63	40	$0.45	–$0.32	2.0	0.6
A	40	23	0.17	–0.13	0.9	0.9
B	43	22	0.54	–0.43	3.3	2.7
C	58	36	0.97	–0.63	7.4	6.0

Interest-Rate Volatility of 9% and 17%

	New OAS (in basis points)		*Change in Price per $100 par (holding OAS constant)*		*Effective Duration*	
	9%	**17%**	**9%**	**17%**	**9%**	**17%**
Collateral class	79	21	$1.03	–$0.94	1.4	1.1
A	52	10	0.37	–0.37	0.9	0.9
B	66	–3	1.63	–1.50	3.1	2.7
C	77	15	2.44	–2.08	6.8	6.5

The top panel of Exhibit 38–6 shows the OAS and the option cost for the collateral and the five classes in the CMO structure. The OAS for the collateral is 51 basis points. Since the option cost is 67 basis points, the static spread is 118 basis points (51 basis points plus 67 basis points). The weighted-average OAS of all the classes (including the residual) is equal to the OAS of the collateral.

At the time this analysis was performed, March 10, 1998, the Treasury yield curve was not steep. As we noted earlier, in such a yield-curve environment, the static spread will not differ significantly from the traditionally computed yield spread. Thus, for the three tranches shown in Exhibit 38–6, the static spread is 83 for A, 115 for B, and 116 for C.

Notice that the classes did not share the OAS equally. The same is true for the option cost. The value tended to go toward the longer bonds, something that occurs in the typical deal. Both the static spread and the option cost increase as the maturity increases. The only tranches where there appears to be a bit of a bargain is tranche C. A money manager contemplating the purchase of this last cash-flow tranche can see that C offers a higher OAS than B and appears to bear less of the risk, as measured by the option cost. The problem money managers may face is that they might not be able to go out as long on the yield curve as the C tranche because of duration, maturity, and average life constraints.

Now let's look at modeling risk. Examination of the sensitivity of the tranches to changes in prepayments and interest rate volatility will help us to understand the interaction of the tranches in the structure and who is bearing the risk.

We begin with prepayments. Specifically, we keep the same interest-rate paths as those used to get the OAS in the base case (the top panel of Exhibit 38–6) but reduce the prepayment rate on each interest-rate path to 80% of the projected rate.

As can be seen in the second panel of Exhibit 38–6, slowing down prepayments increases the OAS and price for the collateral. This is so because the collateral is trading above par. Tranches created by this collateral typically will behave the same way. However, if a tranche was created with a lower coupon, allowing it to trade below par, then it may behave in the opposite fashion. The exhibit reports two results of the sensitivity analysis. First, it indicates the change in the OAS. Second, it indicates the change in the price, holding the OAS constant at the base case.

To see how a money manager can use the information in the second panel, consider tranche A. At 80% of the prepayment speed, the OAS for this class increases from 32 basis points to 40 basis points. If the OAS is held constant, the panel indicates that the buyer of tranche A would gain $0.17 per $100 par value.

Notice that for all the tranches reported in Exhibit 38–6, there is a gain from a slowdown in prepayments. This is so because all the sequential tranches in this deal are priced over par. If the F and S tranches were larger, then the coupon on tranche A would have been smaller. This coupon could have been made small enough for tranche A to trade at a discount to par, which would have caused the bond to lose in a prepayment slowdown. Also notice that while the changes in OAS are about the same for the different tranches, the changes in price are quite different. This arises because the shorter tranches have less duration. Therefore, their prices do not move as much from a change in OAS as a longer tranche. A money manager who is willing to go to the long end of the curve, such as tranche C, would realize the most benefit from the slowdown in prepayments.

Also shown in the second panel of the exhibit is the second part of our experiments to test the sensitivity of prepayments: the prepayment rate is assumed to be 120% of the base case. The collateral loses money in this scenario because it is trading above par. This is reflected in the OAS of the collateral which declines from 51 basis points to 40 basis points.

Now look at the four tranches. They all lost money. Additionally, the S tranche, which is not shown in the exhibit, also loses in an increase in prepayments. The S tranche is an IO tranche, and in general, IO types of tranches will be adversely affected by an increase in prepayments.

Now let's look at the sensitivity to the interest-rate volatility assumption, 13% in the base case. Two experiments are performed: reducing the volatility assumption to 9% and increasing it to 17%. These results are reported in the third panel of Exhibit 38–6.

Reducing the volatility to 9% increases the dollar price of the collateral by $1.03 and increases the OAS from 51 in the base case to 79 basis points. This $1.03 increase in the price of the collateral is not equally distributed, however, between the four tranches. Most of the increase in value is realized by the longer tranches. The OAS gain for each of the tranches follows more or less the OAS durations of those tranches. This makes sense because the longer the duration, the greater the risk, and when volatility declines, the reward is greater for the accepted risk.

At the higher level of assumed interest-rate volatility of 17%, the collateral is severely affected. The collateral's loss is distributed among the tranches in the expected manner: the longer the duration, the greater the loss. In this case, tranche F and the residual are less affected.

Using the OAS methodology, a fair conclusion that can be made about this simple plain-vanilla structure is: what you see is what you get. The only surprise in this structure is the lower option cost in tranche C. In general, however, a money manager willing to extend duration gets paid for that risk in a plain-vanilla structure.

PAC/Support Bond Structure

Now let's look at how to apply the OAS methodology to a more complicated CMO structure, FHLMC Series 1706. The collateral for this structure is Freddie Mac 7s. A summary of the deal is provided in Exhibit 38–7. A diagram of the principal allocation is given in Exhibit 38–8.

While this deal is more complicated than the previous one, it is still relatively simple compared with some deals that have been printed recently. Nonetheless, it brings out all the key points about application of OAS analysis,

EXHIBIT 38–7

Summary of Federal Home Loan Mortgage Corporation—Multiclass Mortgage Participation Certificates (Guaranteed), Series 1706

Total issue:	$300,000,000	Original settlement date:	3/30/94
Issue date:	2/18/94	Days delay:	30
Structure type:	REMIC CMO	Payment frequency:	Monthly; 15th day of month
Issuer	Class: Agency		
Dated date:	3/1/94		

				Original Issue Pricing (225% PSA Assumed)	
Tranche	**Original Balance ($)**	**Coupon (%)**	**Stated Maturity**	**Average Life (yrs)**	**Expected Maturity**
A (PAC Bond)	24,600,000	4.50	10/15/06	1.3	6/15/96*
B (PAC Bond)	11,100,000	5.00	9/15/09	2.5	1/15/97*
C (PAC Bond)	25,500,000	5.25	4/15/14	3.5	6/15/98
D (PAC Bond)	9,150,000	5.65	8/15/15	4.5	1/15/99
E (PAC Bond)	31,650,000	6.00	1/15/19	5.8	1/15/01
G (PAC Bond)	30,750,000	6.25	8/15/21	7.9	5/15/03
H (PAC Bond)	27,450,000	6.50	6/15/23	10.9	10/15/07
J (PAC Bond)	5,220,000	6.50	10/15/23	14.4	9/15/09
K (PAC Bond)	7,612,000	7.00	3/15/24	18.8	5/15/19
LA (SCH Bond)	26,673,000	7.00	11/15/21	3.5	3/15/02
LB (SCH Bond)	36,087,000	7.00	6/15/23	3.5	9/15/02
M (SCH Bond)	18,738,000	7.00	3/15/24	11.2	10/15/08
O (TAC Bond)	13,348,000	7.00	2/15/24	2.5	1/15/08
OA (TAC Bond)	3,600,000	7.00	3/15/24	7.2	4/15/09
IA (IO, PAC Bond)	30,246,000	7.00	10/15/23	7.1	9/15/09
PF (FLTR, Support Bond)	21,016,000	6.75	3/15/24	17.5	5/15/19
PS (INV FLTR, Support Bond)	7,506,000	7.70	3/15/24	17.5	5/15/19
R (Residual)	—	0.00	3/15/24		
RS (Residual)	—	0.00	3/15/24		

Structural Features

Prepayment guarantee:	None
Assumed reinvestment rate:	0%
Cash-flow allocation:	Excess cash flow is not anticipated; in the event that there are proceeds remaining after the payment of the bonds, however, the class R and RS bonds will receive them. Commencing on the first principal payment date of the class A bonds, principal equal to the

EXHIBIT 38–7

(*Continued*)

	amount specified in the prospectus will be applied to the class A, B, C, D, E, G, H, J, K, LA, LB, M, O, OA, PF, and PS bonds. After all other classes have been retired, any remaining principal will be used to retire the class O, OA, LA, LB, M, A, B, C, D, E, G, H, J, and K bonds. The notional class IA bond will have its notional principal amount retired along with the PAC bonds.
Redemption provisions:	Nuisance provision for all classes: Issuer may redeem the bonds, in whole but not in part, on any payment date when the outstanding principal balance declines to less than 1% of the original amount.
Other:	The PAC range is 95% to 300% PSA for the A–K bonds, 190% to 250% PSA for the LA, LB, and M bonds, and 225% PSA for the O and OA bonds.

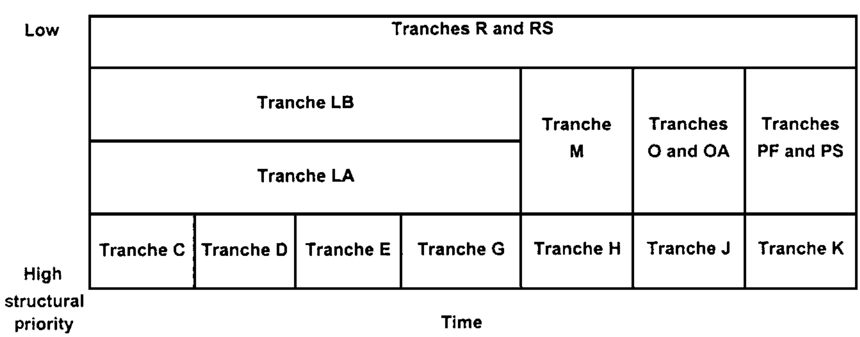
specifically the fact that most deals include cheap bonds, expensive bonds, and fairly priced bonds. The OAS analysis helps a money manager identify how a tranche should be classified.

There are 19 classes in this structure: 10 PAC bonds (including one PAC IO bond), 3 Scheduled bonds, 2 TAC support bonds, a floating-rate support bond, an inverse-floating-rate support bond, and 2 residual bonds. This deal contains no principal-only (PO) tranches.

The deal also includes an IO tranche, IA, which is structured such that the underlying collateral's interest not allocated to the PAC bonds is paid to the IO bond, which causes the PAC bonds to have discount coupons (as shown by the lower coupons of the front PACs in Exhibit 38–7). Unlike a typical mortgage-backed security backed by deep-discount collateral, prepayments for the front

EXHIBIT 38–8

Diagram of Principal Allocation Structure of FHLMC 1706 (as of 3/10/98)



tranches will be faster because the underlying collateral is Freddie Mac 7s, which was premium collateral at the time this analysis was computed. Thus, with PAC C, the investor realizes a low coupon rate but a much higher prepayment rate than would be experienced by such a low-coupon mortgage bond.

Tranches A and B had already paid off all their principal when this analysis was performed. The other PAC bonds are still available. Tranche IA is a PAC IO. The prepayment protection for the PAC bonds is provided by the support or companion bonds. The support bonds in this deal are tranches LA, LB, M, O, OA, PF, and PS. LA is the shortest tranche (an SCH bond), while the floating-rate bonds, PF and PS, are the longest. SCH bonds, as represented by tranches LA and LB, have PSA bands similar to a PAC bond, but they typically have a narrower window of speeds. Also, they are often much less protected from prepayment surprises when the bands are exceeded. The LB tranche, for example, is essentially a support bond, once the PSA bands are broken.

The top panel of Exhibit 38–9 shows the base case OAS and the option cost for the collateral and all but the residual classes. The collateral OAS is 60 basis points, and the option cost is 44 basis points. The static spread of the collateral to the Treasury spot curve is 104 basis points.

The 60 basis points of OAS did not get equally distributed among the tranches, as was the case with the plain-vanilla structure. Tranche LB, the scheduled support, did not realize a good OAS allocation, only 29 basis points, and had an extremely high option cost. Given the prepayment uncertainty associated with this bond, its OAS would be expected to be higher. The reason for the low OAS is that this tranche was priced so that its cash-flow yield is high. Using the static spread as a proxy for the spread over the Treasury yield curve, the 103 basis point spread for tranche LB is high given that this appears to be a short-term tranche. Consequently, "yield buyers" probably bid aggressively for this tranche and thereby drove down its OAS, trading off "yield" for OAS. From a total-return perspective, however, tranche LB should be avoided. It is a rich, or expensive, bond. The three longer supports did not get treated as badly as tranche LB; the OAS for tranches M, O, and OA are 72, 70, and 68 basis points, respectively.

It should be apparent from the results of the base-case OAS analysis reported in the top panel of Exhibit 38–9, where the cheap bonds in the deal are. They are the long PACs, which have a high OAS, a low option cost, and can be positively convex. These are well-protected cash flows.

Notice that the option cost for trancheesIA and PS are extremely high. These two tranches are primarily IOs. An investor who purchases an IO has effectively sold an option, and this explains the large option cost. As long as volatility is low, the owner of the IO will be able to collect the premium because the realized option cost will be less than that implied by the model.

The next two panels in Exhibit 38–9 show the sensitivity of the OAS and the price (holding OAS constant at the base case) to changes in the prepayment speed (80% and 120% of the base case) and to changes in volatility (9% and 17%). This analysis shows that the change in the prepayment speed does not affect the collateral

EXHIBIT 38–9

OAS Analysis of FHLMC 1706 (as of 3/10/98)

Base Case (assumes 13% interest-rate volatility)

	OAS (in basis points)	Option Cost (in basis points)	Effective Duration
Collateral class	60	44	2.6
C (PAC)	15	0	0.2
D (PAC)	16	4	0.6
E (PAC)	26	4	1.7
G (PAC)	42	8	3.3
H (PAC)	50	12	4.9
J (PAC)	56	14	6.8
K (PAC)	57	11	8.6
LA (SCH)	39	12	1.4
LB (SCH)	29	74	1.2
M (SCH)	72	53	4.9
O (TAC)	70	72	3.8
OA (TAC)	68	68	5.4
PF (Support Fltr)	17	58	1.5
PS (Support Inverse Fltr)	54	137	17.3
IA (PAC IO)	50	131	0.5

EXHIBIT 38–9

(Continued)

		New OAS (in basis points)		Change in Price per $100 par (holding OAS constant)		Effective Duration	
Prepayments at 80% and 120% of Prepayment Model (assumes 13% interest-rate volatility)							
	Base Case OAS	**80%**	**120%**	**80%**	**120%**	**80%**	**120%**
Collateral class	60	63	57	$0.17	–$0.11	3.0	2.4
C (PAC)	15	15	15	0.00	0.00	0.2	0.2
D (PAC)	16	16	16	0.00	0.00	0.6	0.6
E (PAC)	26	27	26	0.01	–0.01	1.7	1.6
G (PAC)	42	44	40	0.08	–0.08	3.5	3.1
H (PAC)	50	55	44	0.29	–0.27	5.5	4.7
J (PAC)	56	63	50	0.50	–0.47	7.3	6.4
K (PAC)	57	65	49	0.77	–0.76	9.1	8.1
LA (SCH)	39	31	39	–0.12	0.00	1.5	1.2
LB (SCH)	29	39	18	0.38	–0.19	1.3	1.1
M (SCH)	72	71	76	–0.07	0.18	5.9	4.2
O (TAC)	70	69	72	–0.06	0.10	4.0	3.6
OA (TAC)	68	69	71	0.07	0.15	5.8	5.3
PF (Support Fltr)	17	26	7	0.75	–0.69	1.8	1.3
PS (Support Inverse Fltr)	54	75	49	1.37	–0.27	17.6	17.2
IA (PAC IO)	50	144	–32	0.39	–0.32	1.0	–1.2

EXHIBIT 38–9

(Continued)

Interest-Rate Volatility of 9% and 17%

	Base Case OAS	New OAS (in basis points)		Change in Price per $100 par (holding OAS constant)		Effective Duration	
		9%	17%	9%	17%	9%	17%
Collateral class	60	81	35	$0.96	–$0.94	2.9	2.5
C (PAC)	15	15	15	0.00	0.00	0.2	0.2
D (PAC)	16	16	16	0.00	0.00	0.6	0.6
E (PAC)	26	27	24	0.02	–0.04	1.7	1.7
G (PAC)	42	48	34	0.21	–0.27	3.3	3.3
H (PAC)	50	58	35	0.48	–0.72	5.1	4.9
J (PAC)	56	66	41	0.70	–1.05	7.1	6.6
K (PAC)	57	66	44	0.82	–1.19	8.9	8.4
LA (SCH)	39	47	24	0.09	–0.18	1.3	1.4
LB (SCH)	29	58	–4	0.80	–0.82	1.1	1.2
M (SCH)	72	100	41	1.80	–1.72	5.4	4.7
O (TAC)	70	103	30	2.03	–1.74	3.9	3.8
OA (TAC)	68	103	30	2.40	–1.98	5.8	5.4
PF (Support Fltr)	17	51	–27	3.11	–2.92	1.0	2.1
PS (Support Inverse Fltr)	54	123	–5	4.85	–2.85	20.7	15.6
IA (PAC IO)	50	158	–70	0.45	–0.48	0.8	0.2

significantly, whereas the change in the OAS (holding the price constant) and price (holding OAS constant) for each tranche can be significant. For example, a faster prepayment speed, which decreases the time period over which a PAC IO bondholder is receiving a coupon, significantly reduces the OAS and price. The opposite effect results if prepayments are slower than the base case.

Tranche H, a premium priced medium-term PAC, benefits from a slowing in prepayments, because the bondholder will receive the coupon for a longer time. Faster prepayments represent an adverse scenario. The PAC bonds are quite well protected. The long PACs actually will benefit from a reduced prepayment rate because they will be earning the higher coupon interest longer. Thus, on an OAS basis, our earlier conclusion that the long PACs were allocated a good part of the deal's value holds up under our first stress test.

A slowdown in prepayments helps the support tranche LB and a speedup hurts this tranche. A somewhat surprising result involves the effect that the change in prepayments has on the TAC bond OA. Notice that whether the prepayment speeds are slower or faster, the OAS and the price increases. This result arises from the structure of the bond. The prepayment risk of this bond is more prevalent when prepayments increase sharply and then soon return to the base speed. This phenomenon, known as a "whipsaw," would adversely affect the OA tranche. Without the use of an OAS framework, this would not be intuitively obvious.

The sensitivity of the collateral and the tranches to changes in volatility are shown in the third panel of Exhibit 38–9. A lower volatility increases the value of the collateral, whereas a higher volatility reduces its value. Similarly, but in a more pronounced fashion, lower volatility increases the value of IO instruments, and higher volatility decreases their value. This effect can be seen on the PAC IO tranche IA in Exhibit 38–9.

The long PACs continue to be fairly well protected, whether the volatility is lower or higher. In the two volatility scenarios, they continue to get a good OAS, although not as much as in the base case if volatility is higher (but the OAS still looks like a reasonable value in this scenario). This reinforces our earlier conclusion concerning the investment merit of the long PACs in this deal.

Reverse PAC Deal

We have stressed that the OAS analysis helps the money manager avoid the traps inherent in examination of a deal on a static basis. The next deal we look at is the Bear Stearns 88-5 deal, a reverse-pay deal. While it is an old deal, it highlights this point. The deal is summarized in Exhibit 38–10. It has four PACs and three support bonds, two of which are TACs. The principal allocation diagram is shown in Exhibit 38–11.

Our focus here is on the PAC bonds. According to the average life reported in Exhibit 38–10, PAC D is the longest bond with an average life of 19.7 years. The next-to-the-longest PAC is PAC C with an average of 10.9 years.

EXHIBIT 38–10

Summary of Bear Stearns 88-5 Reverse Pay Deal

Tranche (type)	Coupon (%)	Average Life (years)	Balance (million)
A (PAC)	9.125	2.4	$28.7
B (PAC)	9.250	5.9	30.1
C (PAC)	9.625	10.9	44.4
D (PAC)	9.800	19.7	29.8
E (Support TAC)	9.450	1.1	5.3
F (Support TAC)	9.500	5.9	35.6
G (Support)	9.750	22.2	26.1

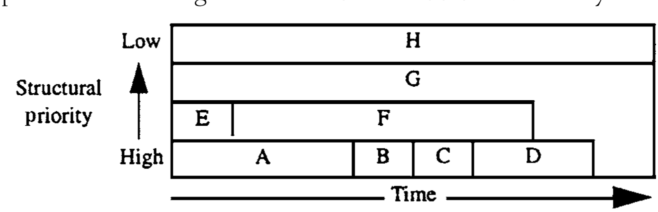
How good is the average life as a proxy for the price sensitivity of a bond? Since the average life is a static measure, it does not take into consideration interest-rate volatility. The option-adjusted duration and convexity of PAC C and PAC D are as follows:

	Average Life	OA-Duration	OA-Convexity
PAC C	10.9	6.3	–0.22
PAC D	19.7	5.9	0.04

PAC C actually has a longer duration than the PAC that follows it because it is a reverse-pay structure. OAS and option-adjusted duration would show the money manager immediately where the risk is. Moreover, it can be seen that PAC C is a negatively convex tranche.

EXHIBIT 38–11

Principal Allocation Diagram of Bear Stearns 88-5 Reverse Pay Deal



SUMMARY

Mortgage-backed securities are complex instruments. The valuation model described in this chapter is a sophisticated analytical tool available to analyze them. The product of this valuation model is the option-adjusted spread. The results of this model should be stress-tested for modeling risk: alternative prepayment and volatility assumptions.

OAS analysis helps the money manager to understand where the risks are in a CMO deal and to identify which tranches are cheap, rich, and fairly priced. Compared with a sophisticated analytical tool such as OAS analysis, traditional static analysis can lead to very different conclusions about the relative value of the tranches in a deal. This may lead a money manager to buy the expensive tranches and miss the opportunity to invest in cheap tranches.

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CHAPTER
THIRTY-NINE

OAS AND EFFECTIVE DURATION

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Bonds with embedded options have uncertain maturities because the decision to exercise the option generally depends on the relationship between the level of interest rates, the exercise price of the option, and the market price of the security. Issuers of callable debt will tend to call their bonds when rates have fallen sufficiently to justify refinancing outstanding debt. However, the exact timing for the exercise of the call option is not always known because the nature of the American-style option allows issuers to exercise their call at any time between the first call date and the final maturity date. This option type is prevalent among corporate, agency, and Treasury securities. The maturities of bonds with embedded put options are known with slightly more certainty because investors will either redeem the bonds on the put date or hold them to final maturity (assuming that there are no other embedded options in addition to the one put option).

The presence of an embedded option complicates the bond-valuation process because the bond's maturity date is uncertain. It is not always clear whether the bond should be analyzed according to its final maturity, first call or put date, or par call date, for example. Consider a 30-year callable utility bond with five years of call protection and a given level of interest-rate volatility. From a price-sensitivity standpoint, does the bond behave more like a 30-year bond, a five-year bond, or an intermediate-maturity bond? From a compensation standpoint, are the yield spread

This chapter was written when David Audley and Richard Chin were employed by Prudential Securities.

and option-adjusted spread (OAS) commensurate with the level of interest-rate risk? The ability to quantify the price sensitivity of a particular bond is a necessary step in gauging the risk/reward trade-offs inherent in any one bond. Furthermore, the hedging of such bonds requires having the means to calculate a bond's price sensitivity to changes in interest rates.

For a bond with a defined set of cash flows, such as a bullet bond, the price/yield relationship is well understood. Consequently, the bullet bond's modified duration may be calculated easily because the amount and timing of all the cash flows are known with certainty. In this chapter, we will illustrate how the effective duration of an option-embedded bond is simply an extension of the already familiar concept used for bullet bonds. Additionally, the chapter discusses why OAS and effective duration by themselves may not provide sufficient information to completely judge the relative value between two securities.

THE PRICE/YIELD RELATIONSHIP FOR OPTION-EMBEDDED BONDS

As a starting point in the conceptual analysis of option-embedded bonds, consider the effect an embedded option has on a bond's maturity in the case of extreme interest-rate movements. If interest rates move to either very high or very low levels, the embedded option very likely will or will not be exercised (depending on whether the option is a call or a put) and, therefore, the maturity of a bond should be known with relative certainty. For example, if long-term Treasury rates drop to 2% and stay at that level, callable-bond issuers will probably exercise their options at the earliest possible date, whereas putable bonds will remain outstanding to final maturity as holders will not exercise their put option. On the other hand, if Treasury rates rise to 25% and remain at that level, putable-bond holders will exercise their options as quickly as possible in order to reinvest the proceeds at higher interest rates, whereas callable bonds will remain outstanding until final maturity because issuers will not exercise their call option. These extreme interest-rate-movement scenarios illustrate that the maturity range of most option-embedded bonds is bound by the first option-exercise date and the final maturity date. Because interest-rate movements generally are milder than those described above, the maturity of an option-embedded bond usually lies somewhere between the first option-exercise date and the final maturity date. Therefore, the price sensitivity of an option-embedded bond lies somewhere between that of a bond priced to final maturity and that of a bond priced to the earliest exercise date.

The following sections describe how the price/yield behavior of a bond with an embedded put or call option may be visualized in relation to the price/yield sensitivities of bonds at either end of the maturity boundaries. We will then extend the analysis to encompass put/call parity, which is helpful in understanding the effects of price/yield sensitivity on duration and OAS. As we will see, the put/call parity relationship inherent in option-embedded bonds is key to understanding the effects of interest-rate volatility on the duration and yield of option-embedded bonds.

The Price/Yield Relationship of Callable Bonds

A callable bond may be viewed as a portfolio consisting of two positions: a long position in an underlying noncallable bond and a short position in a call option. This relationship is illustrated in the following pricing equation:

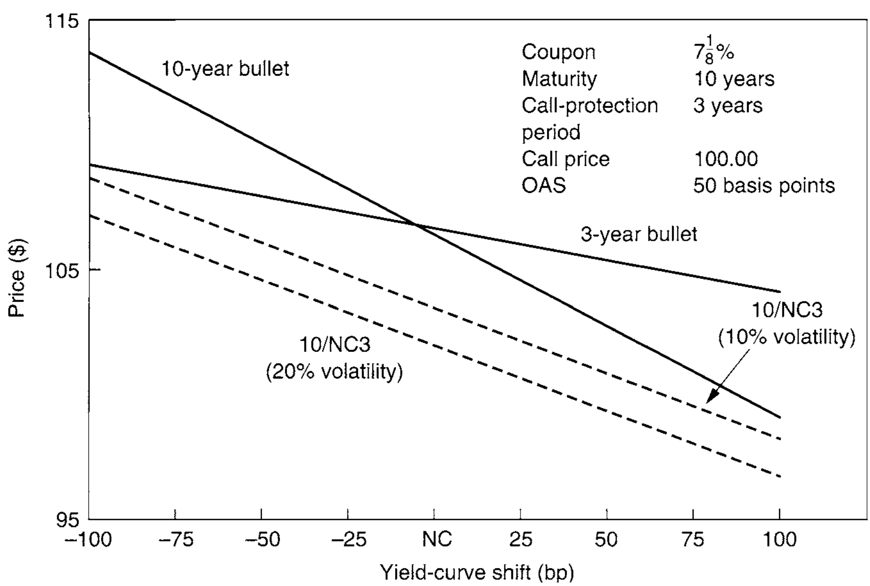
$$\text{Callable bond} = \text{underlying bond} - \text{call option} \tag{39–1}$$

From the equation we can see that if interest rates fall, the price of the underlying bond increases as if it were a bullet bond. However, the magnitude of the overall price increase for the callable bond is limited by a corresponding increase in the value of the call option. If interest rates fall very far, the callable bond's price appreciation will be limited to that of a short-term bond with a maturity that is approximately equal to the option-exercise date.

Exhibit 39–1 shows how the price of a 10-year bond with three years of call protection is affected by changes in interest rates. For this bond, the longest possible maturity is the 10-year final maturity and the shortest term to maturity is

EXHIBIT 39–1

Price Behavior of Hypothetical 10-Year Callable Bond with Three Years of Call Protection



three years, the earliest option-exercise date. Therefore, Exhibit 39–1 also shows price/yield curves for three- and 10-year bullet bonds. At very high yield levels, the callable bond's price/yield curve approaches that of the 10-year bullet bond. This is so because the call option's value decreases as interest rates move higher and higher. As the value of the option declines, the price behavior of the callable bond increasingly resembles that of the bullet bond with the same final maturity date as the callable bond. Conversely, if interest rates fall, the callable bond's price/yield curve becomes more like that of the three-year bullet bond because the likelihood of option exercise increases.

Effect of Volatility on Callable-Bond Pricing

Exhibit 39–1 also indicates that the callable bond's price behavior is a function of interest-rate volatility. As volatility increases from 10% to 20%, the call option's value increases and the price of the callable bond correspondingly decreases. Thus the callable bond's price/yield curve at 20% volatility lies below the bond's price/yield curve at 10% volatility, reflecting a greater degree of negative convexity at the higher volatility levels.

At any given yield level, the vertical distance between the price/yield curves of the callable bond and the underlying noncallable 10-year bond is a reflection of the value of the call option. As volatility increases, the option value also increases, as indicated by the increasing distance between the price/yield curves.

The Price/Yield Relationship of Putable Bonds

A putable bond may be viewed as a portfolio of a long position in an underlying noncallable bond plus a long position in a put option, as shown in the following relationship:

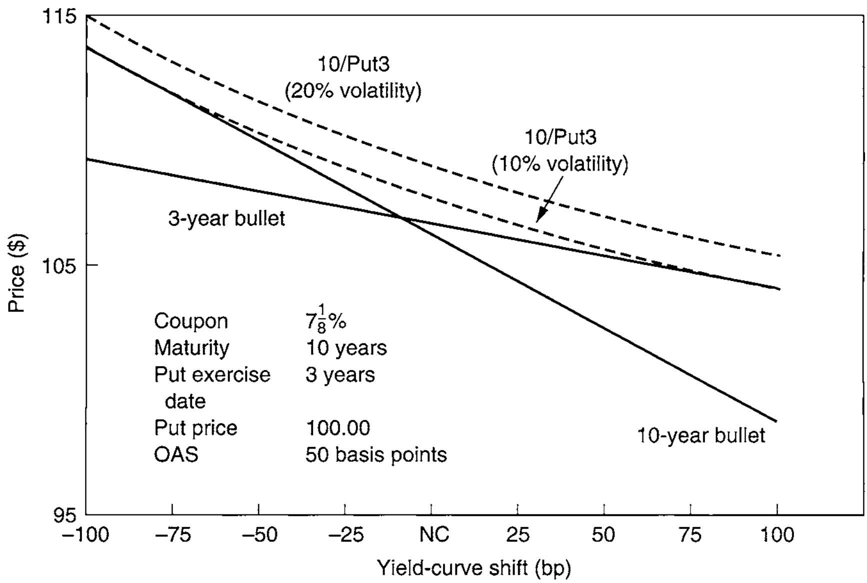
$$\text{Putable bond} = \text{underlying bond} + \text{put option} \tag{39–2}$$

The equation illustrates that if interest rates rise, the price of the underlying bond decreases, but the magnitude of the overall price decrease of the put bond itself is mitigated by an increase in the value of the put option. If interest rates rise sharply, then the price depreciation of the putable bond will be limited to that of a short-term bond maturing on the putable bond's exercise date. Thus the put option cushions the putable-bond holder's downside risk.

Exhibit 39–2 shows the analogous price/yield curves of a 10-year bond with a put option that may be exercised in three years at two different levels of interest-rate volatility (10% and 20%). The price/yield curves for the associated 3- and 10-year bullet bonds also are shown. As yields increase, the price/yield curve for the putable bond approaches that of the three-year bullet bond due to the growing likelihood of option exercise. Conversely, if interest rates fall, then the price/yield curve of the putable bond approaches that of the 10-year bullet because the economic incentive to exercise the put option decreases.

EXHIBIT 39–2

Price Behavior of Hypothetical 10-Year Putable Bond with Put Exercisable in Three Years



Effect of Volatility on Putable-Bond Pricing

As with a callable bond, the shape and level of the price/yield curve for a putable bond is a function of interest-rate volatility. Exhibit 39–2 shows that as volatility increases, the option value increases and, consequently, the price of the putable bond increases. Thus the putable bond's price/yield curve at the 20% volatility level lies above the bond's price/yield curve at 10% volatility.

The next section expands on the concept of viewing option-embedded bonds as portfolios of bonds and options by reviewing the concept of put/call parity. Put/call parity is helpful in further understanding the price/yield relationship and relative valuation of option-embedded bonds.

Put/Call Parity

Put/call parity is an important relationship in option-pricing theory that relates the price of a put option to the price of a call option. As applied to option-embedded bonds, the relationship illustrates that a position in either a callable bond or a putable bond may be viewed in two equivalent ways. We will examine a callable bond first and then a putable bond.

A callable bond may be viewed as a portfolio consisting of a long position in a bond and a short position in an option (notice that we did not specify the type of option).

For example, a 10-year callable bond with three years of call protection may be viewed as a portfolio consisting of a long position in a 10-year bullet bond and a short position in a call option exercisable by the issuer in three years. Under the principles of put/call parity, the same callable-bond position may be viewed as a long position in a three-year bullet bond and a short position in a put option, where the issuer has the right to put a seven-year bullet bond to the investor in three years. Equation (39–3) reflects the duality of the option embedded in a callable bond:

$$\begin{aligned}&\text{Long-maturity bullet bond} - \text{call option}\\&\quad = \text{short-maturity bullet bond} - \text{put option}\end{aligned} \tag{39–3}$$

Similarly, a putable bond may be viewed as a portfolio consisting of a long position in a bullet bond and a long position in an option (notice again that we did not specify the type of option).

For example, a 10-year bond with a put option exercisable in three years may be viewed as a portfolio consisting of a long position in a 10-year bullet bond and a long position in a put exercisable in three years. (This pricing concept is similar to the one we introduced in the section on price/yield relationships of putable bonds.) Alternatively, the same putable bond may be viewed as a portfolio of a long position in a three-year bullet bond and a long position in a call option that gives the bondholder the right to call a seven-year bullet bond away from the issuer. This pricing relationship is shown in Eq. (39–4).

$$\begin{aligned}&\text{Long-maturity bullet bond} + \text{put option}\\&\quad = \text{short-maturity bullet bond} - \text{call option}\end{aligned} \tag{39–4}$$

Note that Eq. (39–4) may be derived by rearranging Eq. (39–3), which simply reflects the change from a short option position in a callable bond to a long option position in a putable bond.

EFFECTIVE DURATION

The objective of effective duration is to quantify an option-embedded bond's price sensitivity to changes in interest rates. If we calculate a security's price for a small change in interest rates (e.g., plus or minus 25 basis points), then the percentage change in price for this specified change in rates represents the bond's effective duration.

Effective-Duration Calculations

An OAS model calculates the value of an option-adjusted spread for a given market price for a security. For small parallel shifts in the yield curve, the prices that

EXHIBIT 39–3

Effective Duration of FHLMC $7^5/_8$ of 9/9/09 Callable at Par from 9/9/02*

Issuer	FHLMC
Coupon	7.65%
Maturity	9/9/09
Call date	9/9/02
Call price	100.000
Price	99.689
Accrued interest	0.000
Yield	7.67
OAS	89 basis points

Effective duration using yield-curve shift

$$= \frac{10{,}000}{\text{price} + \text{accrued}} \times \frac{\text{price up} - \text{price down}}{\text{total shift in yield curve}}$$

$$= \frac{10{,}000}{99.689} \times \frac{100.862 - 98.522}{50}$$

$$= 4.69$$

*Price as of September 2, 1999.
Source: Prudential Securities.

correspond to the same OAS are the security's constant-OAS prices. The effective duration is then found from the expression shown in Eq. (39–5):

$$\text{Effective duration} = \frac{10{,}000}{\text{price} + \text{accrued}} \times \frac{(\text{price up} - \text{price down})}{(\text{total shift in yield curve})} \tag{39–5}$$

where

price = market price of security
accrued = accrued interest
price up = constant-OAS security price for downward yield-curve shift
price down = constant-OAS security price for upward yield-curve shift
total shift = total range of yield-curve shift (in basis points)

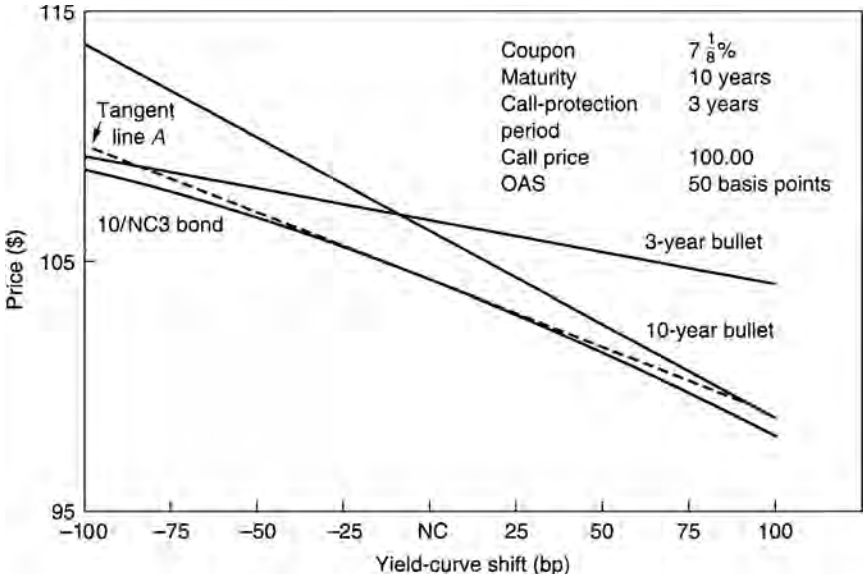
Exhibit 39–3 shows the computation of effective duration.

Effective Duration of Callable Bonds

Just as the slope of the tangent line to a bullet bond's price/yield curve is a measure of the bond's modified duration, the slope of the tangent line to a callable bond's price/yield curve is a measure of the callable bond's effective (modified)

EXHIBIT 39–4

Effective Duration of Hypothetical 10-Year Callable Bond with Three Years of Call Protection



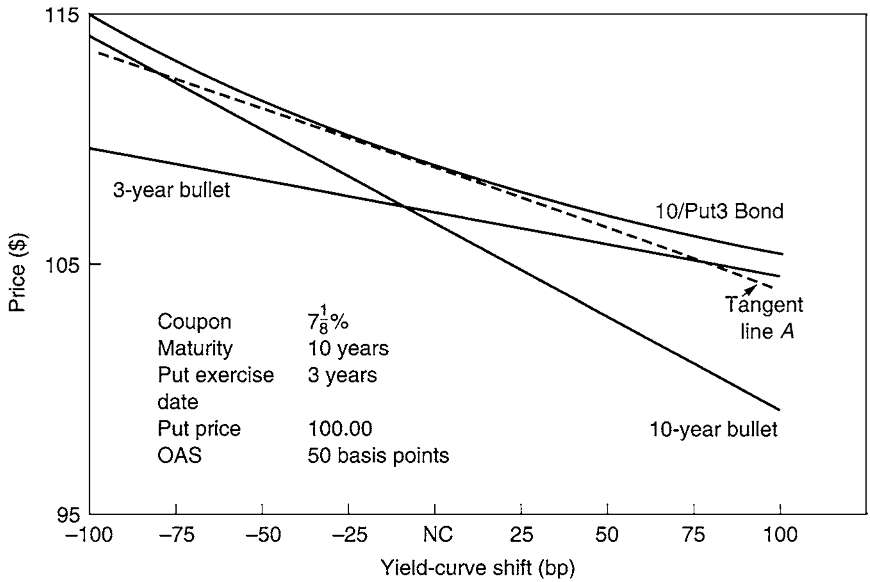
duration. Exhibit 39–4 illustrates that the slope of the line tangent to the callable bond's price/yield curve (tangent line *A*) is between that of the two reference noncallable bonds. This indicates that a callable bond's effective duration is bounded by the modified durations of the noncallable bonds. As interest rates either move up or down, the slope of tangent line *A* correspondingly approaches that of the appropriate noncallable bond.

The Effect of Selling Call Options on Duration

Equation 39–1 illustrates how a change in interest rates affects the duration of a callable bond. If the 10-year callable bond in Exhibit 39–4 is viewed as a portfolio of a long position in a 10-year bullet bond and a short position in a call option exercisable in three years, the decreasing slope of tangent line *A* as interest rates fall shows that selling a call option decreases a portfolio's duration. Conversely, when rates rise, the call option is not exercised so that, in effect, the option holder (the issuer) has elected to put the bond to the bondholder. In this case, the increasing slope of tangent line *A* indicates that selling a put option increases the portfolio's duration when rates rise. In either case of extreme interest-rate movements (plus or minus 100 basis points in Exhibit 39–4), the duration of the portfolio changes in a way that is adverse to the seller of the option (the investor). Hence the portfolio (i.e., the callable bond) is negatively convex.

EXHIBIT 39–5

Effective Duration of Hypothetical 10-Year Putable Bond with Put Exercisable in Three Years



Effective Duration of Put Bonds

Exhibit 39–5 illustrates that the slope of tangent line *A*, which is tangent to the putable bond's price/yield curve, also falls between the slopes of curves of the two underlying bullet bonds. Thus the putable bond's effective duration lies between the durations of the reference bullet bonds. This indicates that although a putable bond may be priced to the put date, its effective duration is at least as high as that of the comparable bullet bond maturing on or near the put date.

The Effect of Buying Put Options on Duration

Similar to callable bonds, the effect of interest-rate changes on a putable bond's duration is illustrated by the relationship shown in Eq. (39–2). If the 10-year putable bond shown in Exhibit 39–5 is viewed as a portfolio consisting of a long position in a 10-year bullet bond plus a long position in a put option exercisable in three years, the decreasing slope of tangent line *A* when interest rates rise shows that buying a put option decreases a portfolio's duration. Conversely, when rates fall, the put option is not exercised, so the holder of the option (the bondholder) has essentially elected to call the bond. In this case, the increasing slope of tangent line *A* indicates that purchasing a call option increases the portfolio's duration when rates drop. In either case of extreme interest-rate movements, the duration of the portfolio changes in a way that benefits the holder of the option (the investor). Thus the portfolio (i.e., the putable bond) is positively convex.

EFFECTIVE MATURITY

Once the effective duration of an option-embedded bond is calculated, it is possible to construct a bullet bond with a modified duration equal to the effective duration of the option-embedded bond. This allows an option-embedded bond's price sensitivity to be expressed in terms of properties that are well understood for bullet bonds. The option-embedded bond's *effective maturity* is stated in terms of the maturity of the duration-matched bullet with the same coupon payments and payment dates.[1] Furthermore, if the option-embedded bond has a premium call schedule that declines to par over time, then the bullet bond's redemption value on the effective maturity date is equal to the call option's exercise price.

For example, a par-priced, 10-year bond that is callable for the last seven years at par may have the price sensitivity of a seven-year bullet bond even though the original bond is priced relative to the 10-year Treasury note. Thus the effective maturity of this callable bond is seven years. Bonds that are more likely to be called, perhaps due to a higher coupon or to an earlier call date, may have shorter effective maturities than bonds that are less likely to be called. Conversely, high-coupon, premium-priced putable bonds, whose put options are less likely to be exercised, may have longer effective maturities than bonds that are more likely to be put, such as deep-discount bonds.[2]

Exhibit 39–6 compares the price/yield curves of a 10-year callable bond with three years of call protection and its duration-matched bullet bond. For relatively small changes in interest rates, the price/yield curves are very close to one another. For larger interest-rate movements, the two price/yield curves begin to diverge as the callable bond's negative convexity begins to dominate.

Exhibit 39–7 displays the effective maturities of a hypothetical 10-year bond, callable at par in three years at two different yield volatilities. Because the value of the call option generally increases with higher volatilities, the negatively convex nature of callable securities is more apparent at 20% volatility than at 10% volatility, as shown by its lower effective maturities. Note, however, that there is a combination of interest-rate shifts and volatilities in which the two

1. The effective maturity date is found by an iterative process in which the maturity date of the duration-matched bullet bond is varied until the modified duration of this bullet bond is equal to the original bond's effective duration.

2. Although the calculation of effective maturity takes into account the range of possible interest rates in the future, the effective maturity does not strictly equal the expected maturity, which is the probability-weighted maturity. In contrast, the effective maturity is the maturity of the duration-matched bullet.

EXHIBIT 39–6

Price/Yield-Curve Comparison of Hypothetical 10/NC3 Bond and Its Duration-Matched Bullet Bond

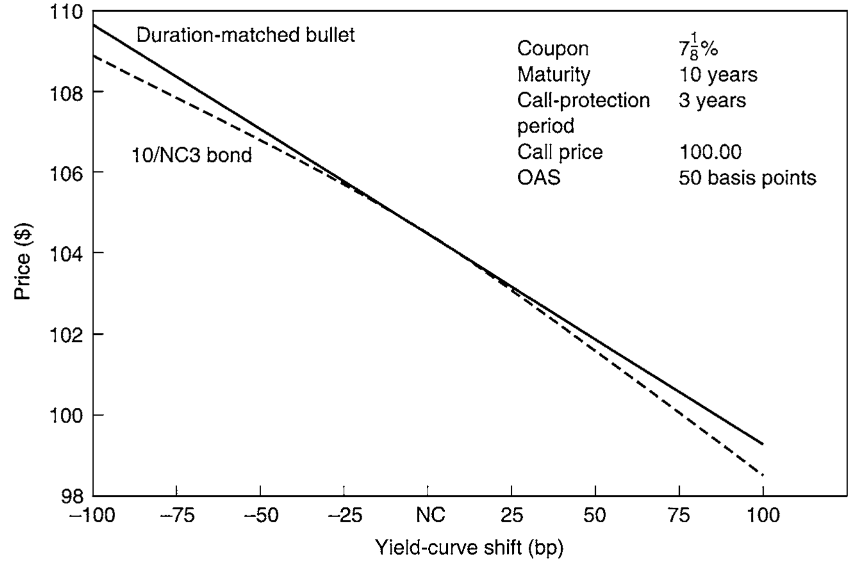
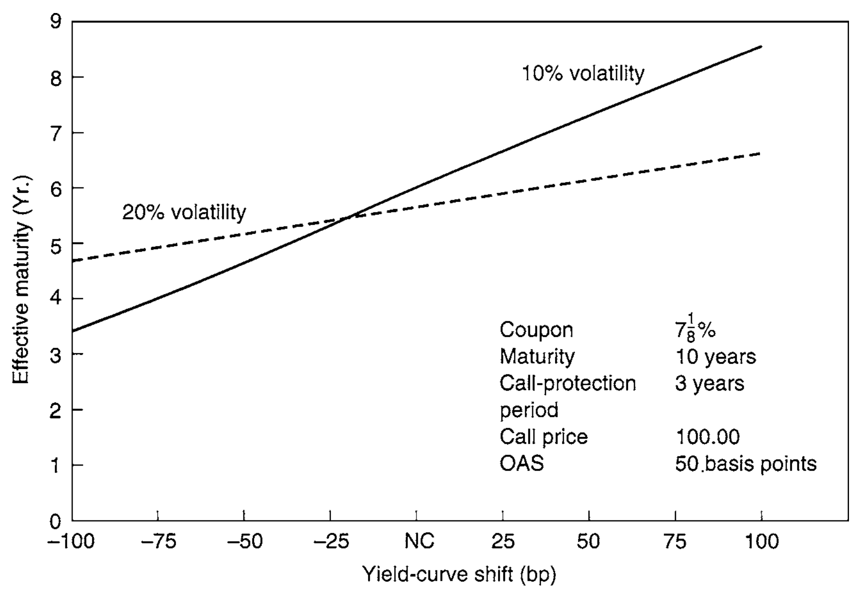


EXHIBIT 39–7

Effective Maturity of 10/NC3 Bond as a Function of Volatility and Yield-Curve Shifts



effective maturity plots cross each other. This occurs at lower interest-rate levels and reflects the situation in which a higher interest-rate volatility actually increases the likelihood that rates may increase.

OPTION-ADJUSTED SPREADS

Up to this point our discussion has centered on using a bond's price sensitivity to interest-rate changes as one measure of risk. Now we'll switch our focus to the other side of the risk/reward equation and consider the OAS an investor receives as compensation for assuming a variety of risks. It is important to note that an OAS value by itself does not provide sufficient information to determine whether a bond is rich or cheap. The OAS and effective duration of one security must be compared with those of another security. In the absence of such a context, it is difficult to assess accurately the relative value between two securities.

For example, a common question that arises about OAS is the point along the maturity spectrum that should be used as a reference point. Should the OAS be viewed as an adjusted yield spread relative to the option-embedded bond's maturity date or its call /put date? Should the OAS of a 10-year callable bond with three years of call protection be compared with the spread of a three-year bullet bond or a 10-year bullet bond? Furthermore, if the callable bond has an effective maturity of seven years, should the OAS be compared to the yield spread of a seven-year bullet bond? Quantitative fixed income analysts usually say yes to all of the preceding because OAS is a spread to the curve.

The view that OAS is a spread over the curve is based on the definition of OAS: *OAS is the spread to short-term interest rates that equates the theoretical price of a bond to its market price.*

It can be demonstrated mathematically that the preceding definition of OAS results in a parallel shift of the entire zero-coupon (spot-yield) curve by an amount equal to the OAS. Thus, in a sense, the OAS is a spread over the entire curve.

A less technical and perhaps more intuitive way of viewing OAS as a spread to the curve is to consider the duality of embedded options in terms of put/call parity. For example, callable bonds usually are quoted either on a yield-to-maturity basis or a yield-to-call basis, depending on the level and direction of interest rates. If interest rates are high or moving higher, then the issuer is unlikely to call the bond. By electing not to exercise the call option, the issuer has effectively put the bond to the investor.

Thus, even though a bond is quoted on a yield-to-maturity basis, a corresponding yield-to-call spread exists. Because the OAS is an adjustment to the nominal yield spread, the OAS can be viewed as the result of the appropriate adjustments to *both* the yield-to-maturity and yield-to-call spreads. In this view, the OAS is an adjusted spread to both the maturity date and the call date. The following equations demonstrate this relationship:

$$\text{OAS} = \text{yield-to-maturity spread} - \text{call-option value in basis points} \qquad (39\text{–}6)$$

or

$$\text{OAS} = \text{yield-to-call spread} - \text{put-option value in basis points} \qquad (39\text{–}7)$$

Moreover, if the option is American style (i.e., the option can be exercised at any time during a specified period), then the OAS may be viewed as an adjusted yield spread over an entire range of call dates.

In considering which point on the yield curve is most appropriate for comparison of OASs to bullet yield spreads, a common first approximation is that the OAS should be compared to the yield spread of the bullet bond whose final maturity is comparable with the effective maturity of the bond with embedded options. Because OAS and effective maturity are risk/reward measures, it is reasonable to determine whether the particular value of OAS is sufficient compensation for an approximately equivalent amount of risk (when compared with the comparable bullet yield spread). For example, if the OAS of the callable 10-year bond is 100 basis points and the effective maturity is seven years, it is reasonable to first compare the OAS to the yield spread of a seven-year bullet from the same or very similar issuer. However, this approach serves only as a general rule, and there are other important factors that enter into the determination of relative value.

Looking Beyond the OAS and Effective Duration Numbers

A common assumption is that comparable bonds with comparable effective durations should have comparable OASs. The result of this view is that bonds with higher OASs are perceived to represent better value. However, a variety of other factors should be considered before rendering a judgment about the relative richness or cheapness between the two securities.

Effect of Exogenous Factors

The technology embedded within an OAS model may be very sophisticated, but a not-too-commonly discussed point is that OAS models quantify the value of the embedded option only within the context of the model's underlying assumptions. By assuming an interest-rate process and a given randomness in interest rates, the value of the option is calculated. Then the OAS is, roughly speaking, the effective yield spread after adjusting for the value of the embedded option. Consequently, the effective yield spread implicitly reflects the host of other considerations (beyond that of the embedded option) that factor into the marketplace's pricing of the bond.

Exogenous factors such as supply and demand in particular market sectors and current investor preferences can cause one bond to be cheap to another bond on an OAS basis. Just as two comparable bullet securities can trade at different yield spread levels, comparable bonds with embedded options can trade at different OASs relative to each other or relative to equivalent-duration bullets. Thus, although there may be circumstances in which two bonds may trade at approximately the same OAS, there can be fundamental factors causing the bonds to trade at substantially different OASs.

Effect of Convexity

The comparison of the OAS versus the effective duration of two bonds provides insight into the local price sensitivities of the securities to changes in interest rates only. For relatively small changes in interest rates, two securities with similar effective durations should have similar price sensitivities. However, as interest rates move significantly, the effective durations of the two securities may no longer be comparable, so any convexity dissimilarities between the two securities begin to take effect. See Exhibit 39–6 (price/yield curve comparison between a callable bond and a bullet bond).

The effective duration number (in the absence of other information) does not highlight, for example, the possibility that a 30-year callable bond with an effective maturity of 10 years can still extend out to 30 years if interest rates rise steadily. Conversely, if interest rates decrease significantly, the effective duration continues to decrease so that the price appreciation of the callable bond is even more muted. The bond's negative convexity, which is a result of the bondholder's selling of options, reflects the potential downside of a short-option position in a volatile interest-rate environment.

Generally, the length of the investment horizon and the outlook on interest rates influence the extent to which investors may be concerned about the magnitude of the convexity effect. If the investment horizon is short and if interest rates are viewed as being stable over that time period, an investor may not be very concerned about the convexity effect. On the other hand, if the horizon spans a longer period of time, long-term price performance and convexity become larger issues. In this latter case, investors may need to be compensated for the greater exposure to negative convexity through a higher OAS, even though the two securities being compared currently may have similar effective durations.

Exhibit 39–8 illustrates such a situation in which two comparable securities do not have similar OASs. In this case, two callable FHLMC bonds with similar final maturities have different OASs. At a 15.8% yield volatility, the 7⅝s have an OAS of 89 basis points, as compared with the OAS of 85 basis points for the 6.45s.

The difference in OAS can be attributed to several competing factors that act to influence the pricing of these securities. First, securities with shorter effective durations tend to have lower OASs than securities with higher effective durations, simply to reflect the trend observed for bullet securities that yield spreads increase with increasing maturities. (This OAS trend would be most evident for securities that clearly trade either to the maturity date or to the option-exercise date.) On this basis, it can be argued that the 7⅝s should have the lower OAS.

On the other hand, for securities with intermediate effective durations (such as the FHLMC 7⅝s), it is not obvious whether the security will be called or remain outstanding to final maturity. Hence it also can be argued that as compensation for the greater degree of uncertainty, the 7⅝s should have a higher OAS

EXHIBIT 39–8

OAS and Effective-Duration Comparison

Issuer	FHLMC	FHLMC
Coupon	7.625%	6.45%
Maturity	9/9/09	4/29/09
Call date	9/9/02	4/29/02
Call price	$100.00	$100.00
Issue size	$1,000 MM	$3,000 MM
Price*	$99.689	$94.389
OAS (15.8% yield volatility)	89 bp	85 bp
Effective maturity	6.06 years	7.06 years
Effective duration	4.69	5.32 years

*Prices as September 2, 1999.
Source: Prudential Securities.

than do the 6.45s. In the final analysis, the higher OAS of the 7⅝s indicates that the market currently demands greater compensation for the maturity uncertainty than for the duration risk.

SUMMARY

Bonds with embedded options and bullet securities can respond very differently to movements in interest rates. Investors may use the analytical concepts of OAS and effective duration to help gauge the relative risk/reward trade-offs across a range of assets to determine relative value. OAS and effective duration can be useful analytical tools, but investors need to recognize that there can be a variety of fundamental and analytical reasons that may cause two comparable securities to trade at widely different OASs.

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CHAPTER

FORTY

A FRAMEWORK FOR ANALYZING YIELD-CURVE TRADES

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In Chapter 8, it was explained that the shape of the yield curve depends on three main determinants: the market's rate expectations, the required bond risk premia, and the convexity bias. In this chapter we show how to decompose the forward rate curve into these three determinants. Even though we cannot observe these determinants directly, the decomposition can clarify our thinking about the yield curve.

Our analysis also produces direct applications—it provides a systematic framework for relative-value analysis of noncallable government bonds. Analogous to the decomposition of forward rates, the total expected return of any government bond position can be viewed as the sum of a few simple building blocks: (1) the yield income, (2) the rolldown return, (3) the value of convexity, and (4) the duration impact of the rate view. A further term should be added for bonds that trade "special" in the repo market and for bonds that trade very rich or cheap against the fitted curve.

The following observations motivate this decomposition. A bond's near-term expected return is a sum of its horizon return given an unchanged yield curve and its expected return from expected changes in the yield curve. The first item, the horizon return, is also called the *rolling yield* because it is a sum of the bond's yield income and the rolldown return (the capital gain that the bond earns because its yield declines as its maturity shortens and it "rolls down" an upward-sloping yield curve). The second item, the expected return from expected changes in the yield curve, can be approximated by duration and convexity effects. The duration impact is zero if the yield curve is expected to remain unchanged, but it may be the main source of expected return if the rate predictions are based on an investor's or economist's market view or on a quantitative forecasting model.

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The value of convexity is always positive and depends on the bond's convexity and on the perceived level of yield volatility.

We argue that both prospective and historical relative-value analysis should focus on near-term expected-return differentials across bond positions instead of on yield spreads. The former measures are more comprehensive in the sense that they take into account all sources of expected return. Moreover, they provide a consistent framework for evaluating all types of government bond positions. We also show, with practical examples, how various expected-return measures are computed and how our framework for relative-value analysis is related to the better-known scenario analysis.

FORWARD RATES AND THEIR DETERMINANTS

Chapter 8 shows that the yield curve can be represented in either par rates, spot rates, or forward rates. Whichever representation is used, there are three main determinants of the yield curve that we discuss next.

How Do the Main Determinants Influence the Yield-Curve Shape?

We describe here how the market's rate expectations, the required bond risk premia,[1] and the convexity bias influence the term structure of interest rates. The market's expectations regarding the future interest-rate behavior probably are the most important influences on today's term structure. Expectations for parallel increases in yields tend to make today's term structure linearly upward sloping, and expectations for falling yields tend to make today's term structure inverted. Expectations for future curve flattening induce today's spot- and forward-rate curves to be concave (functions of maturity), and expectations for future curve steepening induce today's spot- and forward-rate curves to be convex.[2] These are the facts, but what is the intuition behind these relationships?

The traditional intuition is based on the pure expectations hypothesis. In the absence of risk premia and convexity bias, a long rate is a weighted average of the expected short rates over the life of the long bond. If the short rates are

1. The *bond risk premium* is defined as a bond's expected (near-term) holding-period return in excess of the riskless short rate. Historical experience suggests that long-term bonds command some risk premium because of their greater perceived riskiness. However, our term *bond risk premium* also covers required return differentials across bonds that are caused by other reasons than risk, such as liquidity differences, supply effects, or the market sentiment.

2. A concave (but upward-sloping) curve has a steeper slope at short maturities than at long maturities; thus a line connecting two points on the curve is always below the curve. A convex (but upward-sloping) curve has a steeper slope at long maturities than at short maturities; thus a line connecting two points on the curve is always above the curve.

expected to rise, the expected average future short rate (i.e., the long rate) is higher than the current short rate, making today's term structure upward-sloping. A similar logic explains why expectations of falling rates make today's term structure inverted. However, this logic gives few insights about the relation between the market's expectations regarding future curve reshaping and the curvature of today's term structure.

Another perspective to the pure expectations hypothesis may provide a better intuition. The absence of risk premia means that all bonds, independent of maturity, have the same near-term expected return. Recall that a bond's holding-period return equals the sum of the initial yield and the capital gains/losses that yield changes cause. Therefore, if all bonds are to have the same expected return, initial yield differentials across bonds must offset any expected capital gains/losses. Similarly, each bond portfolio with expected capital gains must have a yield disadvantage relative to the riskless asset. If investors expect the long bonds to gain value because of a decline in interest rates, they accept a lower initial yield for long bonds than for short bonds, making today's spot- and forward-rate curves inverted. Conversely, if investors expect the long bonds to lose value because of an increase in interest rates, they demand a higher initial yield for long bonds than for short bonds, making today's spot- and forward-rate curves upward-sloping. Similarly, if investors expect the curve-flattening positions to earn capital gains because of future curve flattening, they accept a lower initial yield for these positions. In such a case, barbells would have lower yields than duration-matched bullets (to equate their near-term expected returns), making today's spot- and forward-rate curves concave. A converse logic links the market's curve-steepening expectations to convex spot- and forward-rate curves.

The preceding analysis presumes that all bond positions have the same near-term expected returns. In reality, investors require higher returns for holding long bonds than short bonds. Many models that acknowledge bond risk premia assume that they increase linearly with duration (or with return volatility) and that they are constant over time. Empirical evidence contradicts both assumptions.[3] Historical average returns increase substantially with duration at the front end of the curve but only modestly beyond intermediate durations. Thus the bond risk premia make the term structure upward-sloping and concave, on average. Moreover, it is possible to forecast when the required bond risk premia are abnormally high or low. Thus the time variation in the bond risk premia can cause significant variation in the shape of the term structure.

Convexity bias refers to the impact that the nonlinearity of a bond's price/yield curve has on the shape of the term structure. This impact is very small at the front end but can be quite significant at very long durations. A positively

3. This evidence is discussed in Antti Ilmanen, "Does Duration Extension Enhance Long-Term Expected Returns?" *Journal of Fixed Income* (September 1996), pp. 23–36; and Antti Ilmanen, "Forecasting U.S. Bond Returns," *Journal of Fixed Income* (June 1997), pp. 22–37.

convex price/yield curve has the property that a given yield decline raises the bond price more than a yield increase of equal magnitude reduces it. All else equal, this property makes a high-convexity bond more valuable than a low-convexity bond, especially if the volatility is high. It follows that investors tend to accept a lower initial yield for a more convex bond because they have the prospect of enhancing their returns as a result of convexity. Because a long bond exhibits much greater convexity than a short bond, it can have a lower yield and yet offer the same near-term expected return. Thus, in the absence of bond risk premia, the convexity bias would make the term structure inverted. In the presence of positive bond risk premia, the convexity bias tends to make the term structure humped—because the negative effect of convexity bias overtakes the positive effect of bond risk premia only at long durations. An increase in the interest-rate volatility makes the bias stronger and thus tends to make the term structure more humped.

The three determinants influence the shape of the term structure simultaneously, making it difficult to distinguish their individual effects. Despite a widespread misconception, the shape of the term structure does not reflect only the market's rate expectations. Forward rates are good measures of the market's rate expectations only if the bond risk premia and the convexity bias can be ignored. This is hardly the case, even though a large portion of the short-term variation in the shape of the curve probably reflects the market's changing expectations about the future level and shape of the curve. The steepness of the curve on a given day depends mainly on the market's view regarding the rate direction, but in the long run, the impact of positive and negative rate expectations largely washes out. Therefore, the average upward slope of the yield curve is mainly attributable to positive bond risk premia. The curvature of the term structure may reflect all three components. On a given day, the spot-rate curve is especially concave (humped) if market participants have strong expectations of future curve flattening or of high future volatility. In the long run, the reshaping expectations should wash out, and the average concave shape of the term structure reflects the concavity of the risk premium curve and the convexity bias.

Decomposing Forward Rates into Their Main Determinants

Conceptually, each one-period forward rate can be decomposed to three parts: the impact of rate expectations, the bond risk premium, and the convexity bias. So far this statement is just an assertion. In this subsection we show intuitively why this relationship holds between the forward rates and their three determinants. We provide a more formal derivation in Appendix 40A (where we take into account the fact that the analysis is not instantaneous but that yield changes occur over a discrete horizon, during which invested capital grows). In Appendix 40B we tie some loose strings together by summarizing various statements about the forward rates and by clarifying the relations between these statements.

EXHIBIT 40–1

Splitting a Zero-Coupon Bond's One-Period Yield Change into Two Parts

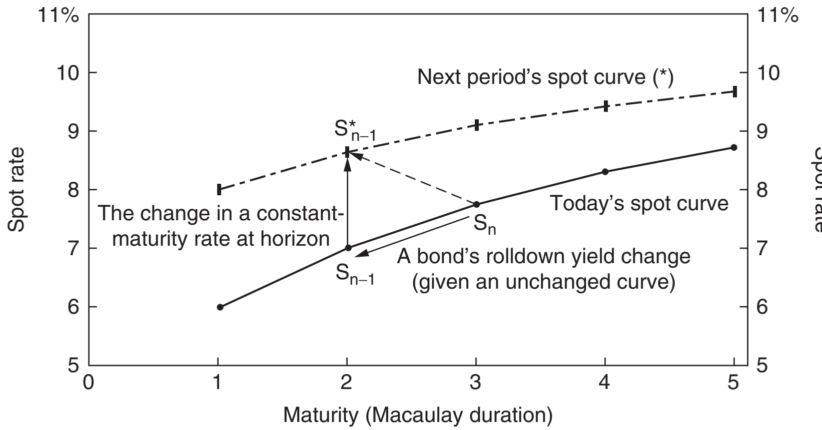


Exhibit 40–1 shows how the yield change of an n-year zero-coupon bond over one period (dashed arrow) can be split to the rolldown yield change and the one-period change in an $n - 1$ year constant-maturity spot rate $s_{n-1}(\Delta s_{n-1} = s^*_{n-1} - s_{n-1})$ (two solid arrows).[4] A zero-coupon bond's price can be split in a similar way (see Appendix 40A). Thus an n-year zero's holding-period return over the next period h_n is

$$h_n = \text{return if the curve is unchanged} + \text{return from the curve changes}$$
$$= \text{rolling yield} + \text{percentage price change (at horizon)}$$
$$\approx \text{(one-period) forward rate} + [(-\text{duration} \times \Delta s_{n-1}) + (0.5 \times \text{convexity} \times \Delta s_{n-1})^2] \quad (40\text{–}1)$$

Equation (40–1) is based on the following relations. First, a bond's one-period horizon return given an unchanged yield curve is called the *rolling yield*. A zero-coupon bond's rolling yield equals the one-period forward rate ($f_{n-1,n}$). For example, if the four-year (five-year) constant-maturity rate remains unchanged at 9.5% (10%) over the next year, a five-year zero bought today at 10% can be sold next year at 9.5% as a four-year zero; then the bond's horizon return is $1.10^5/1.095^4 - 1 = 0.1202 = 12.02\%$, which is the one-year forward rate between four- and five-year maturities [see Eq. (40–11) in Appendix 40B]. The second source of a zero's holding-period return, the price change caused by the yield-curve

4. All rates and returns in this chapter are expressed in percentage terms (200 basis points = 2%).

shift, is approximated very well by duration and convexity effects for all but extremely large yield-curve shifts.

It is more interesting to relate the forward rates to expected returns and expected rate changes than to the realized ones. We take expectations of both sides of Eq. (40–1), split the bond's expected holding-period return into the short rate and the bond risk premium, and recall that $E(\Delta s_{n-1})^2 \approx [\text{vol}(\Delta s_{n-1})]^2$. Then we can rearrange the equation to express the one-period forward rate as a sum of the other terms:

$$\text{Forward rate} \approx \text{short rate} + \text{duration} \times E(\Delta s_{n-1}) + \text{bond risk premium} + \text{convexity bias} \qquad (40\text{–}2)$$

where bond risk premium = $E(h_n - s_1)$, and convexity bias ≈ $-0.5 \times$ convexity × $[\text{vol}(\Delta s_{n-1})]^2$.

If we move the short rate to the left-hand side of the equation, we decompose the "forward-spot premium" $(f_{n-1,n} - s_1)$ into a rate-expectation term, a risk-premium term, and a convexity term (see Eq. 40–10 in Appendix 40A). We interpret the expectations in Eq. (40–2) as the market's rate and volatility expectations and as the expected risk premium that the market requires for holding long-term bonds. The market's expectations are weighted averages of individual market participants' expectations.

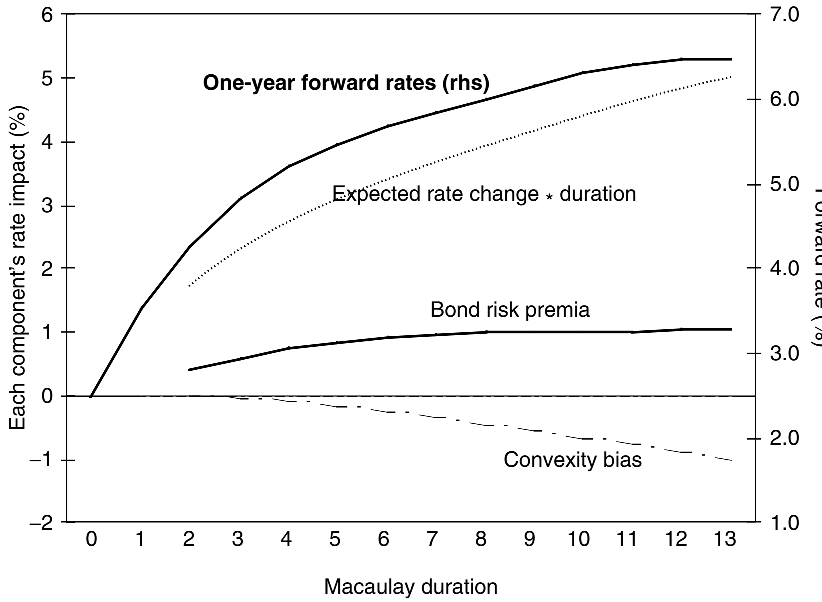
Some readers may wonder why our analysis deals with forward rates and not with the more familiar par and spot rates. The reason is the simplicity of the one-period forward rates. A one-period forward rate is the most basic unit in term-structure analysis, the discount rate of one cash flow over one period. A spot rate is the average discount rate of one cash flow over many periods, whereas a par rate is the average discount rate of many cash flows—those of a par bond—over many periods. All the averaging makes the decomposition messier for the spot rates and the par rates than it is for the one-period forward rate in Eq. (40–2). However, because the spot and the par rates are complex averages of the one-period forward rates, they too can be decomposed conceptually into the three main determinants.

Because the approximate decomposition in Eq. (40–2) is derived mathematically without making specific economic assumptions, it is true in general. In reality, however, it is hard to make this decomposition because the components are not observable and because they vary over time. Further assumptions or proxies are needed for such a decomposition. In Exhibit 40–2 we use historical average returns to compute the bond risk premia and historical rate volatilities to compute the convexity bias—together with the observable market forward rates (as of April 2004)—and back out the only unknown term in Eq. (40–2): the expected spot-rate change times duration. We also could divide this term by duration to infer the market's rate expectations. The rate expectations that we back out in Exhibit 40–2 suggest that the market expects rising short rates but less than forwards imply.

If bond risk premia vary over time, the use of historical average risk premia may be misleading. As an alternative, we can use survey data or rate predictions

EXHIBIT 40–2

Decomposing Forward Rates into Their Components Using Historical Average Risk Premia and Volatilities



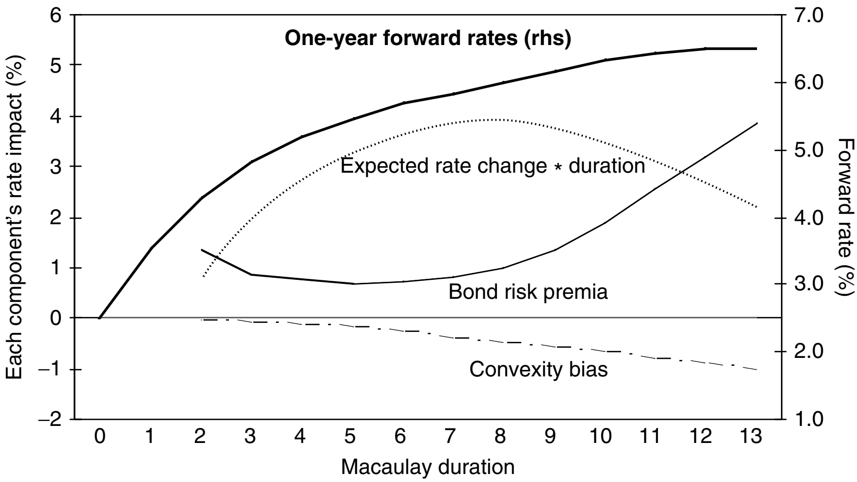
Note: The one-year forward rates are based on the dollar swap curve in April 2004. The bond risk premia are based on the historical arithmetic average returns of various maturity-subsector bond portfolios between 1972–2001, expressed in excess of the riskless one-year return. The convexity bias is based on the historical volatilities of various maturity swaps in 2004. The rate expectation term for each duration is then backed out as the difference—one-year forward rate – one-year spot rate – bond risk premium – convexity bias.

based on a quantitative forecasting model to proxy for the market's rate expectations. In Exhibit 40–3, we use a hypothetical consensus interest-rate forecast that predicts a bear flattening (yields rising 100 basis points at the two-year maturity and 20 basis points at ten years). In addition, we use implied volatilities from swaption prices to compute the convexity bias. These components can be used together with the one-year forward rates to back out estimates of the unobservable bond risk premia.

A comparison of Exhibits 40–2 and 40–3 shows that the two decompositions look similar at short durations but different at intermediate and long durations. The similarity of the convexity bias components in these two exhibits suggests that the use of historical or implied volatilities makes little difference, at least in this case. The hypothetical survey's yield-curve view implies a relatively poor performance of intermediate-duration assets (low expected excess return) and a good performance by the longest assets (whose yields are expected to be stable). Because the forward-rate curve is the same

EXHIBIT 40–3

Decomposing Forward Rates into Their Components Using Hypothetical Survey Rate Expectations and Implied Volatilities



Note: The one-year forward rates are based on the dollar swap curve in April 2004. The market's rate expectations are proxied by a hypothetical consensus interest-rate forecast. The convexity bias is based on the implied basis point volatilities from swaption prices. The bond risk premium for each duration is then backed out as the difference—one-year forward rate – one-year spot rate – expected rate change × duration – convexity bias.

in both exhibits, any smaller predicted rate increases lead to higher bond risk premia in Exhibit 40–3 than in Exhibit 40–2.[5]

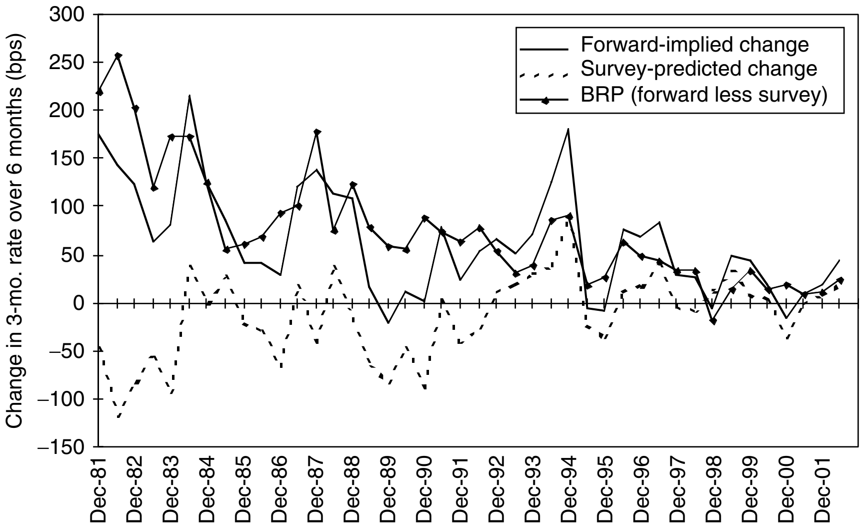
Exhibits 40–2 and 40–3 are snapshots of the forward rates and their components on one date. A comparison of similar decompositions over time would provide insights into the relative variability of each component. In Exhibit 40–4, we try to illustrate the impact of changing rate expectations and risk premia on the steepness of the U.S. Treasury bill curve based on a semiannual survey of economists' rate forecasts. The exhibit shows that the forwards almost always implied larger increases in the three-month rate than the market expected, based on surveys of bond market analysts. The difference is proportional to the required bond risk premium of longer bills over shorter bills (because bills exhibit negligible convexity, its impact can be ignored). This difference clearly varies over time.

The time variation in the survey-based bond risk premium in Exhibit 40–4 appears economically reasonable. It fell secularly from the early 1980s to late 1990s, perhaps reflecting the trend decline in inflation expectations and in level-dependent

5. We hasten to point out that these calculations are quite imprecise, especially at long durations. Even an error of a couple of basis points in our proxy for the market's rate expectation will have a large impact on any long bond's expected return (and thus on the estimated bond risk premium) because the expected yield change is scaled up by duration. Such sensitivity reduces the usefulness of this decomposition at long durations.

EXHIBIT 40–4

Forward-Implied Yield Changes versus Survey-Expected Yield Changes in the Treasury Bill Market, 1981–2002



Note: Forward-implied yield change is the difference between the implied three-month rate six months forward ($f_{0.5,\,0.75}$) and the current three-month rate ($s_{0.25}$) based on market data (fitted Treasury yield curves). Survey-expected yield change is the difference between the expected three-month rate six months ahead [$E(s_{0.25})$] and the current three-month rate, where the market's rate expectation is proxied by the mean in the *Wall Street Journal's* semiannual survey of economist forecasts. The difference between the forward-implied yield change and the survey-expected yield change is proportional to the bond risk premium.

inflation uncertainty. Besides the lower inflation risk premium, improving fiscal prospects likely contributed to this trend decline. The bond risk premium also exhibited cyclic fluctuations that are related to the direction of consensus rate predictions and thus the central bank's policy tightening and easing cycles. Finally, the bond risk premium turned slightly negative during the flight to quality in late 1998, arguably reflecting government bonds' role as safe-haven assets.[6]

DECOMPOSING EXPECTED RETURNS OF BOND POSITIONS

Our framework for decomposing the yield curve also provides a framework for systematic relative-value analysis of government bonds with known cash flows. We can evaluate all bond positions' expected returns comprehensively yet with simple and intuitive building blocks. We emphasize that relative-value

6. Here we analyze the bond risk premium at money market maturities, but we find similar patterns for the 10-year Treasury in Antti Ilmanen, "Stock-Bond Correlations," *Journal of Fixed Income* (September 2003), pp. 55–66.

analysis should be based on near-term expected return differentials, not on yield spreads, which are only one part of them. That is, total-return investors should care more about expected returns than about yields. Thus our approach brings fixed income investors closer to mean-variance analysis in which various positions are evaluated based on the trade off between their expected return and return volatility.

Five Alternative Expected-Return Measures

Equation (40–1) shows that a zero's holding-period return is a sum of its return given an unchanged yield curve and its return caused by the changes in the yield curve. The return given an unchanged yield curve is called the *rolling yield* because it is a sum of the zero's yield and the rolldown return. The return caused by changes in the yield curve can be approximated well by duration and convexity effects. Taking expectations of Eq. (40–1) and splitting the rolling yield into yield income and rolldown return, the near-term expected return of a zero is

Expected return = yield income + rolldown return + value of convexity
+ expected capital gain from the rate "view"

[For details, see Eq. (40–8) in Appendix 40A or the notes below Exhibit 40–5.] A similar relation holds approximately for coupon bonds, and we will describe the three-month expected return of some on-the-run Treasury bonds as the sum of the four preceding components.[7]

This framework is especially useful when evaluating positions of two or more government bonds, such as duration-neutral barbells versus bullets. We first compute expected return separately for each component and then compute the portfolio's expected return by taking a market-value weighted average of all the components' expected returns.

7. However, certain modifications are needed when we analyze coupon bonds' instead of zeros' expected returns—and the approximation will be somewhat worse. We use each bond's rolling yield to measure the horizon return given an unchanged yield curve; this measure no longer equals the one-period forward rate. We also use the end-of-horizon duration and convexity, as well as the change in the constant-maturity rate of a constant-coupon curve at horizon, and we adjust the duration and convexity effects for the fact that the bond's value increases to (1 + rolling yield/100) by the end of the horizon. Besides the approximation error of ignoring higher-order terms than duration and convexity effects, another source of error exists for coupon bonds: The reinvestment-rate assumptions vary across bonds. Recall that the calculation of the yield-to-maturity implicitly assumes that all cash flows are reinvested at the bond's yield-to-maturity. This fact may lead to exaggerated estimates of yield income for long-term bonds if the yield curve is upward-sloping, a problem common to all expected-return measures that use the concept of yield-to-maturity. Even though our approach of using bond-specific yields does not ensure internal consistency of the reinvestment-rate assumptions across bonds, any inconsistencies should have a relatively small impact on the overall level of bonds' expected returns.

It may be helpful to show step by step how the expected-return measures are improved, starting from simple yields and moving toward more comprehensive measures:

- A bond's *yield income* includes coupon income, accrued interest, and the accretion/amortization of price toward par value. Yield-to-maturity is the correct return measure if all interim cash flows can be reinvested at the yield and the bond can be sold at its purchasing yield.[8] Yield ignores the rolldown return the bond earns if the yield curve stays unchanged.
- *Rolling yield* is a better expected-return proxy if an unchanged curve is a reasonable base case. Yet it ignores the value of convexity and thus implicitly assumes no rate uncertainty. Thus the rolling yield measures expected return if no curve change and no volatility are expected.
- Combining the rolling yield with the value of convexity improves the expected-return measure further. This is so because it can be shown that a bond's convexity-adjusted expected return equals the sum of the rolling yield and the value of convexity. This measure recognizes the impact of rate uncertainty but implies that no change is expected in the yield curve.[9] Empirical evidence suggests that an unchanged yield curve is often a reasonable base "view."[10]
- If investors want, they can replace the prediction of an unchanged curve with some other rate (or spread) "view." One possibility is to use survey-based information of the market's current rate forecasts; such an approach may be useful for backing out the market's required return for each bond. Alternatively, investors may ignore the market view and input either their own rate views or an economist's subjective rate forecasts or rate predictions from some quantitative model.[11] The impact of any rate view is approximated by the expected yield change scaled by duration [see Eq. (40–10) in Appendix 40A], which may be added to

8. The yield-to-maturity of a single cash flow is unambiguous, whereas the yield of a portfolio of multiple cash flows is a more controversial measure. The duration-times-market-value weighted yield is a good proxy for a portfolio's true yield-to-maturity (internal rate of return). Capital gains are well-approximated by the product of minus duration and the change in such a yield measure. However, a portfolio's market-value weighted yield may be a better estimate of the portfolio's *likely yield income over a short horizon* (its near-term expected return) than is its yield-to-maturity. The yield-to-maturity weighs longer cash flows more heavily and is more influenced by the built-in reinvestment-rate assumptions.
9. See Antti Ilmanen, "Convexity Bias in the Yield Curve," Chapter 3 in Narasimgan Jegadeesh and Bruce Tuckman (eds.), *Advanced Fixed-Income Valuation Tools* (New York: Wiley, 2000).
10. See Antti Ilmanen, "Market's Rate Expectations and Forward Rates," *Journal of Fixed Income* (September 1996), pp. 8–22.
11. For example, one can use the predictors identified in Antti Ilmanen, "Forecasting U.S. Bond Returns," *Journal of Fixed Income* (June 1997), pp. 22–37.

the convexity-adjusted expected return. The sum gives us the "expected return with a view"—the four-term expected return measure in Eq. (40–3). However, this equation is a perfect description of expected returns only for bonds that lie on the fitted curve. Thus the preceding relative-value measures ignore "local" or bond-specific richness or cheapness relative to the curve.

- Many technical factors can make a specific bond "locally" rich or cheap (relative to adjacent-maturity bonds), or they can make a whole maturity sector rich or cheap relative to the fitted curve. Such factors include supply effects (temporary price pressure on a sector caused by new issuance), demand effects (maturity limitations or preferences of important market participants—for example, the richness of quarter-end bills), liquidity effects (lower transaction costs for on-the-runs versus off-the-runs, for ten-year bonds versus eight-year bonds, for Treasury bills versus duration-matched coupon bonds, etc.), coupon effects (motivated by tax benefits, accounting rules, etc.), and above all, the financing effects (the "special" repo income that is common for on-the-runs).[12] Fortunately, it is easy to add to the four-term expected-return measures the financing advantage and two local cheapness measures—the spread off the fitted curve and the expected cheapening toward the fitted curve. The five-term expected-return measures are comprehensive measures of total expected returns—ignoring small approximation errors, they incorporate all sources of expected return for noncallable government bonds.[13]

As a numerical illustration, Exhibit 40–5 shows the various expected-return measures for three bonds (the three-month Treasury bill and the five- and ten-year on-the-run Treasury notes) and for the barbell combination of the three-month bill

12. Whether such local cheapness effects appear as deviations from a fitted yield curve or as "wiggles" or "kinks" in the fitted curve depends on the curve-estimation technique. Recall that all curve-estimation techniques try to fit bond prices well while keeping the curve reasonably shaped. If the goodness of fit is heavily weighted, all bonds have small or no deviations from the fitted curve. However, a close fit may lead to "unreasonably" jagged forward-rate curves. Based on Eq. (40–2), the forward-rate curve should be smooth rather than jagged because maturity-specific expectations of rate or volatility behavior are hard to justify and because arbitrageurs presumably are quick to exploit any abnormally large expected-return differentials between adjacent-maturity bonds.

13. In our analysis we include the local effects into the expected bond returns separately as a fifth term. As an alternative, we could include the financing advantage (repo income) and the spread off the curve in the yield income, and we could include the expected cheapening in the rolldown return. "Rich" bonds, such as the on-the-runs, are unlikely to roll down the fitted curve if the overall curve remains unchanged. More likely, they eventually will lose their relative richness. It may be reasonable to assume that an on-the-run bond's yield advantage and *expected* cheapening roughly offset its *expected* financing advantage. For other issues than on-the-runs, it is often reasonable to assume (or better, estimate) some reversal toward the issue's "normal" cheapness spread versus the fitted curve.

EXHIBIT 40–5

Three-Month Expected Return Measures and Their Components, as of April 2004

Maturity	0.25	5	10	Barbell
Yield income	**0.259%**	**0.881%**	**1.128%**	**0.742%**
+ *Rolldown return*	*0.000*	*0.321*	*0.281*	*0.156*
= **Rolling yield**	**0.259**	**1.203**	**1.409**	**0.898**
+ *Value of convexity*	*0.000*	*0.047*	*0.129*	*0.072*
= **Convexity-adj. expected return**	**0.259**	**1.250**	**1.538**	**0.970**
+ *Duration impact of the "view"*	*0.000*	*–1.315*	*–1.579*	*–0.879*
= **Expected return with a view**	**0.259**	**–0.065**	**–0.041**	**0.092**
+ *Total local rich/cheap effect*	*0.000*	*0.023*	*0.010*	*0.006*
= **Total expected return**	**0.259**	**-0.042**	**-0.031**	**0.097**
Background Information				
Par yield	1.05	3.59	4.600	NA
Rolldown yield change	NA	–0.074	–0.036	NA
Duration now	0.249	4.54	7.94	4.53
Duration at horizon	0.000	4.33	7.79	4.33
Convexity now	0.002	0.24	0.76	0.42
Convexity at horizon	0.000	0.22	0.73	0.40
Yield volatility	NA	0.656	0.592	NA
Yield change "view"	+0.20	+0.30	+0.20	NA
On-the-run yield	1.00	3.56	4.46	NA
Financing advantage	NA	0.175	0.225	0.13
Spread to the par curve	NA	–0.007	–0.035	–0.02
Expected cheapening return	NA	–0.145	–0.180	–0.10

NA, not available.

Note: Barbell is a combination of 0.56 unit of the ten-year par bond and 0.44 unit of the three-month bond; these weights duration-match the barbell with the five-year par bond bullet. Yield income is the return that a par bond earns over three months if it can be sold at its yield and if any cash flows are reinvested at the yield. The yields are compounded semi-annually and based on the Citigroup Treasury Model's par yield curve. Rolldown return is the capital gain that a bond earns from the rolldown yield change. Rolling yield is a bond's horizon return given an unchanged yield curve. Value of convexity is approximated by 0.5 × convexity at horizon × (yield volatility)^2 × (1 + rolling yield/100), where yield volatility is the basis-point yield volatility over a three-month horizon. The latter is computed by multiplying the on-the-run bond's relative yield volatility—implied volatility based on the price of a three-month OTC option written on this bond—by its yield level and dividing by two (for deannualization). For the three-year bond, we interpolate between the implied volatilities of on-the-run twos and fives. Duration impact of the "view" is (– duration at horizon) × (expected change in a constant-maturity rate over the next three months) × (1 + rolling yield/100). In this example, the "view" reflects the market's yield curve expectations, broadly based on a *Consensus Forecasts* report. The "expected return with a view" measures the expected return for a hypothetical par bond that lies exactly on the model curve, ignoring any local cheapness or financing advantage of actual bonds. We can add to this four-term measure a fifth component called the *total local rich/cheap effect*. It is the sum of three additional sources of return for specific bonds: (1) the financing advantage (the difference between the three-month term repo rate for general collateral and the three-month special term repo rate for the on-the-run bond, divided by four for deannualization), (2) the spread between the on-the-run bond yield and the model par yield, divided by four for deannualization and (3) the bond's expected cheapening as it loses the richness associated with the on-the-run status.

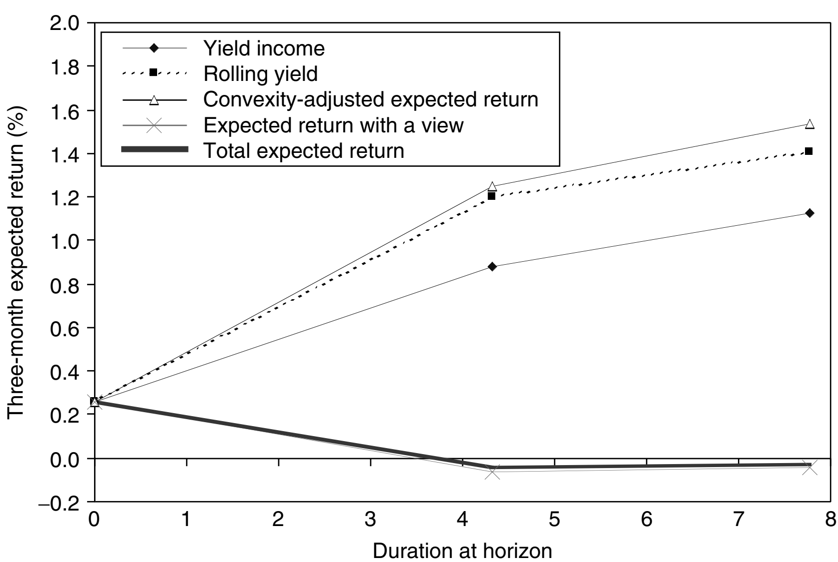
and the ten-year bond. In this example we use as much market-based data as possible, for example, implied volatilities, not historical, to estimate the value of convexity and the "view" (rate predictions) based on survey evidence of the market's rate expectations, not on a quantitative forecasting model. All the numbers are based on the market prices as of April 22, 2004.

The top panel of Exhibit 40–5 shows how nicely the different components of expected returns can be added to each other. Moreover, the barbell's expected return measures are simply the market-value weighted averages of its components' expected returns. In this case, the yield income, the rolldown return, and the value of convexity are all higher for the longer bonds. In contrast, the duration impact of the market's rate view is negative because the consensus forecast indicates that the market expected rising rates over the next quarter. The local rich/cheap effect is marginally positive for the five- and ten-year notes; the reason is that the negative yield spread and the expected cheapening are not sufficient to offset the high repo market advantage. Based on "viewless" expected-return measures, the five-year bullet looks more attractive than the barbell, thanks to its carry and rolldown advantage. However, if we impose a consensus curve-flattening view (30 basis point rise in five-year rates versus 20 basis point rise in ten-year rates), the broad expected-return measures favor the barbell over the bullet.

Exhibit 40–6 shows the five different expected-return curves plotted on the three bonds' durations. In this case, the simplest expected-return measure (yield

EXHIBIT 40–6

Expected Returns of a Three-Month Bill, a Five-Year Bond, and a Ten-Year Bond, in April 2004



income) and the most comprehensive measure (total expected return) look very different, thanks to the strong bear-flattening view on yield-curve reshaping. In general, the relative importance of the five components may be dramatically different from that in Exhibit 40–5. The longer the asset's duration and the shorter the investment horizon, the greater is the relative importance of the duration impact and the smaller is the impact of yield income. It is worth noting that realized returns can be decomposed in the same way as the expected returns and that the duration impact typically dominates the realized returns even more.[14]

The total expected returns, if estimated carefully, should produce the most useful signals for relative-value analysis because they include all sources of expected returns. Yield spreads may be useful signals, but they are only a part of the picture. Therefore, we advocate the monitoring of broader expected-return measures relative to their history as cheapness indicators—just as yield spreads often are monitored relative to their history.

The components of expected returns just discussed are not new. However, few investors have combined these components into an integrated framework and based their historical analysis on broad expected-return measures. An additional useful feature of this framework is that all types of government bond trades can be evaluated consistently within it: the portfolio-duration decision (market-directional view), the maturity-sector positioning and barbell-bullet decision (curve-reshaping view), and the individual-issue selection (local cheapness view). With small modifications, the framework can be extended to include the cross-country analysis of currency-hedged government bond positions. Other possible future extensions include the analysis of foreign-exchange exposure and the analysis of spread positions between government bonds and other fixed income assets.

We finish with some reservations. Even if two investors use the same general framework and the same type of expected-return measure, they may come up with different numbers because of different data sources and different estimation techniques. The whole analysis can be made with any raw material; we emphasize the importance of good-quality inputs. Various candidates for the raw material include on-the-run and off-the-run government bonds, STRIPS, Eurodeposits, swaps, and Eurodeposit futures. [This multitude, of course, opens the possibility of trading between these curves if we can assess how various characteristics (say, convexity) are priced in each curve.] The most common approach is first to estimate the spot curve (or discount function) using a broad universe of coupon government bonds as the raw material and then to compute the forward rates and other relevant numbers. In European bond markets, the liquid swap curve (using cash Eurodeposits and swaps as the raw material) has

14. Realized returns can be split into an expected part and an unexpected part, and both parts can be decomposed further. Equation (40–3) describes the decomposition of the expected part, while the unexpected part can be split into duration and convexity effects. This type of return attribution can have a useful role in risk management and performance evaluation, but these two activities are not our focus in this chapter.

gained more of a benchmark status. Of course, some credit and tax-related spread may exist between the swap curve and the government bond yield curve. Recently, yet another approach has become popular: Eurodeposit futures prices are used as the raw material. In this case, the forward rates are computed by adjusting for the convexity difference between a futures contract and a forward contract, and only then are spot rates computed from the forwards. Some components of expected returns are easier to measure—and less debatable—than others. The yield income is relatively unambiguous. The rolldown return and the local rich/cheap effects depend on the curve-fitting technique. The value of convexity depends on the volatility input and thus on the volatility estimation technique. The rate "view," the fourth term, can be based on various approaches, such as quantitative modeling or subjective forecasting, that rely on fundamental or technical analysis. Even the quantitative approach is not purely objective because infinitely many alternative forecasting models and estimation techniques exist. Forecasting rate changes is, of course, the most difficult task, as well as the one with greatest potential rewards and risks. Forecasting changes in yield spreads may be almost as difficult. The short-term returns of most bond positions depend primarily on the duration impact (rate changes or spread changes). However, even if investors cannot predict rate changes, they may earn superior returns in the long run—and with less volatility—by systematically exploiting the more stable sources of expected-return differentials across bonds: yields, rolldown returns, value of convexity, and local rich/cheap effects. More generally, while the total expected return differentials are, in theory, better relative-value indicators than the yield spreads, in practice, measurement errors conceivably can make them so noisy that they give worse signals. Therefore, it is important to check with historical data that any supposedly superior relative value tools would have enhanced the investment performance, at least in the past.

Link to Scenario Analysis

Many active investors base their investment decisions on subjective yield-curve views, often with the help of scenario analysis. Our framework for relative-value analysis is closely related to scenario analysis. It may be worthwhile to explore the linkages further.

An investor can perform the scenario analysis of noncallable government bonds in two steps. First, the investor specifies a few yield-curve scenarios for a given horizon and computes the total return of her bond portfolio—or perhaps just a particular trade—under each scenario. Second, the investor assigns subjective probabilities to the different scenarios and computes the probability-weighted expected return for her portfolio. Sometimes the second step is not completed, and investors only examine qualitatively the portfolio performance under each scenario. However, we advocate performing this step because investors can gain valuable insights from it. Specifically, the probability-weighted expected return is the "bottom line" number a total return manager should care about. By assigning probabilities to scenarios, investors also can explicitly back out their implied views about the yield-curve reshaping and about yield volatilities and correlations.

In scenario analysis, investors define the mean yield-curve view and the volatility view implicitly by choosing a set of scenarios and by assigning them probabilities. In contrast, our framework for relative-value analysis involves explicitly specifying one yield-curve view (which corresponds to the probability-weighted mean yield-curve scenario) and a volatility view (which corresponds to the dispersion of the yield-curve scenarios). Either way, the yield-curve view determines the duration impact, and the volatility view determines the value of convexity.

Exhibit 40–7 presents a portfolio that consists of five equally weighted zero-coupon bonds with maturities of one to five years and (annually compounded) yields between 6% and 7%. The portfolio's maturity—and its Macaulay duration—initially

EXHIBIT 40–7

Scenario Analysis and Expected Bond Returns

	Bond					Portfolio
Initial maturity	1	2	3	4	5	3
Horizon maturity	0	1	2	3	4	2
Initial yield	6.00%	6.25%	6.50%	6.75%	7.00%	
Yield-change scenarios						
(of 1–5 year constant-maturity rates)						
Bear	1.00	1.00	1.00	1.00	1.00	
Bull	–1.00	–1.00	–1.00	–1.00	–1.00	
Neutral	0.00	0.00	0.00	0.00	0.00	
Bear-flattener	1.00	0.875	0.75	0.625	0.50	
Bull-steepener	–0.50	–0.375	–0.25	–0.125	0.00	
One-year returns in each scenario						
Bear	6.00	5.51	5.02	4.53	4.05	5.02
Bull	6.00	7.51	9.04	10.59	12.15	9.06
Neutral	6.00	6.50	7.00	7.50	8.01	7.00
Bear-flattener	6.00	5.51	5.26	5.26	5.51	5.51
Bull-steepener	6.00	7.01	7.76	8.26	8.51	7.51
Assign equal probability						
(0.2) to each scenario and back out various statistics						
Mean return	6.00	6.41	6.82	7.23	7.65	6.82
Vol. of return	0.00	0.80	1.52	2.17	2.78	1.45
Mean yield change	0.10	0.10	0.10	0.10	0.10	
Vol. of Yield Change	0.80	0.76	0.72	0.69	0.66	

is three. Over a one horizon, each zero's maturity shortens by one year. We specify five alternative yield-curve scenarios over the horizon: parallel shifts of +100 basis points and –100 basis points, no change, a yield increase combined with a curve flattening, and a yield decline combined with a curve steepening (see Exhibit 40–8). We compute the one-year holding-period returns for each asset and for the portfolio under each scenario. In particular, the neutral scenario shows the rolling yield that each zero earns if the yield curve remains unchanged. We can evaluate each scenario separately. However, such analysis gives us limited insight—for example, the last column in Exhibit 40–7 shows just that bearish scenarios produce lower portfolio returns than bullish scenarios.

In contrast, if we assign probabilities to the scenarios, we can back out many numbers of potential interest. We begin with a simple example in which we use only the two first scenarios, parallel shifts of 100 basis points up or down. If we assign these scenarios equal probabilities (0.5), the expected return of the portfolio is 7.04% (= 0.5 × 5.02 + 0.5 × 9.06). On average, these scenarios have no view about curve changes, yet this expected return is 4 basis points higher than the expected portfolio return given no change in the curve (i.e., the 7% rolling yield computed in the neutral scenario). This difference reflects the value of convexity. If we use only one scenario, we implicitly assume zero volatility, which leads to downward-biased expected-return estimates for positively convex bond positions. If we use the two first scenarios (bear and bull), we implicitly assume a 100 basis point yield volatility; this assumption may or may not be reasonable, but it certainly is more reasonable than an assumption of no volatility. This example highlights the importance of using multiple scenarios to recognize the value of convexity. (The value is small here, however, because we focus on short-duration assets that have little convexity.)

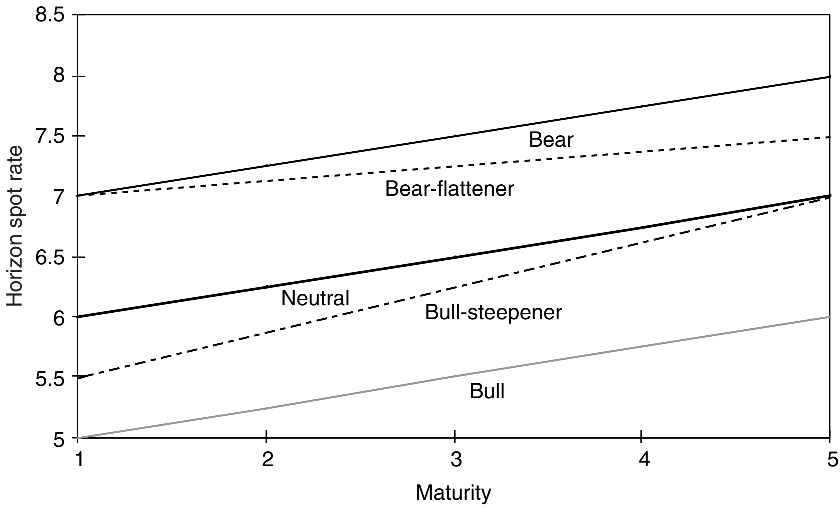
Now we return to the example with all five yield-curve scenarios in Exhibit 40–8. As an illustration, we assign each scenario the same probability (p_i = 0.2). Then it is easy to compute the portfolio's probability-weighted expected return:

$$E(h_p) = \sum_{i=1}^{5} p_i \times h_i = 0.2 \times (5.02 + 9.06 + 7.00 + 5.51 + 7.51) = 6.82 \qquad (40\text{–}3)$$

Given these probabilities, we can compute the expected return for each asset, and it is possible to back out the implied yield-curve views. The lower panel in Exhibit 40–7 shows that the mean yield change across scenarios is +10 basis points for each rate (because the bear-flattener and the bull-steepener scenarios are not quite symmetric in magnitude in this example), implying a mild bearish bias but no implied curve-steepness views. In addition, we can back out the implied basis point yield volatilities (or return volatilities) by measuring how much the yield-change (or return) outcomes in each scenario deviate from the mean. These yield volatility levels are important determinants of the value of convexity. The last line in Exhibit 40–7 shows that the volatilities range from 80 to 66 basis points, implying an inverted term structure of volatility. Finally, we can compute implied correlations between

EXHIBIT 40–8

Various Yield-Curve Scenarios



various-maturity yield changes; the curve behavior across the five scenarios is so similar that all correlations are 0.92 or higher (not shown). Note that all correlations would equal 1.00 if only the first three scenarios were used; the imperfect correlations arise from the bear-flattener and the bull-steepener scenarios.

Whenever an investor uses scenario analysis, he should back out these implicit curve views, volatilities, and correlations—and check that any biases are reasonable and consistent with his own views. Without assigning the probabilities to each scenario, this step cannot be completed; then the investor may overlook hidden biases in his analysis, such as a biased curve view or a very high or low implicit volatility assumption that makes positive convexity positions appear too good or too bad. If investors use quantitative tools—such as scenario analysis, mean-variance optimization, or the approach outlined in this chapter—to evaluate expected returns, they should recognize the importance of their rate views in this process. Strong subjective views can make *any* particular position appear attractive. Therefore, investors should have the discipline and the ability to be fully aware of the views that are input into the quantitative tool.

In addition to the implied curve views, we can back out the four components of expected returns discussed earlier. In this example, we only analyze bonds that lie "on the curve" and thus can ignore the fifth component, the local rich/cheap effects. First, we measure the yield income from the portfolio by a market-value weighted-average yield of the five zeros, which is 6.50%. Second, each asset's rolldown return is the difference between the horizon return given an unchanged yield curve and the yield income. Exhibit 40–7 shows that the horizon return for the portfolio is 7% in the neutral scenario; thus the portfolio's (market-value weighted average) rolldown return is 50 basis points (= 7% – 6.5%). Note that the rolldown return is larger for longer bonds, reflecting the fact that the same rolldown yield change (25 basis points) produces larger capital gains for longer bonds. Third, the value of convexity for each zero can be approximated by 0.5 × convexity at horizon × (basis point yield volatility)^2 × (1 + rolling yield/100). Using the implicit yield volatilities in Exhibit 40–7, this value varies between 0.6 and 4.5 basis points across bonds. The portfolio's value of convexity is a market-value weighted average of the bond-specific values of convexity, or roughly 2 basis points. Fourth, the duration impact of the rate "view" for each bond equals (– duration at horizon) × (expected yield change) × (1 + rolling yield/100). The last term is needed because each invested dollar grows to (1 + rolling yield/100) by the end of horizon when the repricing occurs. The core of the duration impact is the product of duration and expected yield change. The expected yield change refers to the change (over the investment horizon) in a constant-maturity rate of the bond's horizon maturity. In Exhibit 40–7, all rates are expected to increase by 10 basis points, and the duration impact on specific bonds' returns varies between 0 and –40 basis points. The portfolio's duration impact is a market-value weighted average of bond-specific duration impacts, or about –20 basis points.

The four components add up to the total probability-weighted expected return of 6.82% (= 6.50% + 0.50% + 0.02% – 0.20%). Decomposing expected returns into these components should help investors to better understand their own investment positions. For example, they can see what part of the expected return reflects static market conditions and what part reflects their subjective market view. Unless they are extremely confident about their market view, they can emphasize the part of expected-return advantage that reflects static market conditions. In our example, the duration effect is small because the implied rate view is quite mild (10 basis points), and the one-year horizon is relatively long (the "slower" effects need time to accrue). With a shorter horizon and stronger rate views, the duration impact easily would dominate the other effects.

APPENDIX 40A

Decomposing the Forward Rate Structure into Its Main Determinants

In this appendix we show how the forward rate structure is related to the market's rate expectations, bond risk premia, and convexity bias. In particular, the holding-period return of an *n*-year zero-coupon bond can be described as a sum of its horizon return given an unchanged yield curve and the end-of-horizon price change that is caused by a change in the n – 1 year constant-maturity spot rate (Δs_{n-1}). The horizon return equals a one-year forward rate, and the end-of-horizon price change can be approximated by duration and convexity effects. These relations are used to decompose near-term expected bond returns and the one-period forward rates into simple building blocks. All rates and returns used in the following equations are compounded annually and expressed in percentage terms.

$$\frac{h_n}{100} = \frac{P^*_{n-1} - P_n}{P_n} = \frac{(P^*_{n-1} - P_{n-1}) + (P_{n-1} - P_n)}{P_n}$$
$$= \left(\frac{\Delta P_{n-1}}{P_{n-1}} \times \frac{P_{n-1}}{P_n} - 1\right) + \left(\frac{P_{n-1}}{P_n} - 1\right) \quad (40\text{–}4)$$

where h_n is the one-period holding-period return of an n-year bond, P_n is its price (today), P^*_{n-1} is its price in the next period (when its maturity is $n - 1$), and $\Delta P_{n-1} = P^*_{n-1} - P_{n-1}$. The second term on the right-hand side of Eq. (40–4) is the bond's rolling yield (horizon return). The first term on the right-hand side of Eq. (40–4) is the instantaneous percentage price change of an $n - 1$ year zero multiplied by an adjustment term P_{n-1}/P_n.[15]

Equation (40–5) shows that the zero's rolling yield (P_{n-1}/P_n) equals, by construction, the one-year forward rate between $n - 1$ and n. Moreover, the adjustment term equals one plus the forward rate.

$$1 + \frac{f_{n-1,n}}{100} = \frac{\left(1 + \frac{s_n}{100}\right)^n}{\left(1 + \frac{s_{n-1}}{100}\right)^{n-1}} = \frac{P_{n-1}}{P_n} \quad (40\text{–}5)$$

Equation (40–6) shows the well-known result that the percentage price change ($\Delta P/P$) is closely approximated by the first two terms of a Taylor series expansion, duration and convexity effects.

$$100 \times \frac{\Delta P}{P} \approx -\text{dur} \times (\Delta s) + 0.5 \times Cx \times (\Delta s)^2 \quad (40\text{–}6)$$

where

$$\text{dur} \equiv -\frac{dP}{ds} \times \frac{100}{P} \qquad \text{and} \qquad Cx \equiv \frac{d^2P}{d^2s} \times \frac{100}{P}$$

Plugging Eqs. (40–5) and (40–6) into Eq. (40–4), we get

$$h_n \approx f_{n-1,n} + \left(1 + \frac{f_{n-1,n}}{100}\right)[-\text{dur}_{n-1}(\Delta s_{n-1}) + 0.5Cx_{n-1}(\Delta s_{n-1})^2] \quad (40\text{–}7)$$

15. The adjustment term is needed because the bond's instantaneous price change occurs at the end of horizon, not today. The value of the bond position grows from one to P_{n-1}/P_n at the end of horizon if the yield curve is unchanged. The end-of-horizon value (P_{n-1}/P_n) would be subject to the yield shift at horizon.

Even if the yield-curve shifts occur during the horizon, for performance calculation purposes, the repricing takes place at the end of horizon. This disparity causes various differences between the percentage price changes in Eqs. (40–6) and (40–7). First, the amount of capital that experiences the price change grows to $(1 + f_{n-1,n}/100)$ by the end of horizon. Second, the relevant yield change is the change in the $n - 1$ year constant-maturity rate, not in the n-year zero's own yield (the difference is the rolldown yield change).[16] Third, the end-of-horizon (as opposed to the current) duration and convexity determine the price change.

The realized return can be split into an expected part and an unexpected part. Taking expectations of both sides of Eq. (40–7) gives us the n-year zero's expected return over the next year:

$$E(h_n) \approx f_{n-1,n} + \left(1 + \frac{f_{n-1,n}}{100}\right)[-\text{dur}_{n-1}E(\Delta s_{n-1}) + 0.5Cx_{n-1}E(\Delta s_{n-1})^2] \qquad (40–8)$$

Recall from Eq. (40–5) that the one-period forward rate equals a zero's rolling yield, which can be split to yield and rolldown return components. In addition, the expected yield change squared is approximately equal to the variance of the yield change or the squared volatility $E(\Delta s_{n-1})^2 \approx [\text{vol}(\Delta s_{n-1})]^2$. This relation is exact if the expected yield change is zero. Thus the zero's near-term expected return can be written (approximately) as a sum of the yield income, the rolldown return, the value of convexity, and the expected capital gains from the rate "view" (see Eq. 40–3).

We can interpret the expectations in Eq. (40–8) to refer to the market's rate expectations. Mechanically, the forward rate structure and the market's rate expectations on the right-hand side of Eq. (40–8) determine the near-term expected returns on the left-hand side. These expected returns should equal the required returns that the market demands for various bonds if the market's expectations are internally consistent. These required returns, in turn, depend on factors such as each bond's riskiness and the market's risk-aversion level. Thus it is more appropriate to think that the market participants, in the aggregate, *set the bond market prices* to be such that given the forward rate structure and the consensus rate expectations, each bond is expected to earn its required return.[17]

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16. If we used bonds' own yield changes in Eq. (40–7), these yield changes would include the rolldown yield change. In this case, we should not use the forward rate (which includes the impact of the rolldown yield change on the return, in addition to the yield income) as the first term on the right-hand side of Eq. (40–7). Instead, we would use the spot rate.

17. Individual investors also can use Eq. (40–8), but the interpretation is slightly different because most of them are so small that they cannot influence the market rates; thus they are "price takers." Any individual investor can plug her subjective rate expectations into Eq. (40–8) and back out the expected return given these expectations and the market-determined forward rates. These expected returns may differ from the required returns that the market demands; this discrepancy may prompt the investor to trade on her view.

Subtracting the one-period riskless rate (s_1) from both sides of Eq. (40–8), we get

$$E(h_n - s_1) \approx (f_{n-1,n} - s_1) + \left(1 + \frac{f_{n-1,n}}{100}\right)[-\text{dur}_{n-1}E(\Delta s_{n-1}) + 0.5Cx_{n-1}\text{vol}(\Delta s_{n-1})^2] \quad (40\text{–}9)$$

We define the bond risk premium as $BRP_n \equiv E(h_n - s_1)$ and the forward-spot premium as $FSP_n \equiv f_{n-1,n} - s_1$. The forward-spot premium measures the steepness of the one-year forward rate curve (the difference between each point on the forward rate curve and the first point on that curve), and it is closely related to simpler measures of yield-curve steepness. Rearranging Eq. (40–9), we obtain

$$FSP_n \approx BRP_n + \left(1 + \frac{f_{n-1,n}}{100}\right)[\text{dur}_{n-1}E(\Delta s_{n-1}) - 0.5Cx_{n-1}\text{vol}(\Delta s_{n-1})^2] \quad (40\text{–}10)$$

In other words, the forward-spot premium is approximately equal to a sum of the bond risk premium, the impact of rate expectations (expected capital gain/loss caused by the market's rate "view"), and the convexity bias (expected capital gain caused by the rate uncertainty). Unfortunately, none of the three components is directly observable.

The analysis thus far has been very general, based on accounting identities and approximations, not on economic assumptions. Various term-structure hypotheses and models differ in their assumptions. Certain simplifying assumptions lead to well-known hypotheses of the term-structure behavior by making some terms in Eq. (40–10) equal zero—although fully specified term-structure models require even more specific assumptions. First, if constant-maturity rates follow *a random walk,* the forward-spot premium mainly reflects the bond risk premium but also the convexity bias [$E(\Delta s_{n-1}) = 0 \Rightarrow FSP_n \approx BRP_n + CB_{n-1}$]. Second, if the *local-expectations hypothesis* holds (all bonds have the same near-term expected return), the forward-spot premium mainly reflects the market's rate expectations but also the convexity bias [$BRP_n = 0 \Rightarrow FSP_n \approx \text{dur}_{n-1}E(\Delta s_{n-1}) + CB_{n-1}$]. Third, if the *unbiased-expectations hypothesis* holds, the forward-spot premium only reflects the market's rate expectations [$BRP_n + CB_{n-1} = 0 \Rightarrow FSP_n \approx \text{dur}_{n-1}E(\Delta s_{n-1})$]. The last two cases illustrate the distinction between two versions of the pure expectations hypothesis.

APPENDIX 40B

Relating Various Statements about Forward Rates to Each Other

We make several statements about forward rates—describing, interpreting, and decomposing them in various ways. The multitude of these statements may be confusing; therefore, we now try to clarify the relationships between them.

We refer to the spot curve and the forward curves on a given date as if they were unambiguous. In reality, different analysts can produce somewhat different estimates of the spot curve on a given date if they use different curve-fitting techniques or different underlying data (asset universe or pricing source). We acknowledge the importance of these issues—having good raw material is important to any kind of yield-curve analysis—but here we ignore these differences. We take the estimated spot curve as given and focus on showing how to interpret and use the information in this curve.

In contrast, the relations between various depictions of the term structure of interest rates (par, spot, and forward rate curves) are unambiguous. In particular, once a spot curve has been estimated, any forward rate can be computed mathematically by using Eq. (40–11):

$$\left(1+\frac{f_{m,n}}{100}\right)^{n-m} = \frac{\left(1+\frac{s_n}{100}\right)^{n}}{\left(1+\frac{s_m}{100}\right)^{m}} \tag{40–11}$$

where $f_{m,n}$ is the annualized $n - m$ year interest rate m years forward and s_n and s_m are the annualized n-year and m-year spot rates, expressed in percent. Thus a one-to-one mapping exists between forward rates and *current* spot rates. The statement "the forwards imply rising rates" is equivalent to saying that "the spot curve is upward sloping," and the statement "the forwards imply curve flattening" is equivalent to saying that "the spot curve is concave." Moreover, an unambiguous mapping exists between various types of forward curves, such as the implied spot curve one year forward ($f_{1,n}$) and the curve of constant-maturity one-year forward rates ($f_{n-1,n}$).

The forward rate can be the agreed interest rate on an *explicitly* traded contract, a loan between two future dates. More often the forward rate is defined *implicitly* from today's spot curve based on Eq. (40–11). However, arbitrage forces ensure that even the explicitly traded forward rates would equal the implied forward rates and thus be consistent with Eq. (40–11). For example, the implied one-year spot rate four years forward (also called the one-year forward rate four years ahead, $f_{4,5}$) must be such that the equality $(1 + s_5/100)^5 = (1 + s_4/100)^4(1 + f_{4,5}/100)$ holds. If $f_{4,5}$ is higher than this, arbitrageurs can earn profits by short selling the five-year zeros and buying the four-year zeros and the one-year forward contracts four years ahead, and vice versa. Such activity should make the equality hold within transaction costs.

Forward rates can be viewed in many ways: the arbitrage interpretation, the break-even interpretation, and the rolling yield interpretation. According to the arbitrage interpretation, implied forward rates are such rates that would ensure the absence of riskless arbitrage opportunities between spot contracts (zeros) and forward contracts if the latter were traded. According to the break-even interpretation of forward rates, implied forward rates are such *future* spot rates that would equate holding-period returns across bond positions. According to the rolling-yield interpretation, the one-period forward rates show the one-period horizon returns that various zeros earn if the yield curve remains unchanged. Each interpretation is useful for a certain purpose: active view taking relative to the forwards (break-even), relative-value analysis given no yield-curve views (rolling yield), and valuation of derivatives (arbitrage).

All these interpretations hold by construction (from Eq. 40–11). Thus they are not inconsistent with each other. For example, the one-period forward rates can be interpreted and used in quite different ways. The implied one-year spot rate four years forward ($f_{4,5}$) can be viewed as either the break-even one-year rate *four years into the future* or the rolling yield of a five-year zero *over the next year.* Both interpretations follow from the equality $(1 + s_5/100)^5 = (1 + s_4/100)^4(1 + f_{4,5}/100)$. This equation shows that the forward rate is the break-even one-year reinvestment rate that would equate the returns between two strategies (holding the five-year zero to maturity versus buying the four-year zero and reinvesting in the one-year zero when the four-year zero matures) over a five-year horizon. [Rewriting the equality as $(1 + s_4/100)^4 = (1 + s_5/100)^5/(1 + f_{4,5}/100)$ gives a slightly different viewpoint; the forward rate also is the break-even selling rate that would equate the returns between two strategies (holding the four-year zero to maturity versus buying the five-year zero and selling it after four years as a one-year zero) over a four-year horizon.] Finally, rewriting the equality as $1 + f_{4,5}/100 = (1 + s_5/100)^5/(1 + s_4/100)^4$ shows that the forward rate is the horizon return from buying a five-year zero at rate s_5 and selling it one year later as a four-year zero at rate s_4 (thus the constant-maturity four-year rate is unchanged from today). Our analysis focuses on the last (rolling-yield) interpretation.

Interpreting the one-period forward rates as rolling yields enhances our understanding about the relation between the curve of one-year forward rates ($f_{0,1}, f_{1,2}, f_{2,3}, \ldots, f_{n-1,n}$) and the implied spot curve one year forward ($f_{1,2}, f_{1,3}, f_{1,4}, \ldots, f_{1,n}$). The latter "break-even" curve shows how much the spot curve needs to shift to cause capital gains/losses that exactly offset initial rolling-yield differentials across zeros and thereby equalize the holding-period returns. Thus a steeply upward-sloping curve of one-period forward rates requires, or "implies," a large offsetting increase in the spot curve over the horizon, whereas a flat curve of one-period forward rates only implies a small "break-even" shift in the spot curve.[18] A similar link exists for the rolling-yield differential between a duration-neutral barbell versus bullet and the break-even yield-spread change (curve-flattening) that is needed to offset the bullet's rolling-yield advantage. These examples provide insight as to why an upward-sloping spot curve implies rising rates and why a concave spot curve implies a flattening curve.

18. In Chapter 8, we describe one common way to use the break-even forward rates. Investors can compare their subjective views about the yield curve at some future date (or about the path of some constant-maturity rate over time) to the forward rates and directly determine whether bullish or bearish strategies are appropriate. If the rate changes that the forwards imply are realized, all bonds earn the riskless return [because $(1 + s_n/100)^n/(1 + f_{1,n}/100)^{n-1} = 1 + s_1/100$]. If rates rise by more than that, long bonds underperform short bonds. If rates rise by less than that, long bonds outperform short bonds because their capital losses do not quite offset their initial yield advantage.

Appendix 40A showed that forward rates can be decomposed conceptually into three main determinants (rate expectations, risk premia, and convexity bias). One might hope that the arbitrage, break-even, or rolling-yield interpretations could help us in backing out the relative roles of rate expectations, risk premia, and convexity bias in a given day's forward rate structure. However, such hope is in vain. The three interpretations hold quite generally because of their mathematical nature. Thus they do not guide us in decomposing the forward rate structure.

Therefore, even when two analysts agree that today's forward rate structure is an approximate sum of three components, they may disagree about the relative roles of these components. We can try to address this question empirically. It is closely related to the question about the forward rates' ability to forecast future rate changes and future bond returns. Ignoring convexity bias, if the forwards primarily reflect rate expectations, they should be unbiased predictors of future spot rates (and they should tell little about future bond returns). However, if the forwards mainly reflect required bond risk premia, they should be unbiased predictors of future bond returns (and they should tell little about future rate changes).[19,20]

Finally, our analysis does not reveal the fundamental economic determinants of the required risk premia or the market's rate expectations—nor does it tell us to what extent the nominal rate expectations reflect expected inflation and expected real rates. Macroeconomic news about economic growth, inflation rates, budget deficits, and so on can influence both the required risk premia and the market's rate expectations. More work clearly is needed to improve our understanding about the mechanisms of these influences.

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19. We present some empirical evidence indicating that the forward rates are better predictors of future bond returns than of future rate changes in Antti Ilmanen, "Market's Rate Expectations and Forward Rates," *Journal of Fixed Income* (September 1996), pp. 8–22. This evidence also suggests that the current spot curve is a better predictor of the next-period spot curve than is the implied spot curve one period forward. These findings imply that the rolling yields are reasonable proxies for the near-term expected bond returns—although even rolling yields capture a very small part of the short-term realized bond returns. Note that the poorer the forwards are in predicting future rate changes, the better they are in predicting bond returns—because then the implied rate changes that would offset initial yield advantages tend to occur more rarely. Note also that some investors may not care whether the forwards' ability to predict bond returns reflects rational risk premia or the market's inability to forecast rate changes; they want to earn any predictable profit irrespective of its reason.
20. One common misconception is that the forward rates are used in the valuation of swaps, options, and other derivative instruments *because* the forwards are good predictors of future spot rates. In fact, the forwards' ability to predict future spot rates has nothing to do with their usefulness in derivatives pricing. Unlike forecasting returns, the valuation of derivatives is based on arbitrage arguments. For example, traders theoretically can construct, by dynamic hedging, a riskless combination of a risky long-term bond and an option written on it. The price of the option should be such that the hedged position earns the riskless rate—otherwise, a riskless arbitrage opportunity arises. The forward rates are central in this valuation because the traders can lock in these rates for future periods in their hedging activity. This arbitrage argument implies that the yield-curve option pricing models should be calibrated to be consistent with the market forward rates *in spite of* the fact that the forwards are quite poor predictors of future spot rates.

CHAPTER
FORTY-ONE

THE MARKET YIELD CURVE AND FITTING THE TERM STRUCTURE OF INTEREST RATES

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In this chapter we discuss fitting the term structure of interest rates. The term structure is commonly known as the *yield curve,* but the former expression refers only to a curve of spot or zero-coupon interest rates. For an understanding of the methodology used in fitting the term structure, it is necessary to review certain basic concepts. Thus we consider first spot and forward interest rates and the concept of the yield curve itself. We discuss key issues on yield-curve analysis before looking at methods by which we can construct the term structure of interest rates from market prices and yields. This is known as *fitting the term structure*.

BASIC CONCEPTS

There are two types of fixed income securities, *zero-coupon bonds,* also known as *discount bonds* or *strips,* and *coupon bonds*. A zero-coupon bond makes a single payment on its maturity date, whereas a coupon bond makes regular interest payments at regular dates up to and including its maturity date. A coupon bond may be regarded as a set of strips, with each coupon payment and the redemption payment on maturity being equivalent to a zero-coupon bond maturing on that date. This is not a purely academic concept; witness events before the advent of the formal market in U.S. Treasury strips, when a number of investment banks had traded the cash flows of Treasury securities as separate zero-coupon securities. The literature we review in this section is set in a market of default-free bonds, whether they are zero-coupon bonds or coupon bonds. The market is assumed to be liquid so that bonds may be freely bought and sold.

Prices of bonds are determined by the economy-wide supply and demand for the bonds at any time, so they are *macroeconomic* and not set by individual bond issuers or traders.

Zero-Coupon Bonds

A zero-coupon bond is the simplest fixed income security. It is an issue of debt, the issuer promising to pay the face value of the debt to the bondholder on the date the bond matures. There are no coupon payments during the life of the bond, so it is a discount instrument, issued at a price that is below the face or *principal* amount. We denote as $P(t, T)$ the price of a discount bond at time t that matures at time T, with $T \geq t$. The term-to-maturity of the bond is denoted with n, where $n = T - t$. The price increases over time until the maturity date when it reaches the maturity or *par* value. If the par value of the bond is \$1, then the *yield-to-maturity* of the bond at time t is denoted by $r(t, T)$, where r is actually "one plus the percentage yield" that is earned by holding the bond from t to T.

Under the following conditions:

- Frictionless trading conditions
- A competitive and discrete-time economy
- Credit-risk free bonds

assume that we have a set of zero-coupon bonds with maturities $\{0, 1, 2, \ldots, x\}$. The price of a zero-coupon bond with a nominal value of \$1 on maturity at time T (such that $T > t$) is given by

$$P(t,T) = \frac{1}{[r(t,T)]^n} \tag{41–1}$$

which is the price of a bond of maturity T at time t. The yield may be obtained from the bond price and is given by

$$r(t,T) = \left[\frac{1}{P(t,T)}\right]^{1/n} \tag{41–2}$$

which is sometimes written as

$$r(t,T) = P(t,T)^{-(1/n)} \tag{41–3}$$

That the bond price refers to a zero-coupon bond means that it is a discount bond; thus, if we apply the expressions to a bond of nominal value \$1, it enables us to view the bond price as the discount factor. The discount factor will be used again later.

Analysts and researchers frequently work in terms of logarithms of yields and prices or continuously compounded rates. One advantage of this is that it converts the nonlinear relationship in Eq. (41–2) into a linear relationship.[1]

The bond price at time t_2, where $t \le t_2 \le T$, is given by

$$P(t_2,T) = P(t,T)e^{(t_2-t)r(t,T)} \tag{41–4a}$$

which is natural given that the bond price equation in continuous time is

$$P(t,T) = e^{-r(t,T)(T-t)} \tag{41–4b}$$

so that the yield is given by

$$r(t,T) = -\log\left[\frac{P(t,T)}{n}\right] \tag{41–5}$$

which is sometimes written as

$$\log r(t,T) = -\left(\frac{1}{n}\right)\log P(t,T) \tag{41–6}$$

Equation (41–4) includes the exponential function, hence the use of the term *continuously compounded.*

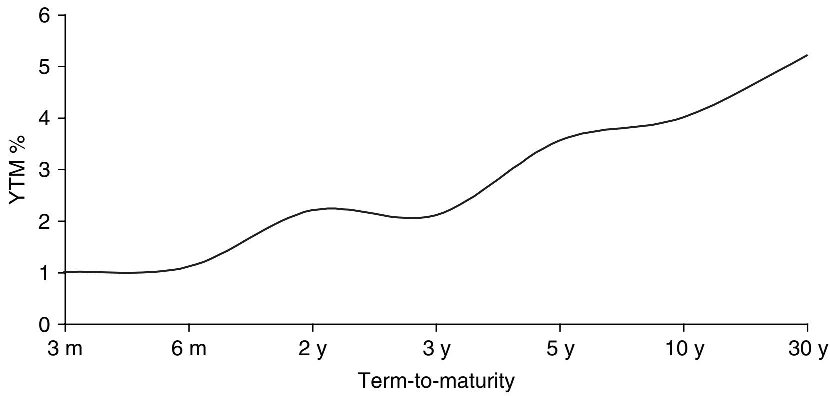
The *term structure of interest rates* is the set of zero-coupon yields at time t for all bonds ranging in maturity from $(t, t + 1)$ to $(t, t + m)$, where the bonds have maturities of $\{0, 1, 2, \ldots, m\}$. It is defined as the relationship between the yield-to-maturity of a homogeneous group of credit-risk-free zero-coupon bonds and their maturities.

The *yield curve* is a plot of the set of yields for $r(t, t + 1)$ to $r(t, t + m)$ against m at time t. For example, Exhibit 41–1 shows the zero-coupon yield curves for U.S. Treasury strips on April 19, 2004. All yield curves exhibit peculiarities in their shape, although the most common type of curve is gently upward sloping, as shown by the the U.S. Treasury curve.

1. A linear relationship in X would be a function $y = f(X)$ in which the X values change via a power or index of 1 only and are not multiplied or divided by another variable or variables. Thus, for example, terms such as X^2, $\sqrt{X}$, and other similar functions are not linear in X, nor are terms such as XZ or X/Z, where Z is another variable. In econometric analysis, if the value of Y is solely dependent on the value of X, then its rate of change with respect to X, or the derivative of Y with respect to X, denoted dY/dX, is independent of X. Therefore if $Y = 5X$, then $dY/dX = 5$, which is independent of the value of X. However if $Y = 5X^2$, then $dY/dX = 10X$, which is not independent of the value of X. Hence this function is not linear in X. The classic regression function $E(Y \mid X_i) = \alpha + \beta X_i$ is a linear function with slope β and intercept α, and the regression "curve" is represented geometrically by a straight line.

EXHIBIT 41–1

U.S. Treasury Zero-Coupon Yield Curve in September 2000



Coupon Bonds

The majority of bonds in the market make periodic interest or *coupon* payments during their life and are known as *coupon bonds*. We have already noted that such bonds may be viewed as a package of individual zero-coupon bonds. The coupons have a nominal value that is a percentage of the nominal value of the bond itself, with steadily longer maturity dates, whereas the final redemption payment has the nominal value of the bond itself and is redeemed on the maturity date. We denote a bond issued at time i and maturing at time T as having a w-element vector of payment dates $(t_1, t_2, \ldots, t_{w-1}, T)$ and matching date payments $C_1, C_2, \ldots, C_{w-1}, C_w$. In the academic literature, these coupon payments are assumed to be made in continuous time so that the stream of coupon payments is given by a positive function of time $C(t)$, $i < t \leq T$. An investor who purchases a bond at time t that matures at time T pays $P(t, T)$ will receive the coupon payments as long as she continues to hold the bond.[2]

The yield-to-maturity at time t of a bond that matures at T is the interest rate that relates the price of the bond to the future returns on the bond, that is, the rate that *discounts* the bond's cash flow stream C_w to its price $P(t, T)$. This is given by

$$P(t,T) = \sum_{t_i > t} C_i e^{-(t_i - t)r(t,T)} \tag{41–7}$$

2. In theoretical treatment, this is the discounted clean price of the bond. For coupon bonds in practice, unless the bond is purchased for value on a coupon date, it will be traded with interest accrued. The interest that has accrued on a pro-rata basis from the last coupon date is added to the clean price of the bond to give the market "dirty" price that is actually paid by the purchaser.

which says that the bond price is given by the present value of the cash-flow stream of the bond discounted at the rate $r(t, T)$. For a zero-coupon bond, Eq. (41–7) reduces to Eq. (41–5). In the academic literature, where it is assumed that coupon payments are made in continuous time, the Σ summation in Eq. (41–7) is replaced by the $\int$ integral.

In some texts the plot of the yield-to-maturity at time t for the term of the bonds m is described as the term structure of interest rates, but it is generally accepted that the term structure is the plot of zero-coupon rates only. Plotting yields-to-maturity is generally described as graphically depicting the yield curve rather than the term structure. Of course, given the law of one price, there is a relationship between the yield-to-maturity yield curve and the zero-coupon term structure, and given the first, one can derive the second.

Equation (41–7) obtains the continuously compounded yield to maturity $r(t, T)$. It is the use of the exponential function that enables us to describe the yield as continuously compounded.

The market frequently uses the measure known as *current yield,* which is

$$rc = \frac{C}{P_d} \times 100 \qquad (41\text{–}8)$$

where P_d is the dirty price of the bond. The measure is also known as the *running yield* or *flat yield*. Current yield is not used to indicate the interest rate or discount rate and therefore should not be mistaken for the yield to maturity.

THE CONCEPT OF THE FORWARD RATE

An investor can combine positions in bonds of differing maturities to guarantee a rate of return that begins at a point in the future. That is, the trade ticket would be written at time t but would cover the period T to $T + 1$, where $t < T$ (sometimes written as beginning at T_1 and ending at T_2, with $t < T_1 < T_2$). The interest rate earned during this period is known as the *forward rate.*[3] For reference, the mechanism by which this forward rate can be guaranteed is shown below.

Forward Rates

As illustrated in Exhibit 41–2, assume that an investor buys at time 1 a unit of a zero-coupon bond maturing at time T, priced at $P(t, T)$ and simultaneously sells $P(t, T)/P(t, T + 1)$ bonds that mature at $T + 1$. From Exhibit 41–2 we see that the

3. See the footnote on page 639 of Robert Shiller, "The Term Structure of Interest Rates," in Chapter 13 of Friedman, B., Hahn, F., (eds.), *Handbook of Monetary Economics,* Vol. 1. (Amsterdam: North-Holland, 1990), for a fascinating insight on the origin of the term *forward rate,* which Mr. Shiller ascribes to John Hicks in his book *Value and Capital,* 2d ed. (Oxford, England: Oxford University Press, 1946).

EXHIBIT 41–2

Transactions	Time: *t*	*T*	*T* + 1
Buy 1 unit of *T*-period bond	$-P(t,T)$	+1	
Sell $P(t,T)/P(t, T+1)$ $T+1$ period bonds	$+[(P(t,T)/P(t, T+1)]P(t, T+1)$		$-P(t, T)/P(t, T+1)$
Net cash flows	0	+1	$-P(t, T)/P(t, T+1)$

net result of these transactions is a zero cash flow. At time T there is a cash inflow of 1, and then at time $T + 1$ there is a cash outflow of $P(t, T)/P(t, T + 1)$. These cash flows are identical to a loan of funds made during the period T to $T + 1$ contracted at time t. The interest rate on this loan is given by $P(t, T)/P(t, T + 1)$, which is therefore the forward rate. That is,

$$f(t,T) = \frac{P(t,T)}{P(t,T+1)} \tag{41–9}$$

which is the forward rate given in terms of the bond price. This rate would be applied to a loan that ran during the period $[T, T + 1]$. Together with our earlier relationships on bond price and yield, from Eq. (41–9) we can define the forward rate in terms of yield, with the return earned during the period $(T, T + 1)$ being

$$f(t,T,T+1) = \frac{1}{[P(t,T+1)/P(t,T)]} = \frac{[r(t,T+1)]^{(T+1)}}{r(t,T)^{T}} \tag{41–10}$$

From Eq. (41–9) we can obtain a bond price equation in terms of the forward rates that hold from t to T, that is,

$$P(t,T) = \frac{1}{\prod_{k=t}^{T-1} f(t,k)} \tag{41–11}$$

Equation (41–11) states that the price of a zero-coupon bond is equal to the nominal value, here assumed to be 1, receivable at time T after it has been discounted at the set of forward rates that apply from t to T.[4]

4. The symbol Π means "take the product of" and is defined as $\Pi_{i=1}^{n} x_i = x_1 \cdot x_2 \cdot \cdots \cdot x_n$ so that $\Pi_{k=t}^{T-1} f(t, k) = f(t, t) \cdot f(t, t+1) \cdot \cdots \cdot f(t, T-1)n$, which is the result of multiplying the rates that obtain when the index k runs from t to $T - 1$.

This expression means

$$\prod_{j=t}^{T-1} f(t,j) = f(t,t)f(t,t+1)\cdots f(t,T-1)$$

that is, the result of multiplying the rates that apply to the interest periods in index j that run from t to $T - 1$. It means that the price of a bond is equal to \$1 received at time T that has been discounted by the forward rates that apply to the maturity periods up to time $T - 1$.

Equation (41–11) is derived as follows. Consider the following expression for the forward rate applicable to the period (t, t):

$$f(t,t) = \frac{P(t,t)}{P(t,t+1)} \tag{41–12}$$

Since $P(t, t)$ is equal to 1, we are able to write

$$f(t,t) = \frac{1}{P(t,t+1)} \tag{41–13}$$

which can be rearranged to give us an expression in terms of bond price, that is,

$$P(t,t+1) = \frac{1}{f(t,t)} \tag{41–14}$$

We can repeat this for each subsequent interest period with a forward start date, so the next one would be

$$f(t,t+1) = \frac{P(t,t+1)}{P(t,t+2)} \tag{41–15}$$

which we rearrange again for the bond price to become

$$P(t,t+2)\frac{P(t,t+1)}{f(t,t+1)} \tag{41–16}$$

If we substitute the expression for $f(t, t + 1)$ that is Eq. (41–15) into Eq. (41–16) and then simplify, we will obtain

$$P(t,t+2) = \frac{1}{f(t,t)f(t,t+1)} \tag{41–17}$$

This process can be continued for all subsequent interest periods from $(t, t + 3)$ onward up to T. Doing this gives us

$$P(t,t+j) = \frac{1}{f(t,t)f(t,t+1)f(t,t+2)\cdots f(t,t+j-1)} \tag{41–18}$$

This equation is Eq. (41–11) after it has been simplified.

We can see then that there is a close relationship between zero-coupon bond prices (discount factors), spot rates, and forward rates. Given a set of risk-free

EXHIBIT 41–3

Zero-Coupon Bond Prices (Discount Factors), Spot Rates, and Forward Rates

Period	Discount Factor [*P*, (0, *T*)]	Spot Rate	Forward Rate
0	1		
1	0.984225	1.016027	1.016027
2	0.967831	1.016483	1.016939
3	0.951187	1.016821	1.017498
4	0.934518	1.017075	1.017836
5	0.917901	1.01728	1.018102
6	0.901395	1.017452	1.018312
7	0.885052	1.017597	1.018465
8	0.868939	1.017715	1.018542
9	0.852514	1.017887	1.019267
10	0.835764	1.01823731	1.019569139

zero-coupon bond prices, it is possible to calculate the forward rate applicable to a specified period of time that matures up to the time $T - 1$. Alternatively, given a set of spot rates or forward rates, we are able to calculate bond prices. We can define forward rates in terms of bond prices, spot rates, and spot-rate discount factors.

Exhibit 41–3 shows the corresponding spot and forward rates that apply to a hypothetical set of zero-coupon bond prices (discount factors). It is possible to tie in any one item of data into its corresponding other two equivalent pieces of data using the set of equations we just presented, as shown in Exhibit 41–3.

When calculating a forward rate, it is as if we are writing an interest rate today that is applicable at the forward start date; in other words, we trade a forward contract. The law of one price, or no arbitrage, is used to calculate the rate. For a loan that begins at T and matures at $T + 1$, similarly to the way we described earlier, consider a purchase of a $T + 1$ period bond and a sale of p amount of the T-period bond. The net cash position at t must be zero, so p is given by

$$p = \frac{P(t, T+1)}{P(t, T)} \tag{41–19}$$

and to avoid arbitrage, the value of p must be the price of the $T + 1$ period bond at time T. Therefore, the forward yield is given by

$$f(t, T+1) = -\frac{\log P(t, T+1) - \log P(t, T)}{(T+1) - T} \tag{41–20}$$

If the period between T and the maturity of the later-dated bond is reduced so that we now have bonds that mature at T and T_2, and $T_2 = T + \Delta t$, then as the incremental change in time Δt becomes progressively smaller, we obtain an instantaneous forward rate that is given by

$$f(t,T) = -\frac{\partial}{\partial T}\log P(t,T) \qquad (41\text{–}21)$$

This rate is defined as the forward rate and is the price today of forward borrowing at time T. The forward rate for borrowing today where $T = t$ is equal to the instantaneous short rate $r(t)$. At time t, the spot and forward rates for the period (t, t) will be identical; at other maturity terms, they will differ.

For all points other than at (t, t), the forward-rate yield curve will lie above the spot-rate curve if the spot curve is positively sloping. The opposite applies if the spot-rate curve is downward-sloping. Campbell and colleagues[5] observe that this property is a standard one for marginal and average-cost curves. That is, when the cost of a marginal unit (say, of production) is above that of an average unit, then the average cost will increase with the addition of a marginal unit. This results in the average cost rising when the marginal cost is above the average cost. Equally, the average cost per unit will decrease when the marginal cost lies below the average cost.

SPOT AND FORWARD YIELD CURVES

From the discussion in this section we see that it is possible to calculate bond prices and spot and forward rates provided that one has a set of only one of these parameters. Therefore, given the following set of zero-coupon rates, observed in the market and given in Exhibit 41–4, we calculate the corresponding forward rates and zero-coupon bond prices as shown. The initial term structure is upward-sloping. The two curves are illustrated in Exhibits 41–5 and 41–6.

There are technical reasons why the theoretical forward rate has a severe kink at the later maturity. The relationship between the spot- and forward-rate curve is stated in Campbell, Lo, and MacKinlay.[6] The forward curve will lie above the spot-rate curve if the latter is increasing and will lie below it if the spot-rate curve is decreasing. This relationship can be shown mathematically; the forward rate or *marginal rate of return* is equal to the spot rate or *average rate of return* plus the rate of increase of the spot rate multiplied by the sum of the increases between t and T. If the spot rate is constant (a flat curve), the forward curve will be equal to it.

However, an increasing spot-rate curve does not always result in an increasing forward-rate curve, only one that lies above it. It is possible for the forward curve to be increasing or decreasing while the spot rate is increasing. If the spot

5. See Shiller, "The Term Structure of Interest Rates," pp. 400–401.
6. See Chapters 10 and 11 in John Campbell, Andrew Lo, and Cragi MacKinlay, *The Econometrics of Financial Markets* (Princeton, NJ: Princeton University Press, 1997).

EXHIBIT 41–4

Hypothetical Zero-Coupon Yield and Forward Rates

Term-to-Maturity (0, *T*)	Spot Rate *r*(0, *T*)*	Forward Rate *f*(0, *T*)*	Bond Price *P*(0, *T*)
0			1
1	1.054	1.054	0.94877
2	1.055	1.056	0.89845
3	1.0563	1.059	0.8484
4	1.0582	1.064	0.79737
5	1.0602	1.068	0.7466
6	1.0628	1.076	0.69386
7	1.06553	1.082	0.64128
8	1.06856	1.0901	0.58833
9	1.07168	1.0972	0.53631
10	1.07526	1.1001	0.48403
11	1.07929	1.1205	0.43198

*Interest rates are given as (1 + *r*).

rate reaches a maximum level and then stays constant or falls below this high point, the forward curve will begin to decrease at a maturity point *earlier* than the spot curve high point. In the example in Exhibit 41–3, the rate of increase in the spot rate in the last period is magnified when converted to the equivalent forward rate; if the last spot rate had been below the previous-period rate, the forward-rate curve would look like that in Exhibit 41–6.

EXHIBIT 41–5

Hypothetical Zero-Coupon and Forward Yield Curve

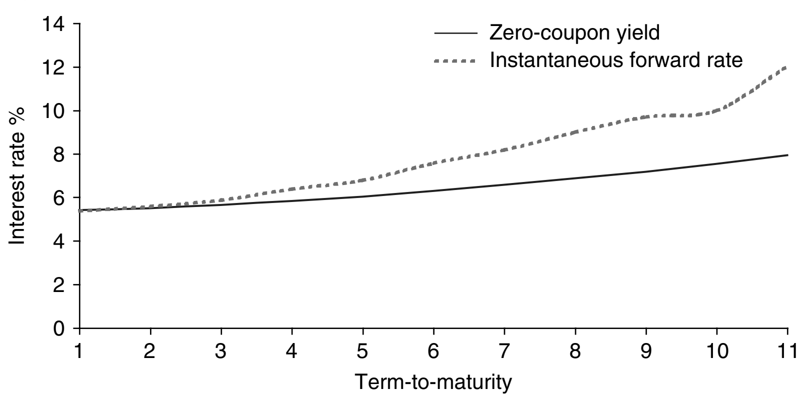
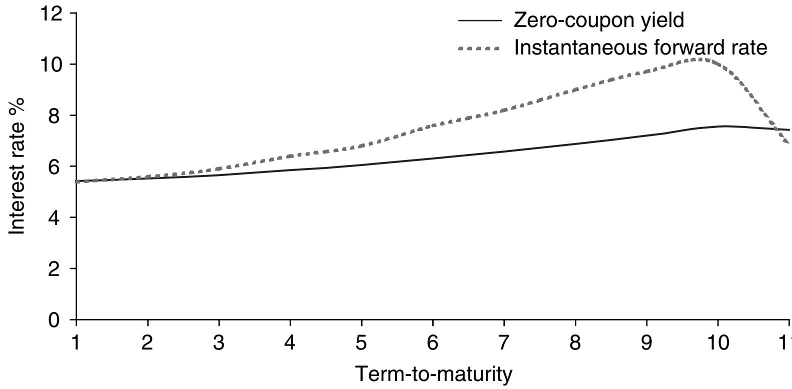


EXHIBIT 41–6

Hypothetical Zero-Coupon and Forward Yield Curve



THE TERM STRUCTURE

We have already referred to the yield curve or *term structure of interest rates*. Strictly speaking, only a spot-rate yield curve is a term structure, but one sometimes encounters the two expressions being used synonymously. At any time *t* there will be a set of coupon and/or zero-coupon bonds with different terms-to-maturity and cash-flow streams. There will be certain fixed maturities that are not represented by actual bonds in the market because there will be more than one bond maturing at or around the same redemption date. It is this paucity of data in selected parts of the curve that makes fitting the term structure problematic at times. We begin by considering the bootstrapping approach to fitting the term structure.

The Bootstrapping Approach Using Discount Factors

In this section we describe how to obtain zero-coupon and forward rates from the yields available from coupon bonds using the *bootstrapping technique*. In a government bond market such as U.S. Treasuries, the bonds are considered to be *default-free*. The rates from a government bond yield curve describe the risk-free rates of return available in the market *today*; however, they also *imply* (risk-free) rates of return for *future time periods.* These implied future rates, known as *implied forward rates,* or simply *forward rates,* can be derived from a given discount function or spot yield curve using bootstrapping. This term reflects the fact that each calculated spot rate is used to determine the next-period spot rate in successive steps.

We illustrate the technique using discount factors. Once we have obtained the discount curve, it is a straightforward process to obtain the spot-rate curve, as we saw earlier when we described the relationship that exists among discount factors, spot rates, and forward rates.

To recap, a *t*-period discount factor is the present value of $1 that is payable at the end of period *t*. Essentially, it is the present-value relationship of Eq. (41–1) expressed in terms of $1. If $d(t)$ is the *t*-year discount factor, then the five-year discount factor at a discount rate of 6% is given by

$$d(5) = \frac{1}{(1+0.06)^6} = 0.747258$$

The set of discount factors for the time period from 1 day to 30 years (or longer) is termed the *discount function*. Discount factors are used to price any financial instrument that is comprised of a future cash flow. For example, if the six-month discount factor is 0.98756, the current value of the maturity payment of a 7% semiannual coupon bond due for receipt in six months time is given by 0.98756 × 103.50, or 102.212. In addition, discount factors may be used to calculate the future value of any current investment. From the preceding example, $0.98756 would be worth $1 in six months' time, so by the same principle, a present sum of $1 at the end of six months would be worth

$$1/d(5) = 1/0.98756 = 1.0126$$

As we saw earlier in this chapter, the interrelationship between discount factors and spots and rates means that we may obtain discount factors from current bond prices. Assume a hypothetical set of semiannual coupon bonds and bond prices as given in Exhibit 41–7, and assume further that the first bond matures in precisely six months time. All other bonds then mature at six-month intervals.

Taking the first bond, this matures in precisely six months time, and its final cash flow will be 103.50, comprised of the $3.50 final coupon payment and the $100 redemption payment. The market-observed price of this bond is $101.65, which allows us to calculate the six-month discount factor as

$$d(0.5) \times 103.50 = 101.65$$

which gives us $d(0.5) = 0.98213$.

EXHIBIT 41–7

Hypothetical Set of Bonds and Bond Prices

Coupon	Maturity Date	Price
7%	6/7/2001	101.65
8%	12/7/2001	101.89
6%	6/7/2002	100.75
6.50%	12/7/2002	100.37

EXHIBIT 41–8

Discount Factors Calculated Using Bootstrapping Technique

Coupon	Maturity Date	Term (years)	Price	*d*(*n*)
7%	6/7/2001	0.5	101.65	0.98213
8%	12/7/2001	1	101.89	0.94194
6%	6/7/2002	1.5	100.75	0.92211
6.50%	12/7/2002	2	100.37	0.88252

From this step we can calculate the discount factors for the following six-month periods. The second bond in Exhibit 41–7, the 8% 2001, has the following cash flows:

- $4 in six months' time
- $104 in one years' time.

The price of this bond is 101.89, the bond's present value, and this comprises the sum of the present values of the bond's total cash flows. Thus we are able to set the following:

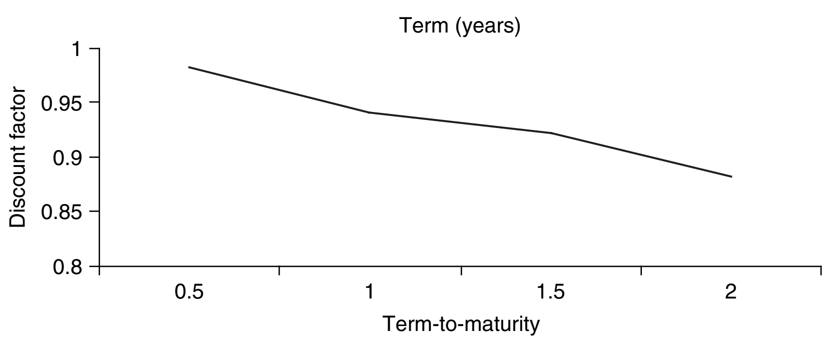
$$101.89 = 4 \times d(0.5) + 101 \times d(1)$$

However, we already know that $d(0.5)$ is 0.98213, which leaves only one unknown in the preceding expression. Therefore, we may solve for $d(1)$, and this is shown to be 0.94194.

If we carry on with this procedure for the remaining two bonds, using successive discount factors, we obtain the complete set of discount factors shown in Exhibit 41–8. The continuous function for the two-year period is shown as the discount function in Exhibit 41–9.

EXHIBIT 41–9

Discount Function



As we saw earlier and in Exhibit 41–3, once we have the discount function, we are able to compute the zero-coupon rates and hence also the forward rates. Thus we can fit the yield curve from the discount function.

The theoretical approach just described is neat and appealing, but in practice there are a number of issues that will complicate the attempt to extract zero-coupon rates from bond yields. The main problem is that it is highly unlikely that we will have a set of bonds that are both precisely six months (or one interest) apart in maturity and priced precisely at par. We also require our procedure to fit as smooth a curve as possible. Setting our coupon bonds at a price of par simplified the analysis in our illustration of bootstrapping, so in reality, we need to apply more advanced techniques. A basic approach for extracting zero-coupon bond prices is described in the next section.

Calculating Spot Rates in Practice

Researchers have applied econometric techniques to the problem of extracting a zero-coupon term structure from coupon bond prices.[7] A summary of the main approaches is contained in James and Webber.[8]

We have noted that a coupon bond may be regarded as a portfolio of zero-coupon bonds. By treating a set of coupon bonds as a larger set of zero-coupon bonds, we can extract an (implied) zero-coupon interest-rate structure from the yields on the coupon bonds.

If the actual term structure is observable so that we know the prices of zero-coupon bonds of £1 nominal value $P_1, P_2, \ldots, P_N$, then the price P_C of a coupon bond of nominal value £1 and coupon C is given by

$$P_C = P_1 C + P_2 C + \cdots + P_N (1 + C) \qquad (41\text{–}22)$$

Conversely, if we can observe the coupon bond yield curve so that we know the prices $P_{C1}, P_{C2}, \ldots, P_{CN}$, then we may use Eq. (41–22) to extract the implied

7. For example, see John McCulloch, "Measuring the Term Structure of Interest Rates," *Journal of Business* 44 (1971), pp. 19–31; Stephen Schaefer, "Measuring a Tax-Specific Term Structure of Interest Rates in the Market for British Government Securities," *Economic Journal* 91 (1981), pp. 415–438; C. Nelson and Siegel, "A Parsimonious Modeling of Yield Curves," *Journal of Business* 60(4) (1987), pp. 473–489; Mark Deacon and Andrew Derry, "Estimating the Term Structure of Interest Rates," Bank of England Working Paper Series No. 24, July 1994; Kenneth Adams and Donald van Deventer, "Fitting Yield Curves and Forward Rate Curves with Maximum Smoothness," *Journal of Fixed Income* 4 (1994), pp. 52–62; David Waggoner, "Spline Methods for Extracting Interest Rate Curves from Coupon Bond Prices," working paper, Federal Reserve Bank of Atlanta, 1997.
8. Jessica James and Neil Webber, *Interest Rate Modelling* (Chichester, England: Wiley, 2000).

zero-coupon term structure. We begin with the one-period coupon bond, for which the price is

$$P_{C1} = P_1(1+C)$$

so that

$$P_1 = \frac{P_{C1}}{(1+C)} \tag{41–23}$$

This process is repeated. Once we have the set of zero-coupon bond prices P_1, P_2, . . . , P_{N-1}, we obtain P_N using

$$P_N = \frac{P_{CN} - P_{N-1}C - \cdots - P_1C}{1+C} \tag{41–24}$$

At this point we apply a regression technique known as *ordinary least squares* (OLS) to fit the term structure.[9]

Equation (41–22) restricts the prices of coupon bonds to be precise functions of the other coupon bond prices. In fact, this is unlikely practice because specific bonds will be treated differently according to liquidity, tax effects, and so on. For this reason, we add an *error term* to Eq. (41–22) and estimate the value using cross-sectional regression against all the other bonds in the market. If we say that these bonds are numbered $i = 1, 2, \ldots, I$, then the regression is given by

$$P_{C_iN_i} = P_1C_i + P_2C_i + \cdots + P_{N_i}(1+C_i) + u_i \tag{41–25}$$

for $i = 1, 2, \ldots, I$ and where C_i is the coupon on the ith bond and N_i is the maturity of the ith bond. In Eq. (41–25) the regressor parameters are the coupon payments at each interest period date, and the coefficients are the prices of the zero-coupon bonds P_1 to P_N, where $j = 1, 2, \ldots, N$. The values are obtained using OLS as long as we have a complete term structure and $I \geq N$.

In practice, we will not have a complete term structure of coupon bonds, and so we are not able to identify the coefficients in Eq. (41–25). McCulloch described a *spline estimation* method that assumes that zero-coupon bond prices vary smoothly with term-to-maturity. In this approach, we define P_N, a function of maturity $P(N)$, as a *discount function* given by

$$P(N) = 1 + \sum_{j=1}^{J} a_j f_j(N) \tag{41–26}$$

The function $f_j(N)$ is a known function of maturity N, and the coefficients a_j must be estimated. We arrive at a regression equation by substituting

9. For an explanation of the method of ordinary least squares, see Damodar Gujarati, *Essentials of Econometrics,* 2d ed. (New York: McGraw-Hill, 1999).

Eq. (41–26) into Eq. (41–25) to give us Eq. (41–27), which can be estimated using OLS.

$$\prod_i = \sum_{j=1}^{J} a_j X_{ij} + u_i, \qquad i = 1, 2, \ldots, I \tag{41–27}$$

where

$$\prod_i \equiv P_{C_i N_i} - 1 - C_i N_i$$

$$X_{ij} \equiv f_j(N_i) + C_i \sum_{l=1}^{N_i} f_j(l)$$

The function $f_j(N)$ usually is specified by setting the discount function as a polynomial. In certain texts (including McCulloch), this is carried out by applying what is known as a *spline function*. Considerable academic research has gone into the use of spline functions as a yield-curve fitting technique, which we introduce next.

FITTING THE YIELD CURVE

We now consider some of the techniques used to actually fit the term structure. In theory, we could use the bootstrapping approach described earlier. For a number of reasons, though, this does not produce accurate results, and so other methods are used instead. Formal term-structure models define interest-rate dynamics under various assumptions about the nature of the stochastic process that drives those rates. However, the zero-coupon curve derived by these models, such as the ones described by Vasicek, Brennan and Schwartz, and Cox, Ingersoll, and Ross do not fit the observed market rates or spot rates implied by market yields.[10] Since market yield curves are found to contain more variable shapes than those derived using term-structure models, this means that such so-called equilibrium curves need to be fitted to market rates. Hence interest-rate models are required to be *calibrated* to the market, and in practice, they are calibrated to the market yield curve. This is carried out in two ways: The model is either calibrated to market instruments such as money market products and interest-rate swaps, which are used to construct the yield curve, or the yield curve is constructed from market instrument rates and the model is calibrated to this constructed curve. If the latter approach is preferred, there are a number of *nonparametric methods* that may be used. We will consider these later.

10. See Oldrich Vasicek, "An Equilibrium Model of the Term Structure of Interest Rates," *Journal of Financial Economics* 5 (1977), pp. 177–188. M. Brennan and E. Schwartz, "A Continuous-Time Approach to the Pricing of Bonds," *Journal of Banking and Finance* 3 (1979), pp. 133–155; John Cox, Jonathan Ingersoll, and Stephen Ross, "An Inter-Temporal General Equilibrium Model of Asset Prices," *Econometrica* 53 (1985), pp. 385–407.

The academic literature contains a good deal of research into the empirical estimation of the term structure, the object of which is to fit a zero-coupon curve[11] that is a reasonably accurate fit to the market prices *and* is a smooth function. There is an element of trade-off between these two objectives. The second objective is as important as the first, however, in order to derive a curve that makes economic sense. (It would be possible to fit the curve perfectly at the expense of smoothness, but this would be almost meaningless.)

In this section we present an overview of some of the methods used to fit the yield curve.

Yield-Curve Smoothing

An approach used to estimate the term structure was described by Carleton and Cooper.[12] This assumed that default-free bond cash flows are payable on specified discrete dates, with a set of unrelated discount factors that apply to each cash flow. These discount factors were then estimated as regression coefficients, with each bond cash flow acting as the independent variables, and the bond price for that date acting as the dependent variable.

Using simple linear regression in this way produces a discrete discount function, not a continuous one, and forward rates that are estimated from this function are very jagged. This lack of "smoothness" is the main reason why this technique is not used in practice. An approach more readily accepted by the market was described by McCulloch,[13] who fitted the discount function using polynomial splines. This method produces a continuous function and one that is linear so that the *ordinary least squares* regression technique can be employed. In a later study, Langetieg and Smoot[14] used an extended McCulloch method, fitting *cubic splines* to zero-coupon rates instead of the discount function, and employing nonlinear methods of estimation.

That was the historical summary of early efforts. Now we wish to describe a technique that can be applied in practice to fit smooth curves. We know that the term structure can be described as the complete set of discount factors, the discount function, that can be extracted from the price of default-free bonds trading in the market. The bootstrapping technique described earlier may be used to extract the relevant discount factors. However, there are a number of reasons why this approach is problematic in practice. First, it is unlikely that the complete set of bonds in the market will pay cash flows at precise six-month intervals every six months from today to

11. The zero-coupon or spot curve or, equivalently, the forward-rate curve or the discount function would be describing the same thing.
12. See C. Carleton and I. Cooper, "Estimation and Uses of the Term Structure of Interest Rates," *Journal of Finance* (September 1976), pp. 1067–1083.
13. *Ibid.*
14. See T. C. Langetieg and J. S. Smoot, "Estimation of the Term Structure of Interest Rates," in G.G. Kaufman (ed.), *Research in Financial Services,* Vol. 1 (Stanford, CT: JAI Publishing Co., 1989), pp. 181–222.

30 years or longer. An adjustment is made for cash flows received at irregular intervals and for the lack of cash flows available at longer maturities. Another issue is the fact that the technique presented earlier allowed practitioners to calculate the discount factor for six-month maturities, whereas it may be necessary to determine the discount factor for nonstandard periods, such as four-month or 14.2-year maturities. This is often the case when pricing derivative instruments.

A third issues concerns the market price of bonds. These often reflect specific investor considerations, which include

- The liquidity or lack thereof of certain bonds, caused by issue sizes, market-maker support, investor demand, nonstandard maturity, and a host of other factors
- The fact that bonds do not trade continuously so that some bond prices will be "newer" than others
- The tax treatment of bond cash flows and the effect that this has on bond prices
- The effect of the bid-offer spread on the market prices used

The statistical term used for bond prices subject to these considerations is *error*. It is also common to come across the statement that these effects introduce *noise* into market prices.

To construct a fit to the yield curve that better handles the preceding considerations, *smoothing* techniques are used to derive the complete set of discount factors from market bond prices known as the *discount function*. Using the simple technique presented earlier, we graph the discount function for U.S. Treasury prices as of April 26, 2004. This is shown at Exhibit 41–10. The yield curve plotted from Treasury redemption yields is shown as a Bloomberg screen curve in

EXHIBIT 41–10

Discount Factors from U.S. Treasury Prices, April 26, 2004

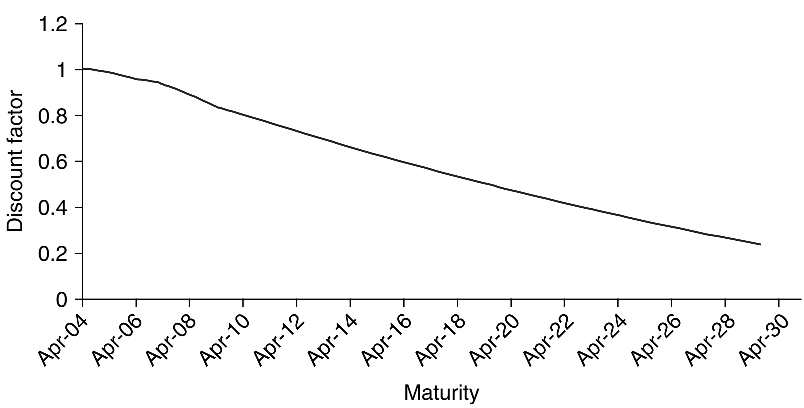
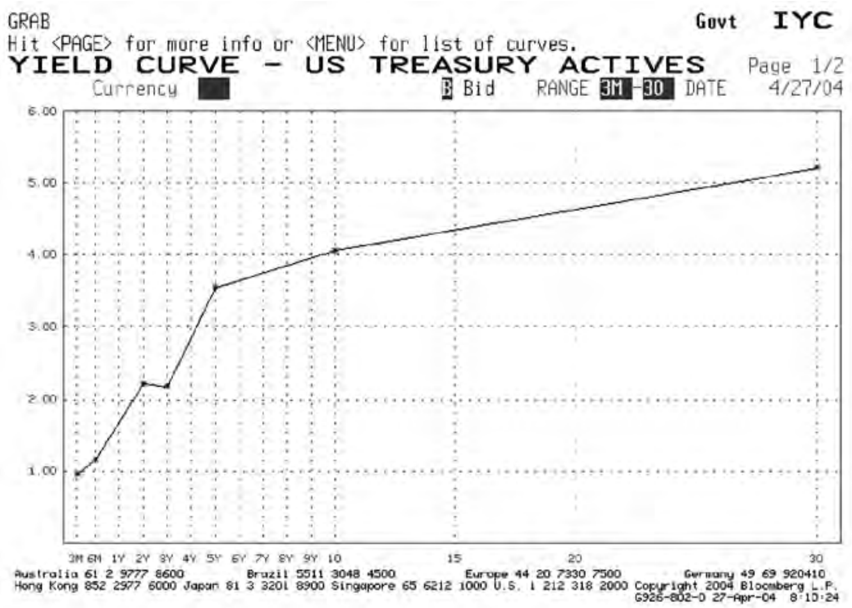


EXHIBIT 41–11

U.S. Treasury Gross Redemption Yields, April 26, 2004



Source: Bloomberg LP.

Exhibit 41–11. Exhibit 41–12 shows the zero-coupon yield curve and forward-rate curve that correspond to the discount function from that date.

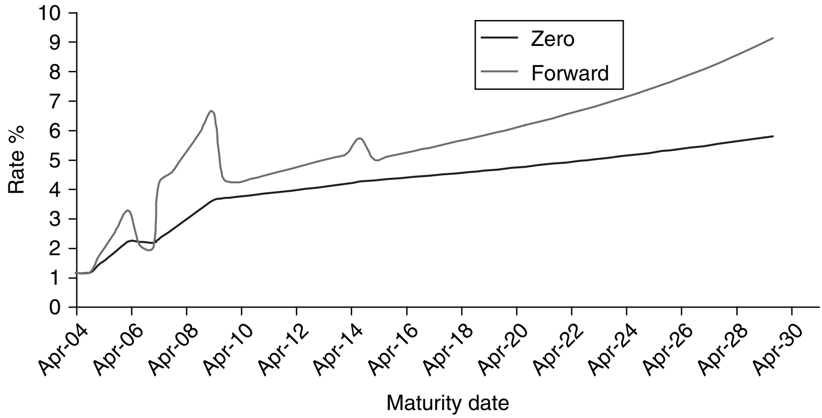
From Exhibit 41–10 we see that the discount function is quite smooth, and the zero-coupon curve is also relatively smooth, although not as smooth as the discount function. The forward-rate curve is distinctly "unsmooth," and there is obviously something wrong. In fact, the jagged nature of implied forward rates is one of the main concerns of the fixed income analyst and indicates in the first instance that the discount function and zero-coupon curve are not as smooth as they appear. Using the naive estimation method here, the main reason why the forward rates oscillate wildly is that minor errors at the discount-factor stage are magnified many times over when translated into the forward rate. That is, any errors in the discount factors (which errors may stem from any of the sources noted earlier) are compounded when spot rates are calculated from them, and these are compounded into larger errors when calculating forward rates.

Smoothing Techniques

A common technique that may be used but which is not accurate and so not recommended is *linear interpolation*. In this approach, the set of bond prices is used to graph a redemption yield curve (as in the preceding section), and where bonds

EXHIBIT 41–12

Zero-Coupon (Spot) and Forward Rates Obtained from Treasury Yields, April 26, 2004



are not available for the required maturity term, the yield is interpolated from actual yields. Using Treasury yields for June 26, 2000, we plot this as shown in Exhibit 41–13. The interpolated yields are the ones not marked by a cross. Exhibit 41–13 looks reasonable for any practitioner's purpose. However, spot and forward yields that are obtained from this curve are apt to behave in unrealistic fashion, as shown in Exhibit 41–14. The forward curve is very bumpy, and each bump will correspond to a bond used in the original set. The spot rate has a kink at 21.5 years, and so the forward curve jumps significantly at this point. This curve would appear to be particularly unrealistic.

EXHIBIT 41–13

Linear Interpolation of Bond Yields, June 26, 2000

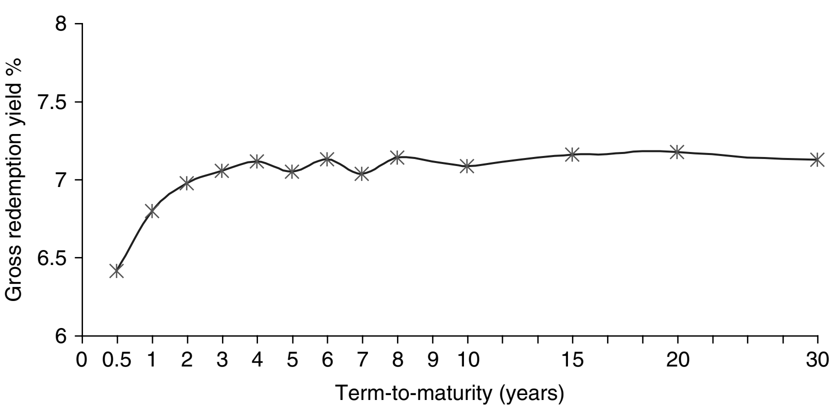
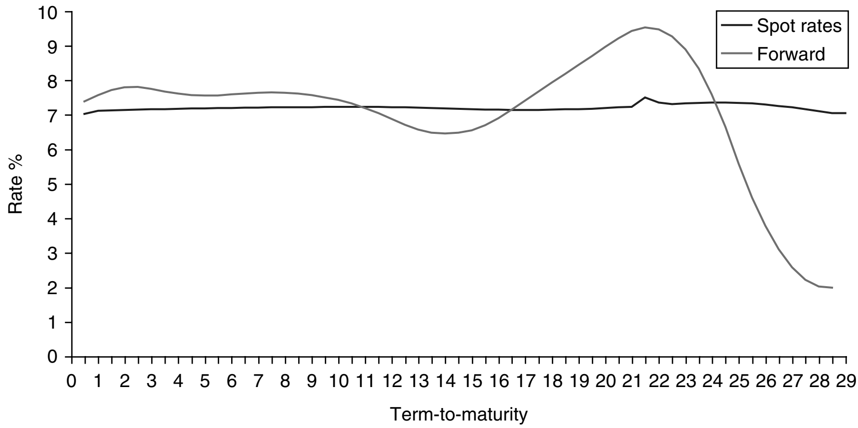


EXHIBIT 41–14

Spot and Forward Rates Implied from Exhibit 41–13



For this reason, market analysts do not bother with linear interpolation and instead use multiple regression or spline-based methods. One approach might be to assume a functional form for the discount function and estimate parameters of this form from the prices of bonds in the market. We consider these approaches next.

Using a Cubic Polynomial

A simple functional form for the discount function is a *cubic polynomial*. This approach consists of approximating the set of discount factors using a cubic function of time. If we say that $d(t)$ is the discount factor for maturity t, we approximate the set of discount factors using the following cubic function[15]:

$$\hat{d}(t) = a_0 + a_1(t) + a_2(t)^2 + a_3(t)^3 \tag{41–28}$$

The discount factor for $t = 0$, that is, at time now, is 1. Therefore, $a_0 = 1$, and Eq. (41–28) then can be rewritten as

$$\hat{d}(t) - 1 = a_1(t) + a_2(t)^2 + a_3(t)^3 \tag{41–29}$$

The market price of a traded coupon bond can be expressed in terms of discount factors. Thus, in Eq. (41–30), we show the expression for the price of an N-maturity bond paying identical coupons C at regular intervals and redeemed at maturity at M.

$$P = d(t_1)C + d(t_2)C + \cdots + d(t_N)(C + M) \tag{41–30}$$

15. In some texts, the coefficients sometimes are written as a, b, and c rather than c_1 and so on.

Using the cubic polynomial Eq. (41–28), Eq. (41–30) is transformed into

$$P = C[1 + a_1(t_1) + a_2(t_1)^2 + a_3(t_1)^3] + \cdots + (C + M)[1 + a_1(t_N) + a_2(t_N)^2 + a_3(t_N)^3] \tag{41–31}$$

We require the coefficients of the cubic function in order to start describing the yield curve, so we rearrange Eq. (41–31) to express it in terms of these coefficients. This is shown in Eq. (41–32):

$$P = M + \sum C + a_1[C(t_1) + \cdots + (C + M)(t_N)] + a_2[C(t_1)^2 + \cdots + (C + M)(t_N)^2] + a_3[C(t_1)^3 + \cdots + (C + M)(t_N)^3] \tag{41–32}$$

In the same way, we can express the pricing equation for each bond in our data set in terms of the unknown parameters of the cubic function.

From Eq. (41–32) we may write

$$P - \left(M + \sum C\right) = a_1X_1 + a_2X_2 + a_3X_3 \tag{41–33}$$

where X_i is the appropriate expression in brackets in Eq. (41–32); this is the form in which the expression is encountered commonly in textbooks.

We can illustrate this technique with an example. Assume that we have a benchmark semiannual coupon four-year bond with a coupon of 8% and trading at a price of 101.25. Assume that the first coupon is precisely six months from now so that $t_1 = 0.5$ and so $t_N = 4$. Set up the cubic function expression.

We have $C = 4$ and $M = 100$, so therefore

$$100 + \sum C = 100 + (8 \times 4) = 132$$

$$P - \left(100 + \sum C\right) = 101.25 - 132 = -30.75$$

$$X_1 = (4 \times 0.5) + (4 \times 1) + (4 \times 1.5) + \cdots + (104 \times 4) = 472$$

$$X_2 = [4 \times (0.5)^2] + [4 \times (1)^2] + [4 \times (1.5)^2] + \cdots + [104 \times (4)^2] = 1{,}796$$

$$X_3 = [4 \times (0.5)^3] + [4 \times (1)^3] + [4 \times (1.5)^3] + \cdots + [104 \times (4)^3] = 7{,}528$$

This means that we now have an expression for the three coefficients, which is

$$472a_1 + 1796a_2 + 7528a_3 = -30.75$$

The prices for all other bonds are expressed in terms of the unknown parameters. To calculate the coefficient values, we use a statistical technique such as linear regression or ordinary least squares to find the best fit for values in the cubic equation.[16]

16. See David Blake, *Financial Market Analysis,* 2d ed. (Chichester, England: Wiley, 2000).

In practice, the cubic polynomial approach is too limited a technique, requiring one equation per bond, and does not have the required flexibility to fit market data satisfactorily. The resulting curve is not really a curve but rather a set of independent discount factors that have been fit with a line of best fit. In addition, the impact of small changes in the data can be significant at the nonlocal level, so, for example, a change in a single data point at the early maturities can result in badly behaved longer maturities. It is still appropriate for many market applications. Alternatively, a *piecewise cubic polynomial approach* is used, whereby $d(t)$ is assumed to be a different cubic polynomial over each maturity range. This means that the parameters a_1, a_2, and a_3 will be different over each maturity range. We will look at a special case of this use, the cubic spline, a little later.

NONPARAMETRIC METHODS

Outside of the cubic polynomial approach described in the preceding section, there are two main approaches to fitting the term structure. These are usually grouped into *parametric* and *nonparametric* curves. Parametric curves are based on term-structure models such as the Vasicek model or Longstaff and Schwartz model.[17] Nonparametric curves are not derived from an interest-rate model and are general approaches described using a set of parameters. They include spline-based methods.

Spline-Based Methods

A *spline* is a statistical technique and a form of linear interpolation. There is more than one way of applying them, and the most straightforward method to understand the process is the spline function fitted using regression techniques. For the purposes of yield-curve construction, this method can cause curves to jump wildly and is oversensitive to changes in parameters.[18] However, we feel that it is the easiest method to understand.

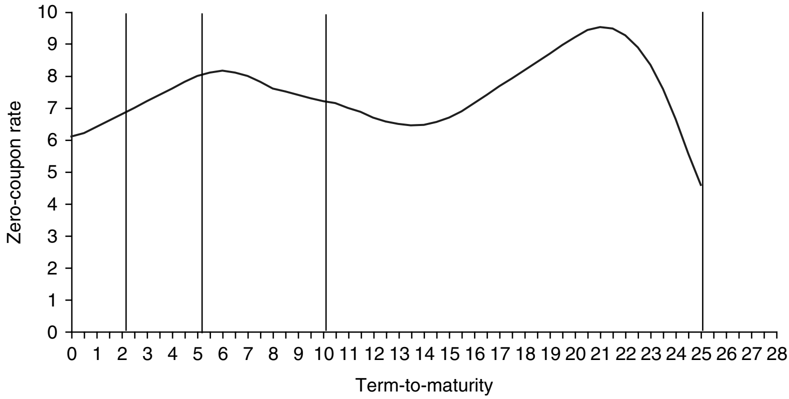
An nth order spline is a piecewise polynomial approximation with n-degree polynomials that are differentiable $n - 1$ times. *Piecewise* means that the different polynomials are connected at arbitrarily selected points known as *knot points.*[19] A cubic spline is a three-order spline and is a piecewise cubic polynomial that is differentiable twice along all its points.

The x axis in the regression is divided into segments at arbitrary points known as *knot points*. At each knot point the slopes of adjoining curves are required to match, as must the curvature. Exhibit 41–15 is a cubic spline. The knot

17. See F. A. Longstaff and E.S. Schwartz, "Interest Rate Volatility and the Term Structure: A Two-Factor General Equilibrium Interest Rate Model," *Journal of Finance* 47, (1992), pp. 1259–1282.
18. For instance, see Section 15.3 in James and Webber, *Interest Rate Modelling*.
19. See Chapter 15 in James and Webber, *Interest Rate Modelling*.

EXHIBIT 41–15

Cubic Spline with Knot Points at 0, 2, 5, 10, and 25 Years



points are selected at 0, 2, 5, 10, and 25 years. At each of these points the curve is a cubic polynomial, and with this function we could accommodate a high and low in each space bounded by the knot points.

Cubic spline interpolation assumes that there is a cubic polynomial that can estimate the yield curve at each maturity gap. One can think of a spline as a number of separate polynomials of $y = f(X)$, where X is the complete range, divided into user-specified segments, which are joined smoothly at the knot points. If we have a set of bond yields $r_0, r_1, r_2, \ldots, r_n$ at maturity points $t_0, t_1, t_2, \ldots, t_n$, we can estimate the cubic spline function in the following way[20]:

- The yield on bond i at time t is expressed as a cubic polynomial of the form $r_i(t) = a_i + b_i t + c_i t^2 + d_i t^3$ for the interval over t_i and t_{i-1}.
- The coefficients of the cubic polynomial are calculated for all n intervals between the $n + 1$ data points, which results in $4n$ unknown coefficients that must be computed.
- These equations can be solved because they are made to fit the observed data. They are twice differentiable at the knot points, and these derivatives are equal at these points.
- The constraints specified are that the curve is instantaneously straight at the start of the curve (the shortest maturity) and instantaneously straight at the end of the curve, the longest maturity, that is, $r''(0) = 0$.

20. An accessible and readable account of the practical implementation of the cubic spline technique can be found in Rod Pienaar and Moorad Choudhry, "Fitting the Term Structure of Interest Rates: A Practical Implementation of the Cubic Spline Methodology," in Frank J. Fabozzi (ed.), *Interest Rates, Term Structure and Valuation Modeling* (Hoboken, NJ: Wiley, 2002).

The general formula for a cubic spline is

$$s(\tau) = \sum_{i=0}^{3} a_i \tau^i + \frac{1}{3!}\sum_{p=1}^{n-1} b_p (\tau - X_p)^3 \tag{41–34}$$

where τ is the time of receipt of cash flows and X_p refers to the points where adjacent polynomials are joined and which are known as *knot points,* with $\{X_0, \ldots, X_n\}$, $X_p < X_{p+1}$, $p = 0, \ldots, n - 1$. In addition $(\tau - X_p) = \max(\tau - X_p, 0)$. The cubic spline is twice differentiable at the knot points. In practice, the spline is written down as a set of basis functions, with the general spline being made up of a combination of these. One way to do this is by using what are known as *B-splines.* For a specified number of knot points $\{X_0, \ldots, X_n\}$ this is given by Eq. (41–35):

$$B_p(\tau) = \sum_{j=p}^{p+4}\left(\prod_{i=p, i\neq p}^{p+4} \frac{1}{X_i - X_j}\right)(\tau - X_p)^3 \tag{41–35}$$

where $B_p(\tau)$ are cubic splines that are approximated on $\{X_0, \ldots, X_n\}$ with the following function:

$$\delta(\tau) = \delta(\tau \mid \lambda_{-3}, \ldots, \lambda_{n-1}) = \sum_{p=-3}^{n-1} \lambda_p B_p(\tau) \tag{41–36}$$

with $\lambda = (\lambda_{-3} \ldots, \lambda_{n-1})$ the required coefficients. The maturity periods $\tau_1, \ldots, \tau_n$ specify the B-splines so that $B = \{B_p(\tau_j)\}_{p=-3,\ldots,n-1, j=1,\ldots,m}$ and $\hat{\delta} = [\delta(\tau_1), \ldots, \delta(\tau_m)]$. This allows us to set

$$\hat{\delta} = B'\lambda \tag{41–37}$$

and, therefore, the regression equation

$$\lambda^* = \arg\min_{\lambda}\{\varepsilon'\varepsilon \mid \varepsilon = P - D\lambda\} \tag{41–38}$$

with $D = CB'$. $\varepsilon'\varepsilon$ are the minimum errors. The regression in Eq. (41–38) is computed using ordinary least squares regression.[21]

Nelson and Siegel Curves

The curve-fitting technique first described by Nelson and Siegel[22] has since been applied and modified by other authors, which is why the curves sometimes are described as a "family" of curves. These curves provide a satisfactory rough fit of

21. An illustration of the use of B-splines is given in James Steeley, "Estimating the Gilt-Edged Term Structure: Basis Splines and Confidence Intervals," *Journal of Business Finance and Accounting* 18 (1991), pp. 513–530. For an illustration with a complete methodology, see Didier Joannas, "B-Spline Modeling," Chapter 9 in M. Choudhry et al. (eds.), *Capital Market Instruments* (London: FT Prentice-Hall, 2001).

22. See Nelson and Siegel, "Parsimonius Modelling of Yield Curves."

the complete term structure, with some loss of accuracy at the very short and very long end. In the original curve, the authors specify four parameters. The approach is not a bootstrapping technique; rather, it is a method for estimating the zero-coupon rate function from the yields observed on T-bills under an assumed function for forward rates.

The Nelson and Spiegel curve states that the implied forward-rate yield curve may be modeled along the entire term structure using the following function:

$$rf(m,\beta) = \beta_0 + \beta_1 \exp\left(\frac{-m}{t_1}\right) + \beta_2\left(\frac{m}{t_1}\right)\exp\left(\frac{-m}{t_1}\right) \qquad (41\text{–}39)$$

where $\beta = (\beta_0, \beta_1, \beta_2, t_1)$ is the vector of parameters describing the yield curve, and m is the maturity at which the forward rate is calculated. There are three components, the constant term, a decay term, and a term reflecting the "humped" nature of the curve. The shape of the curve will lead gradually into an asymptote at the long end, the value of which is given by β_0, with a value of $\beta_0 + \beta_1$ at the short end.

A version of the Nelson and Siegel curve is the Svensson model,[23] with an adjustment to allow for the humped characteristic of the yield curve. This is fitted by adding an extension, as shown by Eq. (41–40):

$$rf(m,\beta) = \beta_0 + \beta_1 \exp\left(\frac{-m}{t_1}\right) + \beta_2\left(\frac{m}{t_1}\right)\exp\left(\frac{-m}{t_1}\right) + \beta_3\left(\frac{m}{t_2}\right)\exp\left(\frac{-m}{t_2}\right) \qquad (41\text{–}40)$$

The Svensson curve is modeled therefore using six parameters, with additional input of β_3 and t_2.

Nelson and Siegel curves are popular in the market because they are straightforward to calculate. Jordan and Mansi[24] state that one of the advantages of these curves is that they force the long-date forward curve into a horizontal asymptote, whereas another is that the user is not required to specify knot points, the choice of which determines the effectiveness or otherwise of cubic spline curves. The disadvantage they note is that these curves are less flexible than spline-based curves, and there is therefore a chance that they do not fit the observed data as accurately as spline models. James and Webber[25] also suggest that Nelson and Siegel curves are slightly inflexible owing to the limited number of parameters and are accurate for yield curves that have only one hump but are unsatisfactory for curves that possess both a hump and trough. Since they are only reasonable for approximations, Nelson and Siegel curves would not be appropriate for no-arbitrage applications.

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23. See Lars Svensson, "Estimating and Interpreting Forward Interest Rates: Sweden 1992–1994," working paper 4871, NBER.
24. See James Jordan and Satar Mansi, "How Well Do Constant Maturity Treasuries Approximate the On-the-Run Term Structure?" *Journal of Fixed Income* 10(2) (September 2000), pp. 35–45.
25. James and Webber, *Interest Rate Modelling,* pp. 444–445.

COMPARING CURVES

Whichever curve is chosen will depend on the user's requirements and the purpose for which the model is required. The choice of modeling methodology is usually a trade-off between simplicity and ease of computation and accuracy. Essentially, the curve chosen must fulfill the qualities of

- *Accuracy.* Is the curve a reasonable fit for the market curve? Is it flexible enough to accommodate a variety of yield-curve shapes?
- *Model consistency.* Is the curve-fitting method consistent with a theoretical yield-curve model such as Vasicek or Cox-Ingersoll-Ross?
- *Simplicity.* Is the curve reasonably straightforward to compute; that is, is it *tractable*? Does it offer ease of application?
- *Its purpose.* Will the curve that is computed be used to price bonds and interest-rate derivatives, or will it be used to identify arbitrage and relative-value opportunities?

The different methodologies all fit these requirements to greater or lesser extent. Most applications can be met with a simple curve-fitting technique such as cubic spline. Options market makers, who need to fit volatility surfaces, are one of the few market practitioners who will need to apply a more complex technique such as a multifactor yield-curve model.

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CHAPTER

FORTY-TWO

HEDGING INTEREST-RATE RISK WITH TERM-STRUCTURE FACTOR MODELS

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Portfolio managers seek to control or hedge the change in the value of a bond position or a bond portfolio to changes in risk factors. The relevant risk factors can be classified into two types: *term-structure risk factors* and *non-term-structure risk factors*. The former risks include parallel and nonparallel shifts in the term structure. Non-term-structure risk includes sector risk, quality risk, and optionality risk. Multifactor risk models that focus only on hedging exposure to interest-rate risks are referred to as the *term-structure factor model*.

Exposure to changes in interest rates is most often measured in terms of a bond or portfolio's *duration*. This is a one-dimensional measure of the bond's sensitivity to interest-rate movements. There is one complication, however: the value of a bond, or a bond portfolio, is affected by changes in interest rates of all possible maturities (i.e., changes in the term structure of interest rates). In other words, there is more than one risk factor that affects bond returns, and simple methods based on a one-dimensional measure of risk such as duration will not allow portfolio managers to manage interest-rate risks properly.[1] Hence the need for term-structure factor models.

In this chapter we show how term-structure factor models can be used in interest-rate risk management. These models have been designed to better account for the complex nature of interest-rate risk. Because it is never easy to hedge the risk associated with too many sources of interest-rate uncertainty, it is always desirable to try to reduce the number of term-structure risk factors and identify a limited number of common factors. There are several ways in which this can be done, and it is important to know the exact assumptions one has to make in the process and try to evaluate the robustness of these assumptions with respect to the specific scenario a portfolio manager has in mind.

We first briefly review the traditional duration hedging method, which is still used heavily in practice and has been illustrated in several chapters in this book. The approach is based on a series of very restrictive and simplistic assumptions, including the assumptions of a small and parallel shift in the yield curve. We then show how to relax these assumptions and implement hedging strategies that are robust with respect to a wider set of possible yield-curve changes. We conclude by analyzing the performance of various hedging techniques in a realistic situation, and we show that satisfying hedging results can be achieved by using a three-factor model for the yield-curve dynamics.

DEFINING INTEREST-RATE RISK(S)

The first fundamental fact about interest-rate risk management can be summarized by the following statement: bond prices move inversely to market yields.[2] More generally, we define as interest-rate risk the potential impact on a bond portfolio value of any given change in the location and shape of the yield curve.

To further illustrate the notion of interest-rate risk, we consider a simple experiment. A portfolio manager wishes to hedge the value of a bond portfolio that delivers deterministic cash flows in the future, typically cash flows from fixed-coupon Treasury securities. Even if these cash flows are known in advance, bond prices change in time, which leaves an investor exposed to a potentially significant capital loss.

1. This complication is not specific to the fixed income environment. In the world of equity investment, it has actually long been recognized that there may be more than one rewarded risk factor that affects stock returns. A number of more general multifactor models, economically justified either by equilibrium or arbitrage arguments, have been applied for risk management and portfolio performance evaluation.
2. There are some derivative mortgage products that do not possess this property.

To fix the notation, we consider at date t a bond (or a bond portfolio) that delivers m certain cash flows CF_i at future dates t_i, for $i = 1, \ldots, m$. The price V of the bond (expressed as a percentage of the face value) can be written as the sum of the future cash flows discounted with the appropriate zero-coupon rate with maturity corresponding to the maturity of the cash flows.

$$V_t = \sum_{i=1}^{m} \frac{CF_i}{[1+R(t,t_i-t)]^{t_i-t}} \tag{42–1}$$

where $R(t, t_i - t)$ is the associated zero-coupon rate, starting at date t for a remaining maturity of $t_i - t$ years.

We see in Eq. (42–1) that the price V_t is a function of m interest-rate variables $R(t, t_i - t)$. This suggests that the value of the bond is subject to a potentially large number m of risk factors. For example, the price of a bond with annual cash flows up to a 10-year maturity is affected by potential changes in 10 zero-coupon rates (i.e., the term structure of interest rates). To hedge a position in this bond, we need to be hedged against a change of all 10 of these risk factors.

In practice, it is not easy to perform risk management in the presence of many risk factors. In principle, one must design a *global portfolio* in such a way that the portfolio is insensitive to all sources of risk (the m interest-rate variables and the time variable t).[3] A global portfolio is one that contains the original portfolio plus any hedging instruments used to control the original portfolio's interest-rate risk. One suitable way to simplify the problem is to reduce the number of risk factors. Everything we cover in this chapter can be seen as a variation on the theme of reducing the dimensionality of the interest-rate risk-management problem.

We first consider the simplest model for interest-rate risk management, also known as *duration hedging,* which is based on a single risk variable, the yield-to-maturity of this portfolio.

HEDGING WITH DURATION

The intuition behind duration hedging is to bypass the complexity of a multidimensional interest-rate risk by identifying a single risk factor that will serve as a "proxy" for the whole term structure. The proxy measure used is the yield of a bond. In the case of a bond portfolio, it is the average portfolio yield.

3. In this chapter we do not consider the change of value owing to time because it is a deterministic term. We only consider changes in value owing to interest-rate variations. For details about the time value of a bond, see Don M. Chance and James V. Jordan, "Duration, Convexity, and Time as Components of Bond Returns," *Journal of Fixed Income* (September 1996), pp. 88–96.

First Approximation: Using a One-Order Taylor Expansion

The first step consists in writing the price of the portfolio V_t (in percent of the face value) as a function of a single source of interest-rate risk, its yield-to-maturity y_t, as shown below:

$$V_t = V(y_t) = \sum_{i=1}^{m} \frac{CF_i}{(1+y_t)^{t_i-t}} \qquad (42\text{–}2)$$

In this case, we can see clearly that the interest-rate risk is (imperfectly) summarized by changes of the yield-to-maturity y_t. Of course, this can only be achieved by losing much generality and imposing important, rather arbitrary and simplifying assumptions. The yield-to-maturity is a complex average of the entire term structure, and it can only be assimilated to the term structure if the term structure happens to be flat (i.e., the yield-to-maturity is the same for each maturity).

A second step involves the derivation of a *Taylor expansion* of the value of the portfolio V as an attempt to quantify the magnitude of value changes that are triggered by small changes y in yield. Before showing how this is done, let's briefly review what a Taylor expansion is. A Taylor expansion is a tool used in calculus to approximate the change in the value of a mathematical function owing to a change in a variable. The change can be approximated by a series of "orders," with each order related to the mathematical derivative of the function. When one refers to approximating a mathematical function by a first derivative, this means using a Taylor expansion with only the first order. Adding to the approximation from the second order to the approximation from the first order improves the approximation.

Let us return now to approximating the change in value of a bond when interest rates change. The mathematical function is Eq. (42–2), the value of a bond portfolio. The function depends on the yield. We denote dV as the change in the value of the portfolio triggered by small changes in yield denoted by dy. The approximate *absolute* change in the value of the portfolio triggered by small changes in yield in using a Taylor expansion is

$$dV(y) = V(y+dy) - V(y) = V'(y)dy + o(y) \approx \$\text{dur}[V(y)]dy \qquad (42\text{–}3)$$

where

$$V'(y) = -\sum_{i=1}^{m} \frac{(t_i - t)F_i}{(1+y_t)^{t_i-t+1}}$$

which is the derivative of the bond value function with respect to the yield-to-maturity. This value is known as the *dollar duration of the portfolio V*, denoted by \$duration, and $o(y)$ a negligible term.

Dividing Eq. (42–3) by $V(y)$, we obtain an approximation of the *relative* change in value of the portfolio as

$$\frac{dV(y)}{V(y)} = \frac{V'(y)}{V(y)}dy + o_1(y) \approx -MD[V(y)]dy \qquad (42\text{–}4)$$

where $MD\,[V(y)] = -[V'(y)/V(y)]$ is known as the *modified duration of portfolio V.*

The \$duration and the modified duration enable us to compute the absolute profit and loss for the portfolio (absolute P&L) and relative P&L of portfolio V for a small change Δy of the yield-to-maturity. That is,

$$\text{Absolute P\&L} \approx N_V \times \$\text{dur} \times \Delta y$$
$$\text{Relative P\&L} \approx -MD \times \Delta y$$

where N_V is the face value of the portfolio.

Performing Duration Hedging

We attempt to hedge a bond portfolio with face value N_V, yield-to-maturity y, and price denoted by $V(y)$. The idea is to consider one hedging instrument with face value N_H, yield-to-maturity y_H (*a priori* different from y), whose price is denoted by $H(y_H)$ and build a global portfolio with value V^* invested in the initial portfolio and some quantity ϕ of the hedging instrument.

$$V^* = N_V V(y) + \phi N_H H(y_H)$$

The goal is to make the global portfolio insensitive to small interest-rate variations. Using Eq. (42–3) and assuming that the yield-to-maturity curve is only affected by parallel shifts so that $dy = dy_H$, we obtain

$$dV^* \approx [N_V V'(y) + \phi N_H H'(y_H)]dy = 0$$

which translates into

$$\phi N_H \$\text{dur}[H(y_H)] = -N_V \$\text{dur}[V(y)]$$
$$\phi N_H H(y_1) MD[H(y_H)] = -N_V V(y) MD[V(y)]$$

so that we finally get

$$\phi = -\frac{N_V \$\text{dur}[V(y)]}{N_H \$\text{dur}[H(y_H)]} = -\frac{N_V V(y) MD[V(y)]}{N_H H(y_1) MD[H(y_H)]} \tag{42–5}$$

The optimal amount invested in the hedging instrument is simply equal to the opposite of the ratio of the \$duration of the bond portfolio to hedge by the \$duration of the hedging instrument when they have the same face value.

When the yield curve is flat, which means $y = y_H$, Eq. (42–5) simplifies to

$$\phi = -\frac{N_V V(y) D[V(y)]}{N_H H(y) D[H(y)]}$$

where the Macaulay duration $D[V(y)]$ is defined as

$$D[V(y)] = -(1+y)MD[V(y)] = \frac{\sum_{i=1}^{m} \frac{(t_i - t)F_i}{(1+y)^{t_i - t}}}{V(y)}$$

In practice, it is preferable to use futures contracts or swaps instead of bonds to hedge a bond portfolio because of significantly lower costs and higher liquidity. For example, using futures as hedging instruments, the hedge ratio ϕ_f is equal to

$$\phi_f = -\frac{N_V \$\mathrm{dur}_V}{N_F \$\mathrm{dur}_{CTD}} \times cf \qquad (42\text{–}6)$$

where N_F is the size of the futures contract. $\$\mathrm{dur}_{CTD}$ is the \$duration of the cheapest to deliver, and *cf* is the conversion factor.

Using standard swaps, the hedge ratio ϕ_s is

$$\phi_s = -\frac{N_V \$\mathrm{dur}_V}{N_S \$\mathrm{dur}_S} \qquad (42\text{–}7)$$

where N_S is the nominal amount of the swap, and $\$\mathrm{dur}_S$ is the \$duration of the fixed-coupon bond forming the fixed leg of the swap contract.[4]

Duration hedging is very simple. However, one should be aware that the method is based on the following, very restrictive assumptions:

- It is explicitly assumed that the value of the portfolio could be approximated by its first-order Taylor expansion. This assumption is all the more disputable that changes of the interest rates are larger. In other words, the method relies on the assumption of small yield-to-maturity changes. This is why the hedging portfolio should be readjusted reasonably often.
- It is also assumed that the yield curve is only affected by parallel shifts. In other words, interest-rate risk simply is considered as a risk on the general level of interest rates.

In what follows, we attempt to relax both assumptions to account for more realistic changes in the term structure of interest rates.

RELAXING THE ASSUMPTION OF A SMALL SHIFT

We have argued that \$duration provides a convenient way to estimate the impact of a *small* change *dy* in yield on the value of a bond or a portfolio.

Using a Second-Order Taylor Expansion

Duration hedging only works effectively for small yield changes because the price of a bond as a function of yield is nonlinear. In other words, the \$duration of a bond changes as the yield changes. When a portfolio manager expects a potentially large

4. For examples of hedging with futures, see Chapter 57. For examples of hedging portfolios constructed with futures contracts and swaps, see Lionel Martellini, Philippe Priaulet, and Stephane Priaulet, *Fixed-Income Securities: Valuation, Risk Management and Portfolio Strategies* (Chichester, England: Wiley, 2003).

shift in the term structure, a convexity term should be introduced, and the price change approximation can be improved if one can account for such nonlinearity by explicitly introducing the convexity term.

Let us take the following example to illustrate this point. We consider a 10-year maturity and 6% annual coupon bond trading at par. Its modified duration and convexity are equal to 7.36 and 57.95, respectively.[5] We assume that the yield-to-maturity goes suddenly from 6% to 8%, and we reprice the bond after this large change. The new price of the bond, obtained by discounting its future cash flows, is now equal to \$86.58, and the exact change in value amounts to –\$13.42 (= \$86.58 – \$100). Using a first-order Taylor expansion, the change in value is approximated by –\$14.72 (= –\$100 × 7.36 × 0.02), which overestimates the decrease in price by \$1.30. We conclude that a first-order Taylor expansion does not provide us with a good approximation of the bond price change when the variation of its yield-to-maturity is large.

If a portfolio manager is concerned about the impact of a larger move *dy* on a bond portfolio value, one needs to use (at least) a second-order version of the Taylor expansion as given below.

$$dV(y) = V'(y)dy + \frac{1}{2}V''(y)(dy)^2 + o[(dy)^2]$$

$$\approx \$\text{dur}[V(y)]dy + \frac{1}{2}\$\text{conv}[V(y)](dy)^2 \qquad (42\text{–}8)$$

where the quantity V'' also denoted \$conv[$V(y)$] is known as the \$convexity of the bond V.

Dividing Eq. (42–8) by $V(y)$, we obtain an approximation of the relative change in value of the portfolio as

$$\frac{dV(y)}{V(y)} \approx -MD[V(y)]dy + \frac{1}{2}RC[V(y)](dy)^2$$

where $RC[V(y)]$ is called the (relative) *convexity of portfolio V*.

We now reconsider the preceding example and approximate the bond price change by using Eq. (42–8). The bond price change is now approximated by –\$13.56[= –14.72 + (100 × 57.95 × 0.02²/2)]. We conclude that the second-order approximation is better suited for larger interest-rate deviations.

Performing Duration-Convexity Hedging

Hedging by taking into consideration first and second orders is called *duration-convexity hedging*. To perform a duration-convexity hedge, a portfolio manager needs to introduce two hedging instruments. We denote the value of the two hedging instructions by H_1 and H_2. The goal is to obtain a portfolio that is both

5. Note that convexity can be scaled in various ways.

\$duration-neutral and \$convexity-neutral. The optimal quantity (ϕ_1, ϕ_2) of these two hedging instruments to hold is then given by the solution to a system of equations at each date, assuming that $dy = dy_1 = dy_2$. The system of equations consists of two equations and two unknowns and can be solved easily algebraically.

More formally, the sytem of equations is

$$\begin{cases} \phi_1 N_{H_1} H_1'(y_1) + \phi_2 N_{H_2} H_2'(y_2) = -N_V V'(y) \\ \phi_1 N_{H_1} H_1''(y_1) + \phi_2 N_{H_2} H_2''(y_2) = -N_V V''(y) \end{cases}$$

which can be rewritten as:

$$\begin{cases} \phi_1 N_{H_1} \$\text{dur}[H_1(y_1)] + \phi_2 N_{H_2} \$\text{dur}[H_2(y_2)] = -N_V \$\text{dur}[V(y)] \\ \phi_1 N_{H_1} \$\text{conv}[H_1(y_1)] + \phi_2 N_{H_2} \$\text{conv}[H_2(y_2)] = -N_V \$\text{conv}[V(y)] \end{cases} \quad (42\text{–}9)$$

or

$$\begin{cases} \phi_1 N_{H_1} H_1(y_1) MD[H_1(y_1)] + \phi_2 N_{H_2} H_2(y_2) MD[H_2(y_2)] = -N_V V(y) MD[V(y)] \\ \phi_1 N_{H_1} H_1(y_1) RC[H_1(y_1)] + \phi_2 N_{H_2} H_2(y_2) MD[H_2(y_2)] = -N_V V(y) RC[V(y)] \end{cases}$$

RELAXING THE ASSUMPTION OF A PARALLEL SHIFT

Duration and duration-convexity hedging are based on single-factor models because only one interest rate is being considered. In this section we look at how we can go beyond a single-factor model to a term-structure factor model.[6]

Accounting for the Presence of Multiple Risk Factors

A major shortcoming of single-factor models is that they imply that all possible zero-coupon rates are perfectly correlated, making bonds redundant assets. We know, however, that rates with different maturities do not always change in the same way. In particular, long-term rates tend to be less volatile than short-term rates. An empirical analysis of the dynamics of the interest-rate term structure suggests that two or three factors account for most of the yield-curve changes. They can be interpreted, respectively, as level, slope and curvature factors (see below). This strongly suggests that a term-structure factor model should be used for pricing and hedging fixed income securities.

There are different ways to generalize duration hedging to account for nonparallel deformations of the term structure. The common principle behind all techniques is the following. Going back to Eq. (42–1), let us express the value of the portfolio using the entire curve of zero-coupon rates, where we now

6. See also Lionel Martellini, Philippe Priaulet, and Stephane Priaulet, "Beyond Duration," *Journal of Bond Trading and Management* (October 2002), pp. 103–119.

make explicit the time dependency of the variables. Hence we consider V_t to be a function of the zero-coupon rates $R(t, t_i - t)$. The risk factor is the yield curve as a whole, *a priori* represented by m components, as opposed to a single variable, the yield-to-maturity y.

The main challenge is then to narrow down this number of factors in the least arbitrary way. The good news is that one can show that a limited number (two or three) of suitably designed risk factors can account for a large fraction of the information in the whole term yield-curve dynamics. There is actually a systematic method that allows us to achieve this very objective through what is known as a *principal components analysis* (PCA) of interest-rate changes, as will now be explained. This arguably has become the state-of-the-art technique for interest-rate risk management.

Regrouping Risk Factors through a Principal Component Analysis

The purpose of PCA is to explain the behavior of observed variables using a smaller set of unobserved, implied variables. From a mathematical standpoint, it consists of transforming a set of m correlated variables into a reduced set of orthogonal variables that reproduce the original information present in the correlation structure. This tool can yield interesting results, especially for the pricing and risk management of correlated positions. Using PCA with historical zero-coupon rate curves (both from the Treasury and interbank markets), it has been observed that the first three principal components of spot-curve changes, which can be interpreted as level, slope, and curvature factors, explain the main part of the returns variations on fixed income securities over time. Exhibit 42–1 summarizes the results of several academic studies on the topic of PCA of spot-rate curves.

Using a PCA of the yield curve, we may now express the change $dR(t,\theta_k) = R(t+1,\theta_k) - R(t,\theta_k)$ of zero-coupon rate $R(t,\theta_k)$ with maturity θ_k at date t as a function of changes in the principal components (unobserved implicit factors)

$$dR(t,\theta_k) = \sum_{l=1}^{m} c_{lk} C_t^l + \varepsilon_{tk}$$

where c_{lk} is the sensitivity of the kth variable to the lth factor, defined as

$$\frac{\Delta\,[dR(t,\theta_k)]}{\Delta(C_t^l)} = c_{lk}$$

which amounts to individually applying a, say, 1% variation to each factor and computing the absolute sensitivity of each zero-coupon yield curve with respect to that unit variation.

These sensitivities are commonly called the *principal component $durations*. C_t^l is the value of the lth factor at date t, and ε_{tk} is the residual part of $dR(t,\theta_k)$ that is not explained by the factor model.

EXHIBIT 42–1

Summary of Results of Principal Component Analysis Applied to Spot-Rate Curves

Researchers	Country (Period)	Range	Factors	% of Explanation*
Litterman and Scheinkman	USA (1984–1988)	6M-18Y	3	88.04/8.38/1.97
Bühler and Zimmermann	Italy (1988–1992)	6M-7Y	3	93.91/5.49/0.42
Barber and Copper	USA (1985–1991)	1M-20Y	3	80.93/11.85/4.36
D'Ecclesia and Zenios	Germany Switzerland (1988–1996)	1M-10Y	3	71/18/4 75/16/3
Golub and Tilman	JP Morgan Risk Metrics—09/30/96	3M-30Y	3	92.8/4.8/1.27
Martellini and Priaulet	France (1995–1998)	1M-10Y	3	66.64/20.52/6.96
Lardic, Priaulet, and Priaulet	Belgium France Germany Italy UK (1998–2000)	1M-30Y	3	62/27/6 62/21/8 61/23/6 59/24/7 60/24/9

*For example, 88.04/8.38/1.97 means that the first factor explains 88.04% of the yield-curve deformations, the second 8.38%, and the third 1.97%.

Sources: Robert Litterman and Jose Scheinkman, "Common Factors Affecting Bond Returns," *Journal of Fixed Income* (September 1991), pp. 54–61; Alfred Bühler and Heinz Zimmermann, "A Statistical Analysis of the Term Structure of Interest Rates in Switzerland and Germany," *Journal of Fixed Income* (December 1996), pp. 55–67; Joel R. Barber and Mark L. Copper, "Immunization Using Principal Component Analysis," *Journal of Portfolio Management* (Fall 1996), pp. 99–105; Rita L. D'Ecclesia and Stavros Zenios, "Risk Factor Analysis and Portfolio Immunization in the Italian Bond Market," *Journal of Fixed Income* (September 1994), pp. 51–58; Bennett W. Golub and Leo M. Tilman, "Measuring Yield Curve Risk Using Principal Components Analysis, Value at Risk, and Key Rate Durations," *Journal of Portfolio Management* (Summer 1997), pp. 72–84; Lionel Martellini and Philippe Priaulet, *Fixed-Income Securities: Dynamic Methods for Interest Rate Risk Pricing and Hedging* (Chichester, England: Wiley, 2000); Sandrine Lardic, Philippe Priaulet, and Stephane Priaulet, "PCA of Yield Curve Dynamics: Questions of Methodologies," *Journal of Bond Trading and Management* (April 2003), pp. 327–349.

One can easily see why this method has become popular. Its main achievement is that it allows for the reduction of the number of risk factors with an optimally small loss of information. Since these three factors (parallel movement, slope oscillation, and curvature), regarded as risk factors, explain most of the variance in interest-rate changes, we may now use not more than three hedging instruments. We now write the changes of value of a fixed income portfolio as

$$dV_t^* \approx \sum_{k=1}^{m}\left[\frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3}\phi_t^j \frac{\partial H_t^j}{\partial R(t,\theta_k)}\right] dR(t,\theta_k)$$

We then use $dR(t,\theta_k) \approx \Sigma_{l=1}^{3} c_{lk} C_t^l$ to obtain

$$dV_t^* \approx \sum_{k=1}^{m} \left\{ \left[\frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3} \phi_t^j \frac{\partial H_t^j}{\partial R(t,\theta_k)} \right] \sum_{l=1}^{3} c_{lk} C_t^l \right\}$$

or

$$\begin{aligned} dV_t^* \approx & \sum_{k=1}^{m} \left[c_{1k} \frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3} \phi_t^j c_{1k} \frac{\partial H_t^j}{\partial R(t,\theta_k)} \right] C_t^1 \\ & + \sum_{k=1}^{m} \left[c_{2k} \frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3} \phi_t^j c_{2k} \frac{\partial H_t^j}{\partial R(t,\theta_k)} \right] C_t^2 \\ & + \sum_{k=1}^{m} \left[c_{3k} \frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3} \phi_t^j c_{3k} \frac{\partial H_t^j}{\partial R(t,\theta_k)} \right] C_t^3 \end{aligned}$$

The first term in this expression is commonly called the *principal component $duration* of portfolio V^* with respect to factor 1.

If we want to set the (first order) variations of the hedged portfolio V_t^* to zero for any possible change in interest rates $dR(t,\theta_k)$ or, equivalently, for any possible evolution of the C_t^l terms, we may take as a sufficient condition, for $l = 1, 2, 3$,

$$\sum_{k=1}^{m} \left[c_{lk} \frac{\partial V_t}{\partial R(t,\theta_k)} + \sum_{j=1}^{3} \phi_t^j c_{lk} \frac{\partial H_t^j}{\partial R(t,\theta_k)} \right] = 0$$

This is a neutral principal component $durations objective.

Finally, on each possible date, we are left with three unknowns ϕ_t^j and three linear equations. Let us introduce the following matrix notation

$$H_t' = \begin{pmatrix} \sum_{k=1}^{m} c_{1k} \frac{\partial H_t^1}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{1k} \frac{\partial H_t^2}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{1k} \frac{\partial H_t^3}{\partial R(t,\theta_k)} \\ \sum_{k=1}^{m} c_{2k} \frac{\partial H_t^1}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{2k} \frac{\partial H_t^2}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{2k} \frac{\partial H_t^3}{\partial R(t,\theta_k)} \\ \sum_{k=1}^{m} c_{3k} \frac{\partial H_t^1}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{3k} \frac{\partial H_t^2}{\partial R(t,\theta_k)} & \sum_{k=1}^{m} c_{3k} \frac{\partial H_t^3}{\partial R(t,\theta_k)} \end{pmatrix}$$

$$\Phi_t = \begin{pmatrix} \phi_t^1 \\ \phi_t^2 \\ \phi_t^3 \end{pmatrix} \qquad V_t' = \begin{pmatrix} -\sum_{k=1}^{m} c_{1k} \frac{\partial V_t}{\partial R(t,\theta_k)} \\ -\sum_{k=1}^{m} c_{2k} \frac{\partial V_t}{\partial R(t,\theta_k)} \\ -\sum_{k=1}^{m} c_{3k} \frac{\partial V_t}{\partial R(t,\theta_k)} \end{pmatrix}$$

We then have the system

$$H_t'\Phi_t = V_t'$$

The solution is given by

$$\Phi_t = (H_t')^{-1} V_t'$$

In practice, one needs to estimate the principal components \$durations used at date t. They are derived from a PCA performed on a period prior to t, for example, $[t - 3 \text{ months}, t]$. As a result, the output of the method becomes strongly sample-dependent. In an attempt to alleviate this concern over robustness, it is actually more convenient to use a suitable functional specification for the zero-coupon yield curve, provided that it is consistent with results from a PCA.

Hedging Using a Three-Factors Model of the Yield Curve

The idea here consists of using a model for the zero-coupon rate function. We detail below the Nelson and Siegel model,[7] as well as the Svensson (or extended Nelson and Siegel) model.[8] One may alternatively use the Vasicek model,[9] the extended Vasicek model, or the Cox-Ingersoll-Ross (CIR) (1985) model,[10] among many others.[11]

Nelson-Siegel and Svensson Models

Nelson and Siegel suggested modeling the continuously compounded zero-coupon rates $R^c(0, \theta)$ as

$$R^C(0,\theta) = \beta_0 + \beta_1\left[\frac{1-\exp(-\theta/\tau_1)}{\theta/\tau_1}\right] + \beta_2\left[\frac{1-\exp(-\theta/\tau_1)}{\theta/\tau_1} - \exp(-\theta/\tau_1)\right]$$

7. Charles R. Nelson and Andrew F. Siegel, "Parsimonious Modeling of Yield Curves," *Journal of Business* (October 1987), pp. 473–489.
8. Lars Svensson, "Estimating and Interpreting Forward Interest Rates: Sweden 1992–94," CEPR discussion paper 1051, October 1994.
9. Oldrich A. Vasicek, "An Equilibrium Characterisation of the Term Structure," *Journal of Financial Economics* (November 1977), pp. 177–188.
10. John C. Cox, Jonathan E. Ingersoll, and Stephen A. Ross, "A Theory of the Term Structure of Interest Rates," *Econometrica* (March 1985), pp. 385–407.
11. For details about these models, see Lionel Martellini and Philippe Priaulet, *Fixed-Income Securities: Dynamic Methods for Interest Rate Risk Pricing and Hedging* (Chichester, England: Wiley, 2000).

a functional form that was later extended by Svensson as

$$R^C(0,\theta) = \beta_0 + \beta_1\left[\frac{1-\exp(-\theta/\tau_1)}{\theta/\tau_1}\right] + \beta_2\left[\frac{1-\exp(-\theta/\tau_1)}{\theta/\tau_1} - \exp(-\theta/\tau_1)\right]$$
$$+\beta_3\left[\frac{1-\exp(-\theta/\tau_2)}{\theta/\tau_2} - \exp(-\theta/\tau_2)\right]$$

where

$R^C(0, \theta)$ = continuously compounded zero-coupon rate at time zero with maturity θ

β_0 = limit of $R^C(0, \theta)$ as θ goes to infinity (In practice, β_0 should be regarded as a long-term interest-rate.)

β_1 = limit of $R^C(0, \theta) - \beta_0$ as θ goes to 0 (In practice, β_1 should be regarded as the short- to long-term spread.)

β_2, β_3 = curvature parameters

τ_1 and τ_2 are scale parameters that measure the rate at which the short- and medium-term components decay to zero.

As shown by Svensson, the extended form is a more flexible model for yield-curve estimation, in particular in the short-term end of the curve, because it allows for more complex shapes such as U-shaped and hump-shaped curves. The parameters β_0, β_1, β_2, and β_3 typically are estimated on a daily basis by using an ordinary least squares (OLS) optimization program, which consists, for a basket of bonds, of minimizing the sum of the squared spread between the market price and the theoretical price of the bond as obtained with the model.[12]

We can see that the evolution of the zero-coupon rate $R^C(0,\theta)$ is entirely driven by the evolution of the beta parameters, the scale parameters being fixed.

In an attempt to hedge a bond, for example, one should design a global portfolio with the bond and hedging instrument so that the portfolio achieves a neutral sensitivity to each of the beta parameters. Before the method can be implemented, one therefore needs to compute the sensitivities of any arbitrary portfolio of bonds to each of the beta parameters.

Consider a bond that delivers principal or coupon and principal payments denoted by F_i at dates θ_i, for $i = 1, \ldots, m$. Its price P_0 at date $t = 0$ is given by the following formula:

$$P_0 = \sum_{i=1}^{m} F_i e^{-\theta_i R^C(0,\theta_i)}$$

12. For more details, see Martellini, Priaulet, and Priaulet, *Fixed-Income Securities: Valuation, Risk Management and Portfolio Strategies*.

In the Nelson and Siegel and Svensson models, we can calculate at date $t = 0$ the \$durations $D_i = \partial P_0 / \partial \beta_i$ for $i = 0, 1, 2, 3$ of the bond P to the parameters β_0, β_1, β_2, and β_3. They are given by the following formulas[13,14]:

$$\begin{cases} D_0 = -\sum_i \theta_i F_i e^{-\theta_i R^C(0,\theta_i)} \\ D_1 = -\sum_i \theta_i \left[\dfrac{1-\exp(-\theta_i/\tau_1)}{\theta_i/\tau_1} \right] F_i e^{-\theta_i R^C(0,\theta_i)} \\ D_2 = -\sum_i \theta_i \left[\dfrac{1-\exp(-\theta_i/\tau_1)}{\theta_i/\tau_1} - \exp(-\theta_i/\tau_1) \right] F_i e^{-\theta_i R^C(0,\theta_i)} \\ D_3 = -\sum_i \theta_i \left[\dfrac{1-\exp(-\theta_i/\tau_2)}{\theta_i/\tau_2} - \exp(-\theta_i/\tau_2) \right] F_i e^{-\theta_i R^C(0,\theta_i)} \end{cases} \tag{42–10}$$

Hedging Method

The next step consists of creating a global portfolio that would be unaffected by (small) changes of parameters β_0, β_1, β_2, and β_3. This portfolio will be made of

- The bond portfolio to be hedged, whose price and face value are denoted by P and N_P
- Four hedging instruments, whose prices and face values are denoted by G_i and N_{G_i}, for $i = 1, 2, 3$, and 4

We therefore look for the quantities q_0, q_1, q_2, and q_3 to invest, respectively, in the four hedging instruments G_0, G_1, G_2, and G_3 so as to satisfy the following linear system:

$$\begin{cases} q_1 N_{G_1} \dfrac{\partial G_1}{\partial \beta_0} + q_2 N_{G_2} \dfrac{\partial G_2}{\partial \beta_0} + q_3 N_{G_3} \dfrac{\partial G_3}{\partial \beta_0} + q_4 N_{G_4} \dfrac{\partial G_4}{\partial \beta_0} = -N_P D_0 \\ q_1 N_{G_1} \dfrac{\partial G_1}{\partial \beta_1} + q_2 N_{G_2} \dfrac{\partial G_2}{\partial \beta_1} + q_3 N_{G_3} \dfrac{\partial G_3}{\partial \beta_1} + q_4 N_{G_4} \dfrac{\partial G_4}{\partial \beta_1} = -N_P D_1 \\ q_1 N_{G_1} \dfrac{\partial G_1}{\partial \beta_2} + q_2 N_{G_2} \dfrac{\partial G_2}{\partial \beta_2} + q_3 N_{G_3} \dfrac{\partial G_3}{\partial \beta_2} + q_4 N_{G_4} \dfrac{\partial G_4}{\partial \beta_2} = -N_P D_2 \\ q_1 N_{G_1} \dfrac{\partial G_1}{\partial \beta_3} + q_2 N_{G_2} \dfrac{\partial G_2}{\partial \beta_3} + q_3 N_{G_3} \dfrac{\partial G_3}{\partial \beta_3} + q_4 N_{G_4} \dfrac{\partial G_4}{\partial \beta_3} = -N_P D_3 \end{cases} \tag{42–11}$$

In the Nelson and Siegel model, we only have three hedging instruments because there are only three parameters.

13. Of course, \$duration D_3 is only obtained in the Svensson model.
14. An example of calculation of the level, slope, and curvature \$durations is given in Martellini, Priaulet, and Priaulet, *Fixed-Income Securities: Valuation, Risk Management and Portfolio Strategies*. See also Andrea J. Heuson, Thomas F. Gosnell, Jr., and W. Brian Barrett, "Yield Curve Shifts and the Selection of Immunization Strategies," *Journal of Fixed Income* (September 1995), pp. 53–64; and Ram Willner, "A New Tool for Portfolio Managers: Level, Slope and Curvature Durations," *Journal of Fixed Income* (June 1996), pp. 48–59.

EXHIBIT 42–2

Characteristics of the Bond Portfolio to Be Hedged

Price	YTM	$duration	$convexity	Level	Slope	Curvature
972.376	7.169%	–5,709.59	79,662.17	–6,118.91	–1,820.02	–1,243.28

COMPARATIVE ANALYSIS OF VARIOUS HEDGING TECHNIQUES

We now analyze the hedging performance of three methods in the context of a specific bond portfolio. The methods we consider in this horse race are the duration hedge, the duration/convexity hedge, and the Nelson-Siegel $durations hedge.

Let us assume that at the initial date $t = 0$ the continuously compounded zero-coupon yield curve is described by the following set of parameters of the Nelson and Siegel model[15]: $\beta_0 = 8\%$, $\beta_1 = -3\%$, $\beta_2 = -1\%$, and $\tau = 3$.

This corresponds to a standard upward-sloping yield curve. We consider a bond portfolio whose features are summarized in Exhibit 42–2. The price is expressed in percentage of the face value, which is equal to $100 million. We compute the yield-to-maturity (YTM), the $duration, the $convexity, and the level, slope, and curvature $durations of the bond portfolio, as given by Eq. (42–10).

To hedge the bond portfolio, we use three-plain vanilla six-month LIBOR swaps whose features are summarized in Exhibit 42–3. $duration, $convexity, and level, slope, and curvature $durations are those of the fixed-coupon bond contained in the swap. The principal amount of the swaps is $1 million. They all have an initial price of zero.

We consider that the bond portfolio and the swap instruments present the same default risk, so we are not concerned with this additional source of uncertainty, and we can use the same yield curve to price them. This curve is the one described earlier with the Nelson and Siegel parameters.

To measure the performance of the three hedging methods, we assume 10 different possible changes in the yield curve. These 10 scenarios are

15. Note that we can obtain the annualized compounded zero-coupon yield curve by using the following equation:

$$R(t,\theta) = \exp[R^C(t,\theta)] - 1$$

where $R^C(t,\theta)$ is the continuously compounded zero-coupon rate at date t with maturity θ, and $R(t,\theta)$ is its annualized compounded equivalent.

EXHIBIT 42–3

Characteristics of the Swap Instruments

Maturity	Swap Rate	$duration	$convexity	Level	Slope	Curvature
2 years	5.7451%	–184.00	517.09	–194.55	–142.66	–41.66
7 years	6.6717%	–545.15	3,809.39	–579.80	–242.66	–166.22
15 years	7.2309%	–897.66	11,002.57	–948.31	–254.58	–206.69

obtained by assuming the following changes in the beta parameters in the Nelson and Siegel model:

- Small parallel shifts with $\beta_0 = +0.1\%$ and $\beta_0 = -0.1\%$
- Large parallel shifts with $\beta_0 = +1\%$ and $\beta_0 = -1\%$
- Decrease and increase of the short- to long-term spread with $\beta_1 = +1\%$ and $\beta_1 = -1\%$
- Curvature moves with $\beta_2 = +0.6\%$ and $\beta_2 = -0.6\%$
- Flattening and steepening moves of the yield curve with ($\beta_0 = -0.4\%$, $\beta_1 = +1.2\%$) and ($\beta_0 = +0.4\%$, $\beta_1 = -1.2\%$)

The six last scenarios, which represent nonparallel shifts, are displayed in Exhibits 42–4, 42–5, and 42–6.

Duration hedging is performed with the 7-year maturity swap using Eq. (42–7), leading us to enter 1,047 payer swaps. Duration/convexity is performed with the 7-year and 15-year maturity swaps using Eq. (42–9), leading us to enter 337 7-year maturity payer swaps and to enter 841 15-year maturity receiver swaps. Nelson and Siegel $durations hedge is performed with the three swaps using Eq. (42–11), leading us to enter 407 2-year maturity payer swaps, to enter 219 7-year maturity receiver swaps, and to enter 696 15-year maturity payer swaps. Results are given in Exhibit 42–7, where we display the change in value of the global portfolio (which aggregates the change in value on the bond portfolio and the hedging instruments), assuming that the yield-curve scenario occurs instantaneously. This change in value can be regarded as the hedging error for the strategy. It would be exactly zero for a perfect hedge.

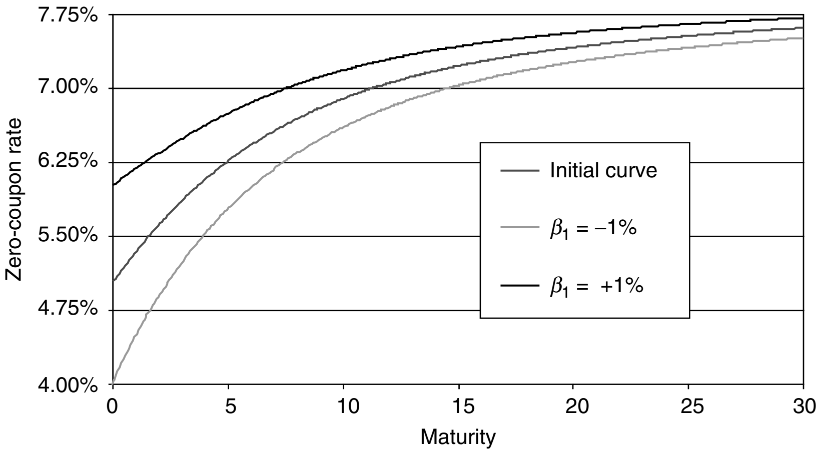
The value of the bond portfolio is equal to $972,375,756.[16] With no hedge, we see clearly that the loss in portfolio value can be significant in all adverse scenarios.

As expected, duration hedging appears to be effective only for small parallel shifts of the yield curve. The hedging error is positive for large parallel shifts

16. Opposite results in terms of hedging errors would be obtained if the investor were to short the bond portfolio.

EXHIBIT 42–4

New Yield Curve after an Increase ($\beta_1 = +1\%$) and a Decrease ($\beta_1 = -1\%$) of the Slope Factor



because of the positive convexity of the portfolio. For nonparallel shifts, the loss incurred by the global portfolio can be very significant. For example, the portfolio value drops by $7,311,245 in the pure-slope scenario when $\beta_1 = -1\%$ and $8,665,316 in the steepening scenario. As also expected, duration-convexity hedging is better than duration hedging when large parallel shifts occur. On the

EXHIBIT 42–5

New Yield Curve after an Increase and a Decrease of the Curvature Factor ($\beta_2 = +0.6\%$) and ($\beta_2 = -0.6\%$)

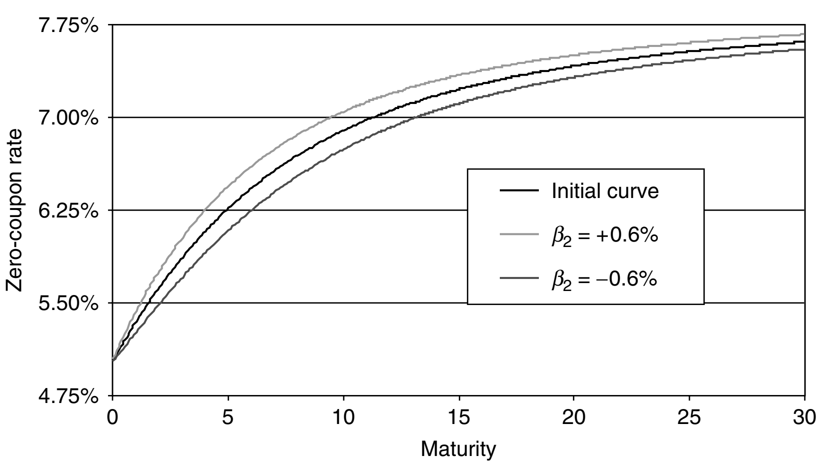
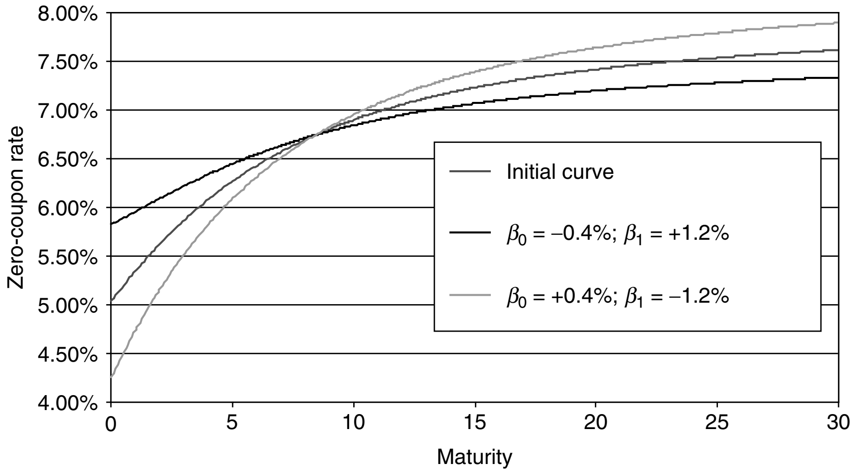


EXHIBIT 42–6

New Yield Curve after a Flattening Movement ($\beta_0 = -0.4\%$, $\beta_1 = +1.2\%$) and a Steepening Movement ($\beta_0 = +0.4\%$, $\beta_1 = -1.2\%$)



other hand, it appears to be ineffective for all other scenarios, even if the hedging errors are still better (smaller) than those obtained with duration hedging. Finally, we see that the Nelson and Siegel $durations hedging scheme is a very reliable method for all kinds of yield-curve scenarios. In all cases, the hedging

EXHIBIT 42–7

Hedging Errors in Dollars of the Three Different Methods: Duration, Duration/Convexity, and Nelson and Siegel $durations

Yield-Curve Scenario	No Hedge	Duration	Duration/ Convexity	Nelson-Siegel $durations
$\beta_0 = +0.1\%$	–6,076,494	–25,627	–97,826	8,573
$\beta_0 = -0.1\%$	6,161,872	71,692	97,435	2,013
$\beta_0 = +1\%$	–57,176,627	1,605,853	–1,050,770	475,891
$\beta_0 = -1\%$	65,743,922	3,028,609	1,026,043	599,622
$\beta_1 = +1\%$	–17,982,901	7,103,063	–4,934,261	15,557
$\beta_1 = -1\%$	18,421,236	–7,311,245	5,001,463	–4,959
$\beta_2 = +0.6\%$	–7,410,125	2,972,451	–400,339	1,131
$\beta_2 = -0.6\%$	7,509,714	–2,991,594	381,400	–9,038
$\beta_0 = +0.4\%$, $\beta_1 = -1.2\%$	–2,438,405	–8,665,316	5,661,669	90,991
$\beta_0 = -0.4\%$, $\beta_1 = +1.2\%$	2,839,537	9,024,298	–5,474,877	94,636

error appears to be negligible when compared with the initial value of the bond portfolio.

SUMMARY

A decline (rise) in interest rates will cause a rise (decline) in bond prices, with the most volatility in bond prices occurring in longer-maturity bonds and bonds with low coupons. Just as the risk on a stock portfolio is usually proxied by its beta, which is a measure of the stock sensitivity to market movements, bond price risk is most often measured in terms of the bond interest-rate sensitivity, or duration. This is a convenient one-dimensional measure of the bond's sensitivity to interest-rate movements.

Duration provides a portfolio manager with a convenient hedging strategy: to offset the risks related to a small change in the level of the yield curve, one should optimally invest in a hedging asset a proportion equal to the opposite of the ratio of the (dollar) duration of the bond portfolio to be hedged by the (dollar) duration of the hedging instrument.

Duration hedging is convenient because it is very simple. On the other hand, it is based on the following, very restrictive assumptions: (1) it is explicitly assumed that changes in the yield curve will be small, and (2) it is also assumed that the yield curve is only affected by parallel shifts. An empirical analysis of bond markets suggests, however, that large variations can affect the yield-to-maturity curve and that three main factors (level, slope, and curvature) have been found to drive the dynamics of the yield curve. This strongly suggests that duration hedging is inefficient in many circumstances.

In this chapter we go "beyond duration" by relaxing the two aforementioned assumptions. Relaxing the assumption of a small change in the yield curve can be performed though the introduction of a convexity adjustment in the hedging procedure. Convexity is a measure of the sensitivity of $duration with respect to yield changes. Accounting for general, nonparallel deformations of the term structure is not easy because it increases the dimensionality of the problem. Because it is never easy to hedge the risk associated with too many sources of uncertainty, it is always desirable to try to reduce the number of risk factors and identify a limited number of common factors. This can be done in a systematic way by using an appropriate statistical analysis of the yield-curve dynamics. Alternatively, one may choose to use a model for the discount-rate function.

Finally, we analyzed the performance of the various hedging techniques in a realistic situation, and we show that satisfying hedging results can be achieved by using a three-factor model for the yield curve.

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PART
SIX

BOND PORTFOLIO MANAGEMENT

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CHAPTER
FORTY-THREE

INTRODUCTION TO BOND PORTFOLIO MANAGEMENT

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Traditional bond management can be likened to a sailing regatta. The index is the lead boat because it does not have expenses and transaction costs to contend with, and all managers (including index fund managers) are the other boats, trying to make up the distance and pass the index boat—or at least keep pace with it. Strategies that may be used to make up the difference and pass the lead boat comprise a wide spectrum of styles and approaches. (Exhibit 43–1 displays the major elements of these approaches.)

In this chapter we'll examine this spectrum, investigating the pros and cons of matching—and mismatching—bond indexes and comparing ways of constructing bond portfolios. Our examination will include a detailed look at the factors to consider when matching a bond index's risk factors, as well as the methods that may be used to provide an edge over an index.

OVERVIEW OF TRADITIONAL BOND MANAGEMENT

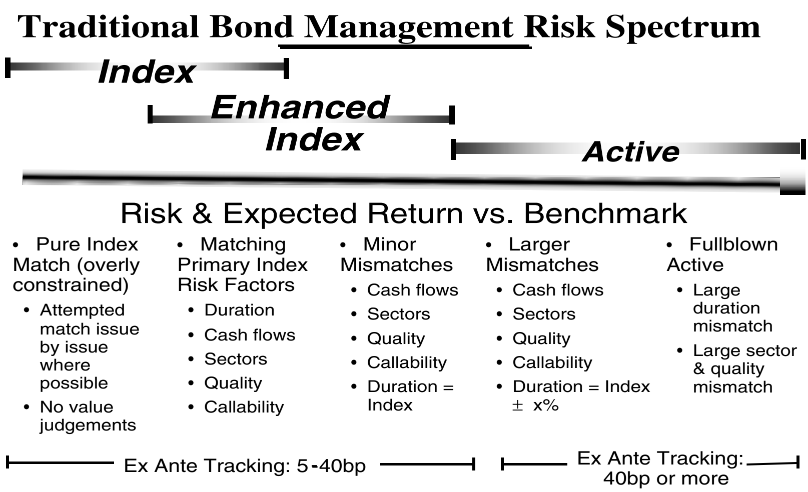
Although bond portfolio management can be complicated, deciding on an investment approach requires an answer to a fairly simple question: How much risk would you like to take?

Pure Bond Index Matching

Pure bond indexing is the lowest-risk (and lowest expected return) approach to bond management versus a specific benchmark. This approach essentially guarantees that returns will lag behind the index by the cost difference (expenses plus transaction costs). Pure bond index matching attempts to fully replicate the index by owning all the bonds in the index in the same proportion as the index. In the bond market, however, such an approach is very difficult to accomplish and very costly to implement. Many bonds in the index were issued years ago and therefore are illiquid. Many bonds also were issued when interest rates were significantly

EXHIBIT 43–1

Traditional Bond Management Risk Sprectrum



different from current rates. Today's holders may be unwilling to incur a gain or loss by selling their bonds to an index fund.

On December 31, 2003, the Lehman Brothers Aggregate Bond Index contained 6,766 different issues comprised of 109 Treasury issues, 693 federal agency issues, 3,482 credit (corporate and foreign government) issues, 719 asset-backed issues, 1,321 commercial mortgage-backed securities, and 442 broadly categorized mortgage issues (essentially hundreds of thousands of mortgage pools). In the Treasury market, matching an index security by security is feasible, although not desirable (for reasons to be covered later). However, full replication cannot be reasonably implemented in the agency, mortgage, or corporate bond markets. Thousands of agency and corporate issues are locked away in long-term bond portfolios and must be purchased from the investors who own them—often at a big premium. For this reason, full replication of a broad bond index is very inefficient, if not impossible. And, as you'll see, it's also unnecessary.

Enhanced Indexing: Matching Primary Risk Factors

This approach involves investing in a large sample of bonds so that the portfolio risk factors match the index's risk factors. The result is a portfolio that will have higher average monthly tracking differences (standard deviation of tracking differences) than the full-replication approach. However, it can be implemented and maintained at much lower cost. This lower cost results in *net* investment performance that is much closer to the index. Returning to the regatta analogy, the portfolio boat stays on the same "tack" as the index boat but "trims its sails" to run a little more efficiently. Staying on the same "tack" means that the sails are set to take the portfolio boat in the same direction as the index boat, thereby being exposed to the same winds and elements. "Trimming the sails" means that the little details of the sail position and sail shape are performed better and executed more efficiently than on the index boat. The risk factors that need to be matched are duration, cash-flow distribution, sector, quality, and call exposure (more on this later). This approach is considered a form of enhanced indexing because the return is enhanced (more on this later) relative to the full-replication indexing approach.

Enhanced Indexing: Minor Risk-Factor Mismatches

This approach allows for minor mismatches in the risk factors (except duration) to tilt the portfolio in favor of particular areas of relative value, such as certain sectors, credit ratings, term structure, call risk, or other factors. Because the mismatches (and impact on tracking) are very small, this is still considered enhanced indexing. These additional enhancements are essentially "sail trimming" strategies.

Active Management: Larger Risk-Factor Mismatches

This is a conservative approach to active management. The manager will make larger mismatches in the risk factors to attempt to add greater value. This approach also may make small duration bets. In most cases, the management fee and transaction costs are significantly higher than for pure or enhanced indexing, yet the net investment return is usually lower. The addition of these additional costs is the reason why a typical index portfolio often outperforms the average active manager in performance universes. Typically, the manager will moderately change tack to seek greater "winds" to overcome the strategy's higher cost. Consequently, manager risk comes into play and increases the likelihood that the portfolio deviates from the market return and structure.

Active Management: Full-Blown Active

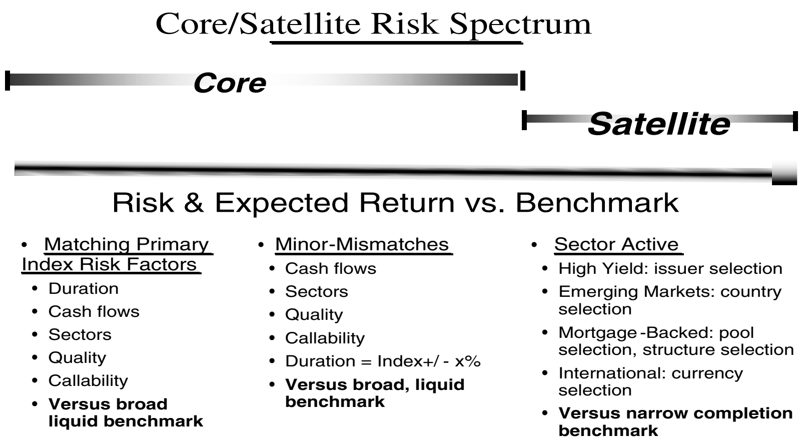
This is an aggressive style in which large duration and sector bets are made and in which significant variation from index can occur. Above-average performance consistency is difficult to find among the mangers that employ this approach. As a result, investors who choose this management style need to look deeper than recent performance to discern the good from the bad. This approach may involve significantly changing "course" relative to the index boat and may risk significant tracking and portfolio structure variations. Of course, the goal of this riskier strategy is to provide a return that is higher than that of the Index.

OVERVIEW OF THE CORE/SATELLITE APPROACH

Although many of these traditional approaches are alive and well, many investment managers have moved a few steps beyond this conventional model and are

EXHIBIT 43–2

Core/Satellite Risk Spectrum



building portfolios with a conservative, low-cost (often index-based) core and satellites that may encompass a variety of active strategies. As shown in Exhibit 43–2, a core portfolio typically is managed against a broad, liquid benchmark within a tight risk budget, generally under 40 basis points ex-ante tracking standard deviation versus the benchmark. As you'll see, there are several ways to build the core and the satellite portions of such portfolios.

Risk-Factor Matching

The first investment approach within the core classification is the "risk-factor matching" approach. In this strategy, the manager creates a broadly diversified portfolio that closely replicates primary index risk factors such as duration, cash-flow distribution, sectors, quality, and callability. The ex-ante tracking error is expected to be below 20 basis points. Since this high-quality, liquid bond market is assumed to be efficiently priced, the expected opportunity to outperform the index is very limited. Therefore, the objective is to match and replicate the risks and generate the returns of the target benchmark at the lowest possible cost (management fee and transactions costs).

Minor Mismatching

The second investment approach within the core classification is the "minor mismatching" approach. Here, the manager is given a larger risk budget (20 to 40 basis points) to mismatch relative to a broad liquid benchmark characteristics such as cash-flow distribution, sector and quality weightings, and even duration, to a limited extent. The expectation is that the manager will add value relative to that broad benchmark. As a result of this expected added value, the manager also would have a higher fee structure.

The Satellite Investments

The satellite portion focuses on the less-liquid sectors that have lower correlations with the broad liquid core. This manager is given a smaller pool of assets and a much larger risk budget relative to the narrow benchmark. This bigger risk budget provides opportunity for the manager to take meaningful selection, sector, and quality risk relative to the benchmark, with the expectation of adding considerable value.

Examples of such narrow, less-liquid markets include high-yield and emerging market bonds. In the case of the high-yield market, issuer and sector selection are primary determinants of added value versus the benchmark. Within the emerging bond market, country selection is a driving force in adding value. In many cases, the mortgage-backed market is also viewed as a satellite market owing to the many structural complexities that are based on interest-rate volatility risk. Securities with exposure to foreign currencies may be considered satellites, as could inflation-protected securities.

A key requirement of the satellite component is that it act as a diversifier and that it have a higher expected return owing to its illiquidity and lower credit quality.

WHY CHOOSE INDEXING?

As we've demonstrated, indexing plays a big part in bond management. In some cases it may be used as a part of a portfolio, and in others it may serve as the approach for an entire portfolio. So what makes indexing an effective method of bond investing? Simply, bond indexing, which has proven its mettle over the past two decades, offers broad diversification and low costs. Low costs are a vitally important aspect of bond indexing because lower costs mean tighter tracking of an index. This, in turn, means that an index portfolio will provide competitive performance that is consistent with the market—or market segment—that it tracks. And it means that nonindex (higher-cost) portfolios will find it tough to beat the index portfolio. Finally, indexing provides a benefit that is mainly psychological: it allows investors to focus on asset allocation—or in the case of the core/satellite approach, on selecting the best investment managers.

Broad Diversification

Broad bond index portfolios provide excellent diversification. The Lehman Brothers Aggregate Bond Index, which is designed to capture the entire U.S.

investment-grade bond market, has over 6,700 issues and more than $7.6 trillion in market value as of December 31, 2003. A large bond index portfolio designed to replicate this index may have 500 or more issues, resulting in significant issuer diversification benefits. Most active portfolios have much heavier specific issuer concentrations, resulting in significant exposure to issuer event (credit) risk.

In addition, an index portfolio designed to match the Lehman Brothers Aggregate Bond Index will have exposure not only to Treasury and agency sectors but also to mortgages, industrials, electric and telephone utilities, finance, dollar-denominated foreign, and asset-backed sectors. Such a portfolio also will have broad exposure to the yield curve with holdings from one year to over 30 years to maturity. These sources of diversification result in a portfolio with lower risk for a given level of return than is available from less diversified portfolios.

Low Cost

The primary reason for competitive performance of index funds is lower cost. This lower cost takes two forms: (1) lower management fees and (2) lower transaction costs associated with lower portfolio turnover rates. This lower cost advantage is durable and predictable—year after year. Don Phillips, president of Morningstar, summarizes the impact of higher costs: "If you pay the executive at Sara Lee more, it doesn't make the cheesecake less good. But with mutual funds (investment management), it comes directly out of the batter." Indeed it does!

Competitive Performance

Since index portfolios have lower management fees and lower transaction costs (resulting from significantly lower portfolio turnover), it is not surprising that they usually outperform the average active portfolio in most universes. After all, a broad index is by design a representation of the whole pie of investment alternatives. Therefore, the sum of all active managers should equal the index in composition. Also, the sum of the investment performance of all active managers (grossed up for the higher management fees and transaction costs) also should equal the index in performance. In the mutual fund market, where the bond index expense ratio advantage is about 0.8% per year, the Lehman Aggregate Bond Index (adjusted for an estimated 20 basis point expense ratio) outperformed over 73% of its Lipper Group over 3 years, 77% over 5 years, and 84% over 10 years ending December 31, 2003. In the large institutional market, where the expense advantage of indexing is lower, index portfolios outperformed 60% to 75% of actively managed portfolios over the same periods (depending on the universe chosen).

Consistent Relative Performance

Exhibit 43–3 shows the performance for the Lehman Aggregate Bond Index (adjusted for an estimated 20 basis point expense ratio) against its Lipper universe (intermediate investment grade) for calendar years starting in 1994.

EXHIBIT 43–3

Annual Performance Relative Consistency Analysis versus Lipper Intermediate Investment Grade

	Index Return*	Percent Outperformed
1994	–3.12	64%
1995	18.27	80%
1996	3.43	70%
1997	9.45	86%
1998	8.49	80%
1999	–1.02	68%
2000	11.43	80%
2001	8.24	82%
2002	10.06	90%
2003	3.90	42%
3 Years	7.37	73%
5 Years	6.42	77%
10 Years	6.75	84%

*Lehman Aggregate return –0.2%.

The only year during which this portfolio outperformed less than 50% of the universe was 2003, when it outperformed 42%. This was due primarily to poor performance from the MBS sector, which suffered at the hands of a heavy refinancing activity. In each of the other years, the portfolio outperformed anywhere from 64% to 90% of the competition in its maturity and quality category. Over the full 10 years, the average was a remarkable 74%. The primary reason for this consistent outperformance was the index portfolio's significantly lower expenses and transaction costs.

Market Performance Predictability

A properly managed broad bond index portfolio can be assured of performing in line with the market as a whole. Regardless of the direction the market takes, the investor can be assured that the performance of a diversified broad will follow along.

A Time-Tested Track Record

Bond index portfolios have been managed successfully since the early 1980s—through rising and falling interest-rate cycles, as well as through cycles during which credit spreads widened and narrowed. Through all these market changes, bond indexing has proven to provide a more than competitive return with low to moderate risk.

Perhaps the most significant benefit of indexing is that it enables investors to concentrate on more important decisions, namely, allocating assets properly. Very often, time and effort are wasted on the hope of adding 20 to 40 basis points on the very efficiently priced bond portion of a portfolio when existing misallocation of assets to stocks or international investments are resulting in hundreds of basis points of underperformance for the entire portfolio. Indexing the core of the portfolio that represents the highly liquid markets helps to facilitate more effective use of limited decision-making resources available to most investors. For those using a core/satellite approach, indexing provides an opportunity to focus on selecting the best managers for the satellites.

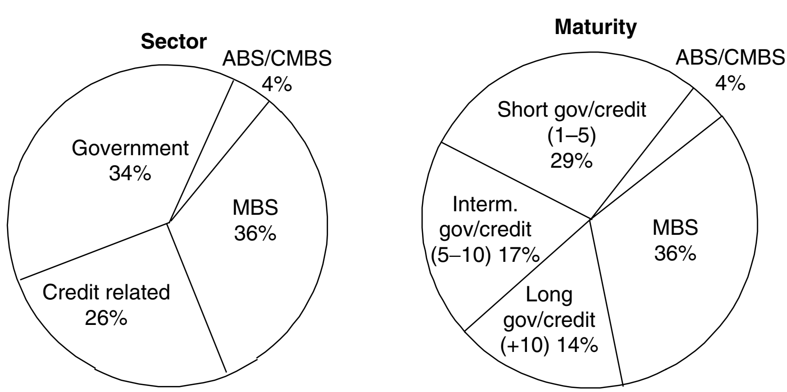
WHICH INDEX SHOULD BE USED?

Once you have decided to take advantage of the indexing approach to bond management, your attention should turn to the next important question: Which index? A bond index is defined by a set of rules (characteristics) that are then applied to all issues in the marketplace. The rules include maturity, size, sector, and quality characteristics. The issues that fit the rules are then combined, as if in a portfolio, with each issue's weight determined by its relative market value outstanding.

Generally, the broader the index, the better is the benchmark. The broadest U.S. bond index is the Lehman Brothers Aggregate Bond Index. (The Lehman Aggregate is essentially identical to the Salomon Broad Investment Grade Index and the Merrill Lynch Domestic Master Index.) On December 31, 2003, the Lehman Aggregate consisted of more than 6,700 issues, representing a market value of more than $7.6 trillion. The composition of the index, illustrated in Exhibit 43–4, was 34%

EXHIBIT 43–4

Lehman Brothers Aggregate Bond Index Composition



government (U.S. Treasury and agency) bonds, 26% credit-related (corporate and foreign government), 4% asset-backed bonds and commercial mortgage-backed bonds, and 36% mortgage-backed securities. The option-adjusted duration—a number that reflects the possibility of bonds being called by the issuer—was 4.5, with an average maturity of 7.7, making it the broadest domestic intermediate investment-grade index available. Subindices of the Lehman Aggregate can be created to capture this result in different risk/return profiles. For example, a corporate-only index may appeal to those who seek lower credit quality, or a one- to five-year government/corporate index would better serve those who are seeking a short-duration portfolio.

An important part of choosing an index is understanding the risks that are involved in the various segments of the bond market. Chief among these risks are market-value risk and income risk, although the degree to which they apply to a given part of the bond market can vary widely.

Market-Value Risk

Generally, the longer the maturity of the bond portfolio, the higher is its yield. (This assumes a normally sloped yield curve.) The total return of a bond is made up of the coupon (or income) component and the principal (or price change) component. Since the yield curve, which affects the principal component of total return, is likely to shift, the longer-term bond portfolio will not necessarily have a higher total return. Exhibit 43–5 shows the one-year total

EXHIBIT 43–5

Market-Value Risk

High-Interest-Rate Environment				***One-Year Return (Income + Price Return)***	
Coupon	**Maturity**	**Price**	**Duration**	**Rates Rise 1%**	**Rates Fall 1%**
12%	3 Year	100	2.5	9.6%	14.5%
12%	7 Year	100	4.6	7.5%	16.8%
12%	20 Year	100	7.5	4.9%	20.0%
Low-Interest-Rate Environment				***One-Year Return (Income + Price Return)***	
Coupon	**Maturity**	**Price**	**Duration**	**Rates Rise 1%**	**Rates Fall 1%**
4%	3 Year	100	2.8	2.1%	5.9%
4%	7 Year	100	6.2	–1.1%	9.4%
4%	20 Year	100	14.3	–8.2%	18.4%

return of different maturity securities in both high- and low-rate environments. Clearly, as the maturity or duration of the portfolio lengthens, market-value risk rises. In addition, the lower the interest-rate environment, the greater is the market-value risk, especially for the intermediate- and long-term portfolios. This is the result of two factors: the portfolio's duration increases as interest rates decrease, and the portfolio's lower yield-to-maturity provides less of a cushion to offset principal losses. Therefore, for investors who are risk-averse in terms of their principal, the short- or intermediate-term index may be more appropriate than the long-term index.

Income Risk

Many investors invest for income. They spend only the income that their investment distributes, and they avoid dipping into their principal. Foundations and retirees invest for a stable—and ideally growing—income stream that they can depend on for current and future consumption. Exhibit 43–6 shows the income stream from a $10,000 investment in a short-term (3-year), intermediate-term (7-year), and long-term (20-year) mutual fund over the last 24 years, assuming equivalent growth rates for the portfolios. It's obvious that if stability and durability of income are the primary concerns, the long-term portfolio is the least risky, and the short portfolio is the most risky.

EXHIBIT 43–6

Income Risk

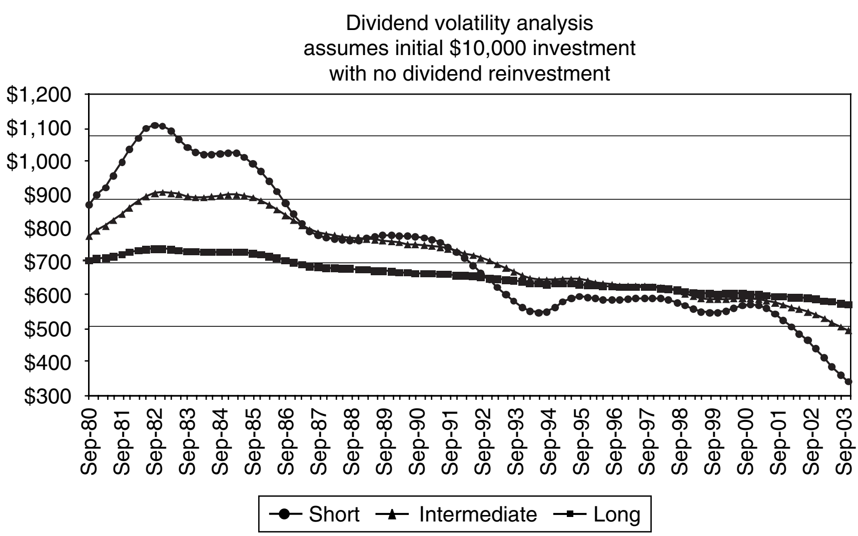


EXHIBIT 43–7

Bond Market Risk Summary

NAV Type	Market-Value Risk	Income or Liability Risk	Average Maturity	Current Duration	Portfolios
Stable-dollar NAV	Lowest	Highest	30–90 Days	0.1	Money market portfolios
Variable NAV	Low	High	2–4 Years	2.5	Short-term portfolios
	Medium	Medium	7–10 Years	5.0	Intermediate-term portfolios
	High	Low	15–25 Years	10.0	Long-term portfolios

Liability-Framework Risk

Pension funds and financial institutions invest to finance future liabilities. Long-term liabilities require investments in long-term assets to minimize risk, resulting in both a portfolio and a liability stream that are equally sensitive to interest-rate changes. A portfolio that invests in short-term bonds may look less risky on an absolute-return basis, but it is actually much riskier when the portfolio market value is compared with the present value of the pension liability. (The difference is the surplus or deficit.) This is so because of the short-term portfolio's mismatch with its long-term liabilities. The "surplus" risk will be minimized on a fully funded plan when the duration of the portfolio is matched (or immunized) to the duration of the liability.

Exhibit 43–7 contains a summary comparison showing that the investment with the lowest market-value risk has the highest income or liability risk. Likewise, the investment with the highest market-value risk has the lowest income or liability risk. Clearly, the risk framework chosen depends on whether the investment objective is principal preservation or income durability.

PRIMARY BOND INDEXING RISK FACTORS

As effective as indexing is as a bond management tool, it by no means eliminates the risks of bond investing. Successful indexing requires matching the primary risk factors of the benchmark index in a credit-diversified portfolio. This does not mean that an index manager must fully replicate an index. Rather, it means that the manager must understand the risk factors and how they are measured. Exhibit 43–8 lists the primary risk factors that apply to the government, corporate, and mortgage sectors, accompanied by an explanation of these primary risk factors.

EXHIBIT 43–8

Primary Bond Index Matching Factors

	Government	Corporate	MBS
Modified adjusted duration	x	x	
Present value of cash flows	x	x	
Percent in sector and quality		x	
Duration contribution of sector		x	
Sector/coupon/maturity cell weights		x	x
Issuer exposure control		x	

Modified Adjusted Duration

The modified adjusted duration (or option-adjusted modified duration) is a simple single measure of interest-rate risk of the portfolio. It is a great place to start but is entirely too rough of a measure to track an index adequately. Duration is the average time to receipt of the present value of the bond cash flows. The portfolio duration will give the manager a rough approximation of the price change observed if interest rates rise or fall (in a parallel fashion) immediately by 1%. If rates rise by 1%, a five-year-duration portfolio will experience a 5% decline in value [(+1% yield change) × (portfolio duration of 5) × (–1)]. If the yield curve does not move in a parallel fashion, then the duration is of limited value. For obvious reasons, it is important to match the duration of the portfolio to the duration of the benchmark index.

Present-Value Distribution of Cash Flows

A more accurate way to capture yield-curve risk is by matching the cash-flow distribution of the index. Yield-curve changes are composed of parallel shifts, curve twists (e.g., short rates down, intermediate rates unchanged, long rates up), and curve butterfly (e.g., short and long rates down, intermediate rates up) movements. By decomposing the index (and portfolio) into a stream of future payments and discounting each payment to the present value and summing these values, one calculates the index (and portfolio) market value. By matching the percent of the portfolio's present value that comes due at certain intervals in time (each vertex) with that of the benchmark index, the portfolio largely will be protected from tracking error (versus the benchmark) associated with yield-curve changes. Since the portfolio duration is equal to the benchmark index duration [duration is the sum of all vertices (Exhibit 43–9) of the percent of present value multiplied by

EXHIBIT 43–9

Cash-Flow Distribution Analysis

Time	Percent of Value	Duration Contribution	Percent of Duration
0	3.2	0.00	0.0
0.5	7.2	0.04	0.8
1	8.5	0.09	1.9
1.5	10.5	0.16	3.5
2	13.3	0.27	5.9
3	12.9	0.39	8.6
4	9.8	0.39	8.7
5	7.6	0.38	8.4
6	4.9	0.29	6.5
7	4.5	0.32	7.0
8	3.9	0.31	7.0
9	3.6	0.32	7.1
10	2.7	0.27	6.0
12	2.3	0.27	6.0
15	2.3	0.34	7.5
20	1.6	0.31	6.9
25	1.0	0.26	5.8
30	0.3	0.10	2.3
40	0.0	0.01	0.2
TOTAL	100.0	4.50	100.0

the vertex (time)], this method will guard against parallel changes in yield. Since all points in time (vertices) are closely matched in percent, any local term-structure movements (nonparallel changes) will not affect tracking (these yield-change risks are essentially immunized). For callable securities, the cash flows need to be distributed to the vertices in accordance with the probability of call. A 10-year bond that is highly likely to be called in three years should have cash flows that are allocated primarily to the three-year vertex.

Percent in Sector and Quality

The yield of the index is largely replicated by matching the percentage weight in the various sectors and qualities, assuming that all maturity categories are fully accounted for by the replicating portfolio. Matching duration contribution of sectors and qualities without also matching the portfolio percentage weight exposed to the sectors and qualities may expose the portfolio to significant tracking risk during periods of extreme duress. This is due to the default risk that can reduce the value of all bonds of an issuer by a given magnitude, regardless of the maturity.

Duration Contribution of Sector

An effective way (without excessively constraining the process, subject to also managing the market weights as described earlier) to protect a portfolio from tracking differences associated with changes in sector spreads (industry risk) is to match the amount of the index duration (Exhibit 43–10) that comes from the various sectors. If this can be accomplished, a given change in sector spreads will have an equal impact on the portfolio and the index.

EXHIBIT 43–10

Sector and Quality Distribution Analysis for Aggregate Bond Index (12/31/2003)

Sector	Percent of PV (12/31/03)	Duration (12/31/03)	Duration Contribution	Percent of Duration
Treasury	22.16	5.7	1.25	27.8
Agency	11.56	4.3	0.50	11.1
Industrial	12.36	6.4	0.79	17.5
Utility	1.97	6.3	0.12	2.8
Finance	7.82	5.1	0.40	8.8
Sovereign	1.58	5.6	0.09	1.9
Foreign corporate	1.51	5.8	0.09	1.9
Supranational	1.12	3.6	0.04	0.9
GNMA	4.92	2.6	0.13	2.9
FNMA	18.02	3.1	0.55	12.2
FGLMC	12.65	3.0	0.38	8.4
Asset-backed	1.69	2.7	0.05	1.0
CMBS	2.63	4.7	0.12	2.7
TOTAL	99.99		4.50	100.0
Quality				
AAA	75.68	4.1	3.07	68.1
AA	2.69	5.2	0.14	3.1
A	10.23	5.7	0.59	13.0
BAA	11.4	6.2	0.71	15.8
TOTAL	100.0		4.50	100.0

Duration Contribution of Quality

Similarly, the most effective way to protect a portfolio from tracking differences related to changes in quality spreads (leverage/economic risk) is to match the amount of the index duration that comes from the various quality categories. This is particularly important in the lower-rated categories, which are characterized by larger spread changes.

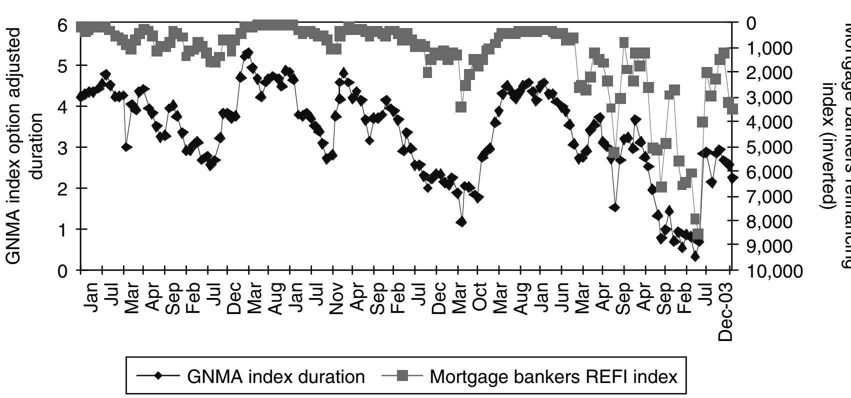
Sector/Coupon/Maturity Cell Weights

The call exposure of an index is a difficult factor to replicate. The convexity value (convexity measures how a bond's duration changes as yield levels change) alone is inadequate because it measures expected changes in duration over a small change in yield levels. In addition, the change in convexity can be very different as yield levels change. Managers who attempt only to match the index convexity value often find themselves having to buy or sell highly illiquid callable securities to stay matched and, in the process, generate excessive transaction costs. A better method of matching the call exposure is to match the sector, coupon, and maturity weights of the callable sectors. By matching these weights, the convexity of the index should be matched. In addition, as rates change, the changes in call exposure (convexity) of the portfolio will be matched to the index, requiring little or no rebalancing.

In the mortgage market, call (prepayment) risk is very significant. The volatility in the option-adjusted duration of the Lehman Brothers Mortgage Index, which measures the extent of the call exposure of the mortgage market, is shown in Exhibit 43–11. Also shown on the graph is the Mortgage Bankers Refinancing Index (inverted), which measures the extent of mortgage refinancing

EXHIBIT 43–11

Mortgage Call Exposure Analysis



occurring in the market. Clearly, the greater the refinancing activity, the shorter is the index duration owing to the greater likelihood that the higher coupons (issues priced above par) will be refinanced with lower-coupon securities. For this reason, matching the coupon distribution of the mortgage index is critical. The best risk management is accomplished by matching the index weights in a multidimensional matrix of the maturity (balloon, 15-year, 30-year), sector (FNMA, FGLMC, GNMA), coupon (1/2% increments), and seasoning (new, moderate, and seasoned). This level of detail is accomplished easily in a large portfolio (more than $1 billion in assets) but more difficult in smaller portfolios.

A new twist has been added by the recent GSE disclosures by FNMA and FHLMC of additional pool detail, such as FICO scores and average loan balances. Like pool age, which has influenced pool pricing in past years, these new disclosures likely will result in further bifurcation of mortgage pricing of specified pools from TBA—"to be announced"—mortgage pricing. This development will make replicating the MBS index more challenging in the years to come.

Issuer Exposure

If the major risk factors just described are matched, but with too few issues, there remains significant risk that can still be diversified away. "Event risk"—a risk widely watched in the late 1980s when there was significant corporate leveraging (LBOs)—is the final primary risk factor that needs to be measured and controlled. Issuer exposure, like exposure to sector and quality, needs to be measured first in percentage terms versus the issuer weight in the index because, during periods of serious economic distress, bond prices, regardless of maturity, can drop precipitously. However, setting market-value limits without regard to issuer duration risk and issuer index weights is not adequate. Spreads immediately widen following a negative credit "event." Therefore, an additional measure of the issuer event risk impact on a portfolio is the impact on portfolio market value of that spread widening. This can be measured by calculating how much of the portfolio duration ("duration contribution") comes from the holdings in each issuer. This calculation also should be figured for the index. The basis point impact on tracking of a spread-widening event will be the spread change (of the issuer) multiplied by the difference in duration contribution (portfolio-index) multiplied by (–1). Exhibit 43–12 contains an example of this analysis. Issuer XXX Corp has an equal percent weight to the index, but its duration contribution is 0.16 greater. If an event occurred that would widen XXX Corp spreads by 100 basis points, the portfolio would suffer an unfavorable tracking difference of 16 basis points versus the index (100 basis point spread change × 0.16 duration contribution overweight × –1). If the same 100 basis point widening were to occur to XYZ Corp bonds, the tracking difference would be a favorable 8 basis points even though the percent weight is matched to the index. For effective index fund management, duration contribution exposure limits (versus the index) need to be set at the issuer level.

EXHIBIT 43–12

Issuer Exposure Comparison (Percent of Market Value versus Duration Contribution)

	Portfolio			***Index***			***Portfolio-Index***	
	Percent of Market Value	**Duration**	**Duration Contribution**	**Percent of Market Value**	**Duration**	**Duration Contribution**	**Percent Difference**	**Contribution Difference**
XXX Corp	4%	8	0.32	4%	4	0.16	0%	0.16
ZZZ Corp	4%	4	0.16	4%	4	0.16	0%	0.00
XYZ Corp	4%	2	0.08	4%	4	0%	0%	–0.08

ENHANCING BOND INDEXING

In sailing, speed comes from paying close attention to the details, not simply from "watching the wind." And in bond management, the return versus the benchmark is a function of more than just interest-rate maneuvering. Portfolio managers can "trim" their portfolio sails to compete more efficiently in the investment management race. The trimming strategies include lower costs, issue selection, yield-curve positioning, sector and quality positioning, and call-exposure positioning.

Why Enhancements Are Necessary

Since the index does not incur expenses or transaction costs, enhancements are necessary just to provide a net return equal to the index. Operating expenses provide a significant headwind, but transaction costs associated with portfolio growth are a major contributor to return shortfalls. Exhibit 43–13 shows the transaction costs and resulting tracking error associated with single-contribution growth and compares it with multiple-contribution growth. In the example, the single-contribution portfolio had a tracking error of 18 basis points associated with investing net cash flow. In the multiple-contribution portfolio, the tracking error is significantly higher, at 41 basis points, even though the dollar cost of transaction costs is identical ($450,000). Therefore, portfolios with high growth rates will suffer additional negative tracking error. Thus, enhancements are necessary simply to stay equal to a no-growth or slow-growth portfolio. Exhibit 43–14 shows in graphic form the cumulative adverse tracking impact resulting from portfolio growth for Treasury, government/corporate, and corporate portfolios. The greater the growth rate—and/or the less liquid the market—the greater is the adverse impact on tracking error.

Lower-Cost Enhancements

One of the simplest yet most overlooked forms of enhancements is keeping costs low. Expenses/management fees and transaction costs have a significant impact on portfolio performance. Enhanced indexers work hard to add an incremental 10 to 30 basis points per year to portfolio returns. Yet, in the mutual fund arena, the average bond fund expense ratio is 80 basis points greater than that of the lowest-cost index portfolio. As a result, net returns of the high-expense-ratio funds are significantly lower. Even in the indexing arena, expenses vary by large margins. Simply shopping around for the index fund with the lowest expenses—provided that the net return is competitive with other index funds—is a simple way to enhance returns. For a plan sponsor with outside index managers, having the existing manager and one or two other reputable indexers rebid the business every few years will help to make sure that expenses are as low as possible.

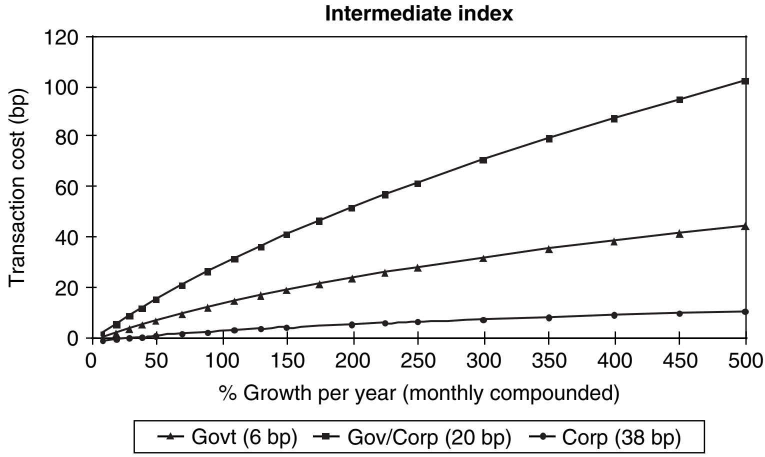
EXHIBIT 43–13

Single Contribution versus Multiple Contributions

	Portfolio Market Value	Contribution	Trans. Cost ($ at 18 bp)	Now Portfolio Value	Tracking Error from Trans cost (bp)	(bp)
Single contribution	$ —	$250,000,000	$450,000	$249,550,000	18.0	18.0
Multiple contributions	$ —	$ 50,000,000	$ 90,000	$ 49,910,000	18.0	18.0
	$ 49,910,000	$ 50,000,000	$ 90,000	$ 99,820,000	9.0	27.0
	$ 99,820,000	$ 50,000,000	$ 90,000	$149,730,000	6.0	33.1
	$149,730,000	$ 50,000,000	$ 90,000	$199,640,000	4.5	37.6
	$199,640,000	$ 50,000,000	$ 90,000	$249,550,000	3.6	41.2
		$250,000,000	$450,000			

EXHIBIT 43–14

Why Enhancements Are Necessary: Return Impact of Transaction Costs Over One Year



The other major cost factor is transaction costs. Since bond index funds have low annual turnover (about 40%) versus active portfolios (generally over 100%), transaction costs are significantly lower for index portfolios. In addition, the development of a competitive trading process will further reduce the transaction-cost impact. It should go without saying that it is imperative to include many brokers in the bidding process. For rapidly growing portfolios, where most of the transactions are offerings, an effective competitive trading process is essential. Since there is no central exchange for corporate bonds, an efficient system of evaluating real-time offerings of target issuers from many different brokers to compare relative value will yield significant transaction-cost savings, hence further enhancing the returns.

Recent developments in electronic trading (TradeWeb, MarketAxess, etc.) in the government and corporate bond markets, as well as the increased pricing transparency that now exists in the corporate bond market, are lowering the average transaction cost of trading in the corporate bond market. (The pricing transparency is the result of a Securities and Exchange Commission requirement that dealers release bond trading information on TRACE.)

Issue-Selection Enhancements

For U.S. Treasury securities, the primary tool for selecting cheap bonds is comparing actual bond prices with the theoretical "fitted" price. The theoretical curve is derived to minimize the pricing errors of all Treasury issues in the market, subject to various curve-smoothing rules. Each actual bond's yield is then compared with the bond's fitted yield, which is calculated using the theoretical curve. Bonds yielding more than the fitted yield are cheap, and those yielding less are rich. Another useful supplement is an analysis of the recent history of the bond yield versus the fitted yield. This analysis will indicate whether a cheap bond has been getting cheaper or richer.

Corporate issue-selection enhancements come primarily from staying clear of deteriorating credits and owning improving credits. The greater the manager's confidence in the ability of the credit analysts of the firm to add value via issuer selection, the larger is the maximum issuer exposure limit (see "Primary Index Risk Factors: Issuer Exposure"). If the manager does not believe the firm's credit analysts can add value via issuer selection, the diversification among issuers must be greater.

Yield-Curve Enhancements

Various maturities along the term structure are consistently overvalued or undervalued. For example, the 30-year Treasury region tends to be consistently overvalued. Likewise, the high-coupon callable bonds maturing in 2009–2012 tend to be consistently undervalued. Strategies that overweight the undervalued maturities and underweight the overvalued maturities, while keeping the same general term-structure exposure, have tended to outperform the index. This analysis is similar to looking for the maturities that have the more favorable "rolldown" characteristics—meaning that the near-term passage of time may result in the bond rolling down the yield curve. The result is that the security trades at a lower yield and therefore has more opportunity for price appreciation. Cheap parts of the curve tend to have favorable "rolldown," whereas rich parts of the curve (e.g., 30-year area) tend to have little or no "rolldown" opportunities.

Sector/Quality Enhancements

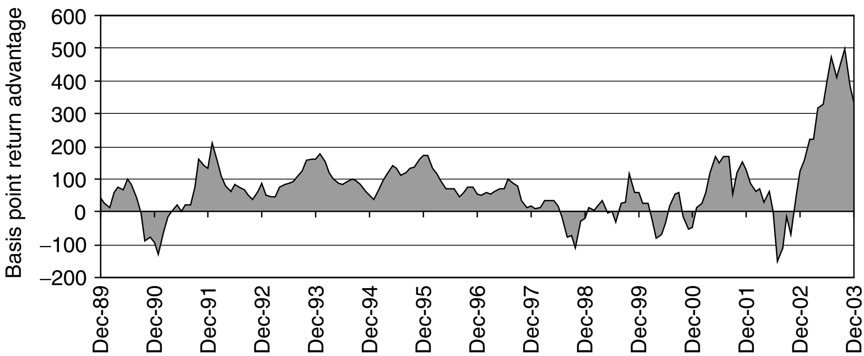
Sector and quality enhancements take two primary forms: ongoing yield tilt toward short-duration corporates and periodic minor over- or underweighting of sectors or qualities.

The yield-tilt enhancement (also called *corporate substitution*) strategy recognizes that the best yield spread per unit of duration risk is available in short-term (under five) corporates. A strategy that underweights one- to five-year government bonds and overweights one- to five-year corporates has tended to increase the yield of the portfolio with a less than commensurate increase in risk—except during periods of severe economic stress. Exhibit 43–15 shows the rolling 12-month return differential of the Lehman Brothers 1–5 Year Corporate Index versus the Lehman Brothers 1–5 Year Treasury Index.

The persistent return enhancement is obvious for all periods over the last 15 years except the brief spread-widening periods of 1990, 1998, 2000, and

EXHIBIT 43–15

Lehman 1–5 Year Corporate versus Lehman 1–5 Year Treasury Index: Rolling 12-Month Total Return Difference



2002. The primary reason the strategy is effective is that the yield advantage of a broadly diversified portfolio of short-term corporates requires a significant corporate spread-widening move over a one-year period for short-term corporates to perform as poorly as short-term Treasuries. Exhibit 43–16 shows the spread increases that would be required to break even with equal-risk Treasury securities over a one-year holding period. With the passage of time, the duration of corporate bonds shortens, and the yield spread over comparable Treasury securities generally narrows. These two risk-reducing and return-enhancing forces, when combined with the yield-spread advantage, provide compelling reasons to overweight short corporates using a broadly diversified credit portfolio. Even at narrow spreads, significant protection is available in maturities under five years.

EXHIBIT 43–16

Break-Even Spread-Widening Analysis: Corporates versus Treasuries (Assumes One-Year Holding Period)

Maturity	Wide Spreads	Break-Even Add'l Widening	Moderate Spreads	Break-Even Add'l Widening	Narrow Spreads	Break-Even Add'l Widening
2 years	120	155	80	105	40	55
3 years	130	81	90	59	50	37
5 years	140	46	100	34	60	23
10 years	150	25	110	19	70	13
30 years	200	18	150	14	100	10

A diversified two-year corporate portfolio with a yield spread of 40 basis points can widen by 55 basis points versus a comparable-duration Treasury portfolio security over the next year before it performs as poorly as the comparable Treasury portfolio. Clearly, as the maturities increase, the spread-widening protection decreases.

The risks involved in the strategy are (1) recessionary spread-widening risk and (2) issuer default risk. The recessionary spread-widening risk tends to be short-lived and overcome quickly by the increased yield advantage of the strategy. The issuer default risk can be minimized by broad issuer diversification (50 or more issuers), limitations of the strategy to A-rated and higher issuers, and credit analyst oversight.

The periodic over- or underweighting of sectors and qualities is a scaled-back version of active "sector rotation." The primary way this can be implemented on a cost-effective basis is to allow new cash flow (net new portfolio growth) to facilitate the mismatching. For example, if spreads are narrow going into the fourth quarter and the manager expects some widening, new money may be invested primarily in Treasury securities, resulting in a gradual reduction in the corporate exposure versus the index. Once the corporate spread widening materializes, Treasury securities (with low transaction costs) can be sold and corporates overweighted. Expected first-quarter asset growth eventually will bring the corporate weighting back in line with the index. A strategy of outright selling of corporates to buy Treasury securities is always difficult to justify because of the higher corporate transaction costs involved, in addition to the yield "penalty" associated with Treasury securities.

Call-Exposure Enhancements

The option-adjusted duration of a callable bond is the average of what the model duration is if rates rise and fall marginally. These durations (under rising and falling rates) can be quite different for bonds that are trading at a price where the bond changes from trading to maturity to trading to call (or vice versa). The result is a situation where the actual performance of a bond could be significantly different from what would be expected given its beginning of period option-adjusted duration.

Generally, the greater the expected yield change, the greater is the desire to have more call protection. For premium callable bonds (bonds trading to call), the empirical duration (observed price sensitivity) tends to be less than the option-adjusted duration, resulting in underperformance during periods when rates are falling. For discount callable bonds (bonds trading to maturity), the empirical duration tends to be greater than the option-adjusted duration, resulting in underperformance in rising-rate environments. Any large deviations from the index exposure to call risk should recognize the potential significant tracking implications and the market directionality of the bet.

MEASURING SUCCESS

Common sense dictates that you cannot manage what you cannot measure. Managers know this to be true, yet they often find themselves without the necessary measurement tools. Specifically, they lack accurate gauges of the extent of their bets and the value added or lost from those bets. Measuring the extent of the bets was covered in the sections on “Risk Factors” and “Enhancements.” This section will discuss how to measure whether any value has been added—and, if so, where the added value came from.

Outperform Adjusted Index Returns

Returning to the sailing theme, it’s always critical to understand how the portfolio sailboat is doing versus the index sailboat. Is the portfolio making any ground against the index? To evaluate relative performance, the portfolio returns need to be adjusted for pricing, transaction costs of growth and rebalancing, and expenses. Pricing is a key factor that needs to be considered, especially in enhanced indexing, where deviations versus the index are small, and pricing errors can hide valuable information. If a Lehman Brothers Index is the benchmark, the portfolio needs to be repriced with Lehman Brothers prices. Small differences in either the time of pricing or the pricing matrix may result in large differences (among pricing services) in periodic returns over short measurement periods. Over longer periods, these pricing differences will wash away, but for value-added measurement purposes, periodic pricing accuracy is critical.

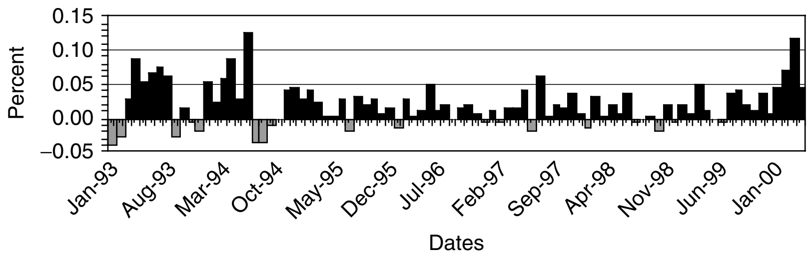
Since the index does not have transaction costs associated with asset growth, principal reinvestment, or income reinvestment, accurate adjustments need to be made to portfolio returns to account for these differences. A simple way to account for this is to maintain a trading log with implied transaction costs as a percent of total portfolio assets. The periodic summation of these implied costs will provide a good estimate of tracking-error drag associated with growth and income reinvestment.

Finally, an adjustment for expenses is required. As was discussed earlier, keeping expenses low is a simple way to enhance returns. Nevertheless, portfolio returns should be “grossed up” by these expenses to put the portfolio on equal footing with the index for measurement purposes.

Exhibit 43–17 shows the monthly *adjusted* tracking of a large bond index (enhanced) mutual fund. This portfolio is managed against the Lehman Brothers Aggregate Bond Index. If the sources of enhancements are multiple and of a controlled nature, it is expected that the average tracking difference will be small and usually positive. During periods of extreme market stress or spread volatility (i.e., the Asian/Russian debt crises of 1997–1998), the enhancement strategies are likely to result in increased tracking differences. As shown, during this experience the monthly tracking differences are small (between +13 basis points and –4 basis points) and mostly positive. Exhibit 43–18 shows a rolling 12-month summation

EXHIBIT 43–17

Consistent Positive Tracking (Bond Index Portfolio versus Lehman Aggregate Index, Monthly Adjusted Tracking Difference)



of the monthly *adjusted* tracking differences. An enhanced indexing strategy that has good risk management and diversified enhancements should be able to consistently perform above the index most periods. Falling below the index return over 12 months most likely would be the result of either not matching the index risk properly, of the enhancement strategies not being diversified adequately, or of significant market stresses (three or more standard deviation events) adversely affecting the enhancement strategies.

Low and Stable Monthly Tracking Differences

The other measure of indexing success is how closely the portfolio is exposed to the same risk factors as the index. This can be measured by evaluating the rolling 12-month standard deviation of *adjusted* tracking differences of the portfolio versus the index. Exhibit 43–19 is an example from the same bond index mutual fund managed against the Lehman Brothers Aggregate Bond Index. If a portfolio is

EXHIBIT 43–18

Consistent Positive Tracking: Bond Index Portfolio versus Lehman Index (Trailing 12-Month Total Adjusted Tracking Difference)

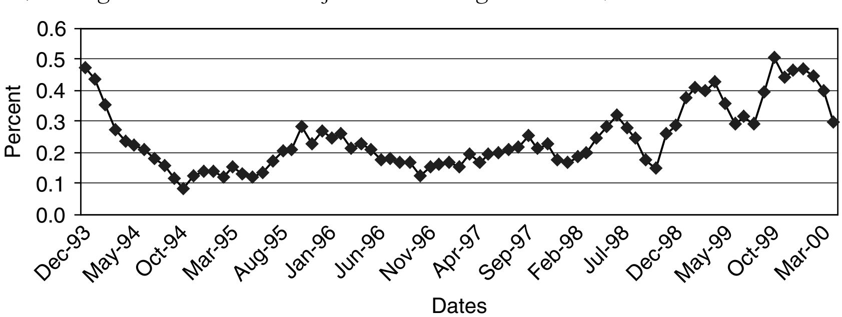
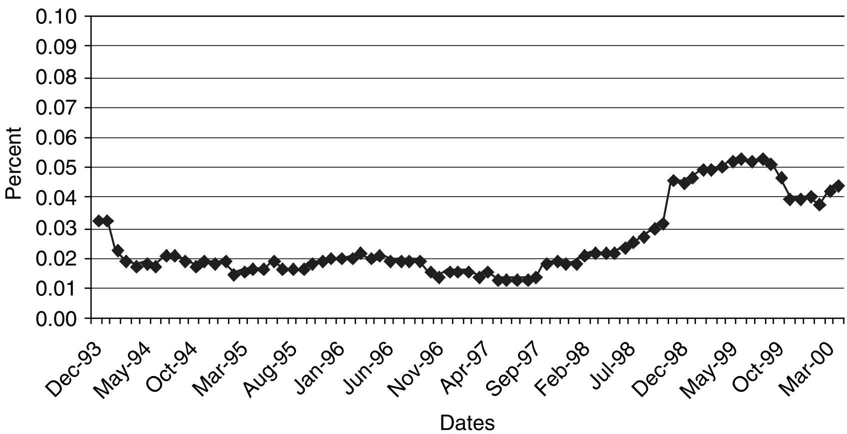


EXHIBIT 43–19

Consistent Positive Tracking: Bond Index Portfolio versus Lehman Aggregate Index (Trailing 12-Month Standard Deviation of Adjusted Tracking Difference)



properly exposed to the index risk factors, the standard deviation will be low and stable over most periods, as shown. Periods of excess market stress and spread volatility may result in higher standard deviations of tracking differences. However, the increases should be roughly proportional to the spread volatility increase or explainable by idiosyncratic credit risk (sample risk).

Consistently Positive Information Ratios

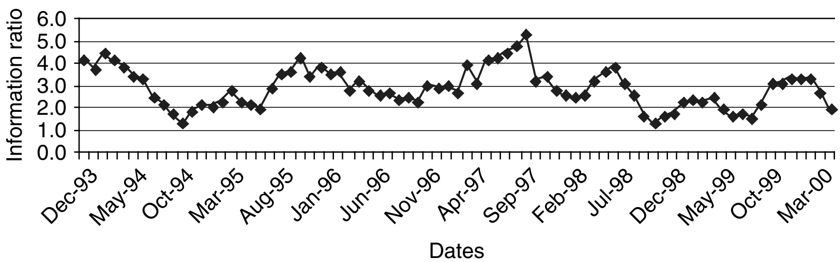
A good way to evaluate enhanced indexing success is the information ratio. This measures the amount of value added versus the index relative to the risk taken. It can be calculated by dividing the trailing 12-month tracking difference (adjusted for expenses, transaction costs of growth, and pricing) by the annualized trailing 12-month standard deviation of monthly adjusted tracking errors. An effective, and diversified, enhanced indexing strategy should be able to keep this ratio in the range of 1 to 3 over most periods. Exhibit 43–20 is an example of consistent positive information ratio from this same mutual fund example.

Detailed Performance Attribution

To accurately measure the success of risk-factor management and the enhancement strategies, the manager needs excellent performance-attribution tools. The performance-attribution analysis should be able to attribute tracking error to term-structure factors, sector bets, quality bets, and issue selection across sectors and qualities.

EXHIBIT 43–20

Consistent Positive Information Ratio: Bond Index Portfolio versus Lehman Aggregate Index (Trailing 12-Month Information Ratio)



The term-structure attribution should be analyzed at the portfolio level versus the index. The sector and quality attribution (allocation and issue selection) should be analyzed at the sector and subsector levels (detailed sector and maturity categories) with the ability to drill down to issue-level detail. Issue performance should be risk-adjusted (versus Treasury equivalent returns) with subsector, sector, and portfolio returns rolled up from the security level. This level of attribution will provide the manager with the tools to measure with precision the risk-matching and return-enhancing strategies. The result: winning the race against the index and against most managers.

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CHAPTER

FORTY-FOUR

QUANTITATIVE MANAGEMENT OF BENCHMARKED PORTFOLIOS

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Most fixed income portfolios today are managed relative to a benchmark. Depending on the investment objective and style, the role of the benchmark varies. At one end of the spectrum are passive indexed funds that strive to match benchmark risk exposures as closely as possible. At the other end are very active portfolios with high risk tolerance that freely maximize outperformance by investing outside the benchmark and use the latter only as a nonbinding reference point. The majority of existing pools of fixed income assets fall somewhere between these extremes. Typically, a sponsor, an investment committee, a chief investment officer, or some other party that sets the investment objective specifies both the benchmark and the limits for deviation from it. The portfolio manager is then judged by the achieved outperformance versus the benchmark and the amount of risk that had to be taken to generate this outperformance.

For the portfolio manager, the benchmark represents the zero-risk position. Over time, unless the manager deviates substantially from the benchmark or perhaps has a consistent bias in a given sector, the portfolio's performance largely will be determined by the choice of the benchmark. The obvious importance of the benchmark calls for extreme care in choosing one for each individual portfolio. There is an ever-growing number of bond market indexes published by the leading investment banks and other financial institutions. Often, an appropriate benchmark can be selected from this wide array of indexes. But there are many cases when none of the ready-made indexes matches the desired characteristics of the portfolio. To ensure that the benchmark correctly reflects a given investment opportunity set and constraints, an existing index may need to be modified. Sometimes, a new, highly specialized index needs to be constructed. Finally, for some investors, the right benchmark may not even be a traditional total-return market index.

Fixed income markets are extremely diverse, so most indexes tend to include hundreds or thousands of securities. The sources of risk affecting fixed income securities are equally diverse and often difficult to analyze. These conditions turn even relatively straightforward tasks into complicated endeavors. Such a seemingly trivial problem as "buying the benchmark" for most portfolios means selecting a relatively small subset of constituent securities while ensuring somehow that its behavior in unpredictable market conditions will be reasonably similar to the broad universe. Understanding portfolio risk versus a benchmark is equally complicated because of the many relevant risk dimensions and intricate interactions among them.

As a result of this, essentially all functions of the bond portfolio management process are aided greatly by robust quantitative methods. In this chapter we review some major issues facing bond portfolio managers, as well as quantitative approaches for dealing with them: selecting and customizing a benchmark, analyzing portfolio risk and performance, replicating benchmarks, and optimizing portfolio structure for outperformance.

SELECTION AND CUSTOMIZATION OF BENCHMARKS

Financial literature lists several desirable qualities for performance benchmarks. For example, a good benchmark has been defined as investable, transparent, known in advance, or diversified. It is not always possible to achieve all these goals to the same degree. While all these are important attributes, first and foremost, the benchmark should be *appropriate*. An appropriate benchmark should match the desired or required strategic allocation of portfolio assets so that the portfolio manager is able to "buy the benchmark" when and if he so decides. When comparing portfolio performance to the benchmark, it is critical to know that any difference is due to the manager's decisions and not to any in-built mismatches over which the manager has no control. Any constraints imposed on the portfolio that limit its opportunity set must be reflected in the benchmark as well. The Lehman bond indexes, for example, comprise all debt outstanding that meets index rules, weighted by market value. An index may provide an accurate gauge of the performance of a particular segment of the fixed income markets, but that does not necessarily make it an appropriate benchmark. For example, while the Lehman Aggregate Index is a widely used benchmark for the U.S. investment-grade fixed income market, the average duration of this index (4.33 as of March 31, 2004) may make it unsuitable for some portfolios funding long-duration liabilities.

Reflecting Investor Opportunity Set and Constraints

When an investment policy requires specific allocations to certain asset classes or imposes other restrictions, or perhaps a duration target, a standard market-weighted index may not be an appropriate benchmark. In the simplest case, a customized index merely changes relative weights of standard index components while still including all securities in the standard index. Often, a minimum credit-rating threshold is imposed on the securities that the portfolio can buy. Limitations may be placed on maximum exposure to an industry, country, and so on. Many other portfolio securities' attributes, such as minimum or maximum maturity, age, coupon, etc., may be controlled, requiring corresponding changes to the benchmark. In all cases, though, the goal should be to keep the benchmark as broad-based and well-diversified as possible while still meeting all the requirements of the investment policy. However numerous the modifications to the original market-based index, one important property always should be preserved: the objectivity of the benchmark, that is, the requirement that it be based on a set of rules specified beforehand and kept constant. The rule-based nature of a benchmark also allows for a historical analysis of its past behavior. Such analysis can be quite useful at the stage of selecting a benchmark.

One widely used method to achieve outperformance is to invest outside the benchmark. Such investments frequently are referred to as "core-plus." Even when the exposure to core-plus assets is constantly present in the portfolio, many managers still prefer to keep such assets out of the benchmark. Their motivation, of course, is to have this potential source of outperformance always at their disposal. Although this is valid reasoning, a case can be made for inclusion of frequently used core-plus assets into the benchmark. Typically, core-plus investments represent such higher-risk and less-liquid markets as high-yield credit or emerging market debt. There is usually no way to directly short such instruments. Yet a manager who has expertise in these markets can benefit from a short position just as much and as frequently as from a long position. The only way to effectively short such assets is to underweight them versus the benchmark. This, of course, is only possible when they are included in the benchmark. Of course, such a decision can be made only after ensuring that with the inclusion of these asset classes, the benchmark will remain appropriate for the portfolio's investment objective and style.

Targeting Duration/Cash-Flow Profile

Sometimes a customized benchmark is necessary not because of sector, quality, or other allocation constraints but because the portfolio is expected to have a particular term-structure exposure. For example, liability funding portfolios often are managed to provide a particular cash-flow stream. At the simplest level, portfolio duration may be kept equal to the duration of the liability stream. Dedication is another widely used method for ensuring the necessary cash flows while (usually) minimizing the portfolio cost. Of course, funding the future liabilities is the main investment objective in such cases. Yet actual investment policies of many liability funding portfolios can be quite liberal, providing an opportunity set that leaves plenty of room for the pursuit of outperformance while ensuring sufficient cash flows.

Such portfolios would benefit from having a diversified benchmark with a cash-flow profile that matches the expected liabilities stream and at the same time fully reflects the manager's opportunity set. Consider, for example, a liability funding portfolio that is free to invest in any security in the Lehman Credit Index. An appropriate benchmark for such a portfolio could match the sector and quality distribution of the credit index while matching the cash-flow profile of the liabilities. Such a "liability-based" benchmark retains many of the desirable attributes of a broad market-based index: it is well-defined, so the portfolio manager can stay neutral to it, and the benchmark returns are calculated using market prices. Because this benchmark consists of marketable securities, its performance can be calculated and published by a third-party index provider.[1]

Even outside the asset-liability context, many fixed income portfolios are managed with a specific duration target. If this target is not close to the duration of any standard (published) index, an appropriate benchmark may be constructed as a blend of two indexes, one of which is longer and the other shorter than the target. The weights needed to achieve a desired duration remain fairly stable over time for indexes that consist mainly of option-free securities.

Things may get more complicated for portfolios containing a large proportion of securities with embedded optionality. Duration of such portfolios is likely to be unstable, changing in response to interest-rate movements. For example, the duration of a mortgage-backed securities (MBS) portfolio can be quite volatile. If maintaining a stable duration is an important requirement, managers may engage in such techniques as delta hedging to overcome the effect of negative convexity and keep duration at a relatively constant level. Hedging techniques entail various costs, from the more obvious transaction costs to the less obvious but potentially much more devastating "whipsaw" costs.[2] It is unfair to judge the performance of a manager who must engage in costly delta hedging against a benchmark that does not bear similar costs. Delta hedging can be applied to the benchmark as well to construct a "constant duration" index that provides a fairer benchmark for a delta-hedged mortgage portfolio.[3] An example of such a benchmark could be a market-weighted MBS index dynamically hedged with a liquid leveraged overlay of Treasuries or futures contracts.

1. See, for example, "Liability-Based Benchmarks" in *Global Relative Value,* Lehman Brothers, New York, March 2001.
2. Negative convexity causes duration to decline with falling rates. The term *whipsaw* refers to having to add duration after rates have just fallen and prices have gone up and to shed duration after the opposite movement.
3. Lev Dynkin, Jay Hyman, Vadim Konstantinovsky, and Ravi K. Mattu, "Constant Duration Mortgage Index," *Journal of Fixed Income,* 10 (2000), pp. 79–96.

Asset-Swapped Indexes

Some investors can take credit positions but are required to match their interest-rate exposure to their funding source (e.g., three-month LIBOR). For example, some bank and insurance investment managers must manage their portfolios to a short duration target for asset-liability management purposes but are free to exercise their credit skills in asset selection. Leveraged investors often concentrate on credit exposure but minimize interest-rate exposure by managing their portfolio duration to their short-term LIBOR funding. In an environment of moderate credit spreads and low interest rates (and worries about rising rates), traditional total-return managers are also likely to keep durations very short while maintaining an overweight to spread sectors. These managers want to continue to exercise their credit skills but avoid term-structure risk.

The most straightforward way to create and maintain such exposures is to turn to the floating-rate market. However, this may create an unintended concentration of systematic sector exposures or issuer idiosyncratic risk. Ideally, the manager would want to match diversified systematic spread-sector risks (i.e., credit quality and sector exposures) of a broad credit market index while simultaneously removing exposure to all systematic Treasury key-rate risk factors except, perhaps, the six-month key rate. The challenge of designing a benchmark for such a portfolio is to ensure a very short Treasury duration and at the same time match the overall index allocations to the credit sectors.

To exercise their spread-sector skills while minimizing interest-rate exposure, investors can buy fixed-rate spread assets on an "asset-swapped" basis. Asset swaps are combinations of a fixed-rate bond (and its credit exposure) and an interest-rate swap that exchanges the fixed-rate coupons for floating-rate coupons. In essence, an asset swap gives an investor an opportunity to take spread-sector exposure with little term-structure risk.

There are no formal indexes of asset swaps performance. To benchmark an asset-swapped portfolio effectively, the benchmark must represent a "neutral" spread-sector allocation. Then the manager's deviations from neutral may lead to outperformance of the benchmark. Using three-month LIBOR as a benchmark is inadequate because LIBOR reflects only a single credit (i.e., swap spreads) and does not represent the wide array of spread-sector choices that may be available to the investment manager. An ideal benchmark design for asset-swapped portfolios is a floating-rate benchmark that reflects a diversified set of spread-sector exposures. One approach to constructing such benchmarks[4] starts with the creation, for each asset class, of a "mirror" swap index that matches the key-rate duration profile of that asset class. Then short positions in these mirror-swap indexes are combined with long positions in the corresponding asset-class indexes, as well as with a short-term asset (e.g., one-month LIBOR). This creates

4. For a detailed description of this methodology see "Benchmarks for Asset Swapped Portfolios" in *Global Relative Value,* Lehman Brothers, New York, February 2002.

"asset-swapped indexes" for all asset classes in the benchmark. Finally, individual asset-swapped indexes are merged into the final composite benchmark according to the portfolio's "neutral" allocations.

Book Accounting Based Indexes

Fixed income investors typically measure portfolio performance by calculating returns using market prices at the beginning and end of the performance period. This calculation implies that the contents of a portfolio may not be held until maturity, as market prices correctly track the portfolio's cash value in the event of liquidation. A consequence of using market prices is that the portfolio's market value fluctuates with changing Treasury yields, spreads, and prepayments. Another consequence is that the standard fixed income indexes are market-return based. Many portfolio tools have been built to analyze a market-based portfolio against similar indexes.

However, there is a large class of investors (e.g., insurance companies and banks) less concerned about short-term market fluctuations. These investors purchase fixed income assets to match a set of liabilities whose net present value is not marked-to-market. Typically, these fixed income portfolios are relatively static. Investors expect the portfolio to earn an adequate spread over the cost of the liabilities, provided that the assets do not default or prepay at a rate unanticipated at the time of purchase. Given that liabilities are valued using book accounting, these investors (and their regulators) prefer to measure portfolio performance similarly, either by the portfolio's "book return" which is book income divided by book value, or the portfolio's "book yield" which is its internal rate of return calculated at time of purchase. However, how can such investors measure their investment skill?

Lately, the fixed income market has seen the introduction of book accounting based indexes, or "BOOKINs" that are, in theory, replicable investment portfolios. For example, suppose that in January 2005, an investor restricted to assets in the Lehman Aggregate Index must fund a newly acquired liability. The investor could passively invest in the JAN05 Aggregate BOOKIN. The composition of this BOOKIN is set to reflect the Aggregate Index as of January 2005, and its book yield and book return are calculated every month. Over the course of the month, the BOOKIN will generate cash flow (coupon, prepayments, proceeds from maturities) which is re-invested in the February 2005 Aggregate Index. Consequently, by February 2005, the JAN05 Aggregate BOOKIN becomes a conglomeration of the initial investment in the January Aggregate Index plus a smaller investment in the February Aggregate Index. This process is repeated every month. The performance of the JAN05 Aggregate BOOKIN reflects what the investor could have achieved (using book accounting) by passively investing in the Aggregate Index starting in January 2005, and thus can be directly compared to the performance of the investor's actual portfolio.

DIVERSIFICATION ISSUES IN BENCHMARKS

Issuer-specific risk always has been an important consideration in credit *portfolios*. Increasingly, though, *benchmarks* are scrutinized for the security-specific risks embedded in them. Excessive exposure to individual issuers became a concern not just for portfolio managers. Plan sponsors now reexamine benchmark design and pay close attention to large single-issuer concentrations. This is a serious issue even for the users of very broad market indexes. As Exhibit 44–1 shows, as of February 2004, the top 10 issuers in the Lehman U.S. Corporate Index accounted for 22% of the overall market value. For some plan sponsors, this is too much security-specific risk. An asset manager benchmarked to a market-value-weighted credit index may feel compelled to have exposure in some of these large-cap issuers just because the benchmark has a significant weight in them. The concerns about the high level of absolute issuer risk in some commonly adopted benchmarks led to a number of developments in benchmark design that attempt to mitigate this risk.

Issuer-Capped Benchmarks

An issuer-capped benchmark imposes a maximum on the market-value weight that a large issuer can have in the index to limit the exposure to the idiosyncratic risk of that issuer. In the simplest case, a market-value cap (e.g., 1%) is imposed, and every issuer's capitalization is checked against this ceiling. The market value

EXHIBIT 44–1

Market-Value Weights of the Top 10 Issuers in the Lehman Corporate Index, August 1999–February 2004

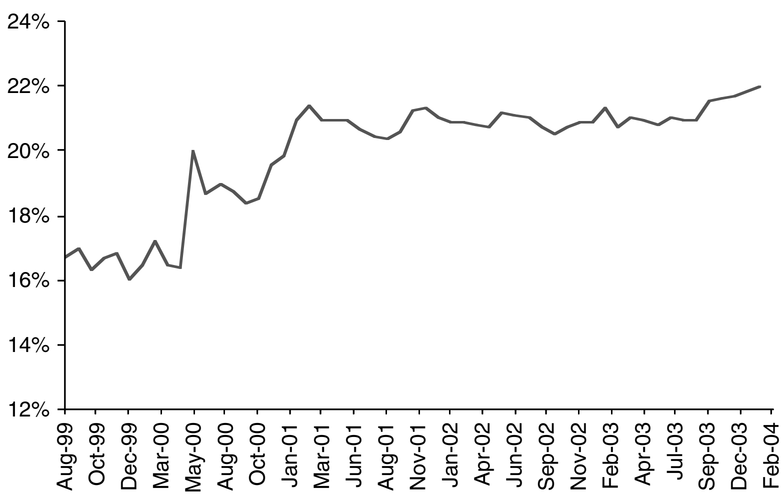
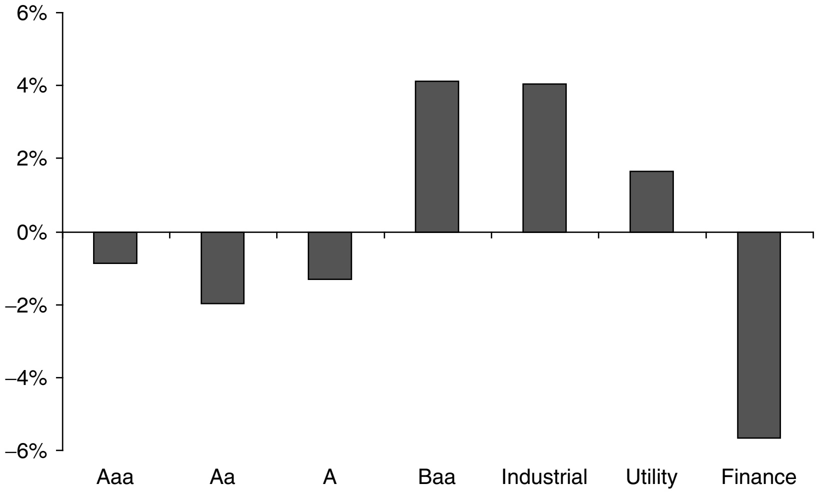


EXHIBIT 44–2

Lehman Corporate Index: Average Sector and Quality Exposures of the 1% Capped Index versus the Original Index, August 1999–February 2004



in excess of the cap is "shaved off" and distributed to all other issuers in the index in proportion to their market-value weights. The caps can be chosen to be different for various credit ratings, reflecting the differences in issuer-specific risk between higher and lower credit qualities. While issuer-capped portfolios have existed for quite a while, issuer-capped benchmarks are new and emerged as a direct response to the increased levels of security-specific risk in credit markets.

On the surface, issuer-capped indexes seem very straightforward. However, the cap level and the redistribution rule can have a significant impact on the risk and return characteristics of an index. Some redistribution rules can limit the benefits of issuer capping by inadvertently introducing unfavorable sector-quality risk exposures relative to the uncapped index.[5]

For example, many investors initially used an "index-wide" redistribution rule that allocates the "excess" market value across all noncapped issuers in the index in proportion to their weights. However, this procedure may produce an index with very different (and most likely unintentional) sector and quality exposures compared with the uncapped index. For example, Exhibit 44–2 shows that the index-wide redistribution rule in a 1% issuer-capped Lehman Corporate Index produces significant overweights in Baa-rated and industrial issues and a significant underweight to financials compared with the uncapped index.

5. For a detailed analysis, see "Portfolio and Index Strategies During Stressful Credit Markets," Lehman Brothers, New York, January 2004.

This inadvertent introduction of potentially unfavorable sector-quality risk exposures can be avoided by a "quality-sector-neutral" redistribution rule that preserves the sector and quality profiles of the uncapped index.

Another "side effect" of capping large issuers in an index is the increase in weights of smaller ones. By construction, in a capped index, the market-value weights of smaller issuers exceed their actual weights in the marketplace, sometimes dramatically so. This raises a concern that the available supply may not allow the manager to match (if he so chooses) the required allocation in the issuer-capped index.

Despite these subtle issues, issuer-capped indexes are now a permanent fixture of the investment management landscape. With good judgment, investors can design issuer-capped indexes that meet their risk-management preferences in dealing with issuer-specific risk.

Swap-Based Benchmarks

A somewhat radical approach to dealing with issuer-specific risk in credit benchmarks is not to have this risk at all. Apart from the naive solution of adopting an all-Treasuries benchmark, one type of benchmark that is becoming increasingly popular is based on interest-rate swaps. Swaps offer excellent liquidity, limited idiosyncratic or "headline" risk, and an opportunity to capture some of the long-term spread advantage of investing in non-Treasury product. Swaps have been a key feature of the debt markets since the early 1990s. In fact, in several ways the swaps market is larger and more heavily traded than the U.S. Treasury market.

Swap payments are based on LIBOR, and therefore, the par swap rate curve can be viewed as a generic yield curve for large, Aa-rated banks whose interbank lending rates constitute the LIBOR index.[6] Correspondingly, the swap spread is considered a generic proxy for high-grade credit spreads (the swap spread does not reflect the counterparty risk that is effectively eliminated through collateral management).

This relationship has prompted some investors to consider swaps as return benchmarks for their credit portfolios. However, unlike returns on regular fixed income securities, returns on swaps are not directly observable in the marketplace. While swap yields and spreads are available from many sources, swap returns are not. To create total return indexes for the swaps market, a certain methodology has to be developed. At Lehman Brothers, such methodology relies on the creation of hypothetical constant-maturity swap "securities" from the swap curve.

At the start of every month we create a set of such swap securities with coupons taken from the appropriate maturity points on the swap curve. Over the

6. A list of the banks that currently participate in the "LIBOR panel" for U.S. dollar LIBOR and other currency deposit rates is available from the British Bankers Association's Web site at bba.org.uk.

course of the month, these securities generate total return from price fluctuations and coupon accrual. Cash is assumed to be invested in three-month LIBOR to cancel the floating leg of the swap. The returns on such hypothetical swap securities form returns on swap indexes.

A swap index can be constructed[7] with any desired term-structure profile (e.g., to match a particular liability duration target). A manager who has a swap index as a benchmark is completely free to hold only those credits which she thinks will outperform and to avoid credits expected to underperform duration-matched swaps. Credits on which the manager is neutral or has no view need not be in the portfolio at all. In contrast, if the benchmark is such a market index as the Lehman U.S. Corporate Index, the manager is under pressure to have at least some exposure to the largest issuers in the benchmark. Even when the manager has a negative view on a large issuer in the corporate index, she is unlikely to hold a zero weight because that creates a large active bet against the benchmark.

Downgrade-Tolerant Benchmarks

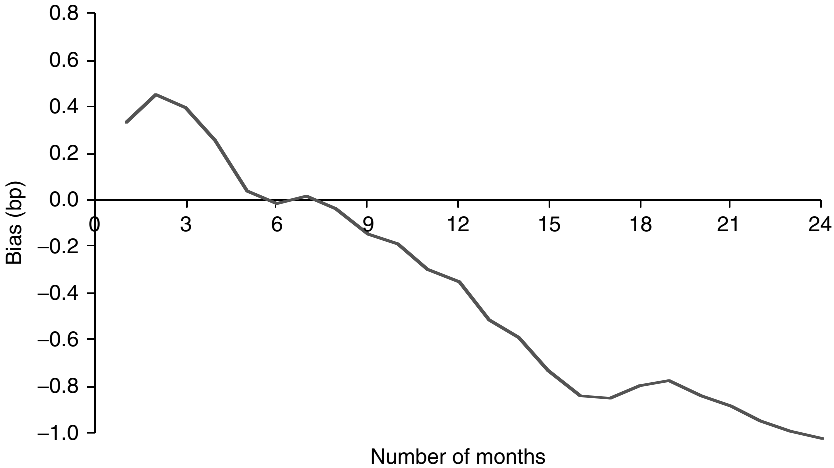
In periods of stressful credit markets, broad corporate market indexes may present another problem for managers attempting to replicate their benchmarks. The index inclusion rules (e.g., investment-grade only) demand the removal from the index of the so-called fallen angels, i.e., securities that have fallen below the quality threshold. In an index, this removal takes place at the end of the downgrade month. Usually such issues are removed at a price level that reflects where they can be sold at the margin, not where all outstanding amounts of the bonds can be sold. In contrast, a portfolio manager must find willing buyers and often has little choice but to hold onto the fallen angels for at least several months after they leave the index, until buyers can be found and the price stabilizes. This disparity may produce a "survivorship bias" that makes the index difficult to replicate accurately during stressful markets. Many investors claim that the index possesses a performance advantage because it can immediately remove fallen angels, whereas a real-life manager needs time to sell.

In response to this valid concern, the benchmark can be modified to produce so-called downgrade-tolerant indexes that keep fallen angels for a certain period of time after the downgrade. We have found that the magnitude of the survivorship bias is typically small but not negligible. However, the bias is volatile and can be positive or negative. Also, the bias is generally a decreasing function of the tolerance period. Exhibit 44–3 illustrates the survivorship bias in downgrade-tolerant versions of the Lehman Corporate Index. For example, the bias is largest if the portfolio manager held onto fallen angels for three months or less. The bias disappears and then turns negative at the six-month tolerance period,

7. Lev Dynkin, Yuri Greenfield, and Dev Joneja, "The Lehman Brothers Swap Indexes," *Journal of Fixed Income* 12 (2002), pp. 28–42.

EXHIBIT 44–3

Downgrade-Tolerant Lehman Corporate Index: Survivorship Bias as a Function of the Tolerance Period, January 1990–March 2004



reflecting the general recovery of fallen angels. The lesson here is that if plan sponsors are willing to give managers time to ease out of downgraded issues, they should give the managers at least six months to do so.[8]

PORTFOLIO ANALYSIS RELATIVE TO A BENCHMARK

The selection of the investment guidelines and appropriate benchmark marks the beginning of the portfolio management process. Once a portfolio is established, investors monitor its positioning relative to the benchmark continually. Apart from investing new funds, periodic transactions help to maintain desired exposures and express changes in market outlook.

Managing a benchmarked portfolio tends to be a cyclic process. The cycle may be well defined and stable—for example, a calendar month. In this case, certain analyses are performed at regular intervals and in a set sequence. Or the cycle may be "functional" rather than "procedural," reflecting a set of actions performed on an ongoing basis as need arises and not necessarily in a fixed order. Yet, however different the operational details might be, there are certain common functions that most portfolio managers have to perform and certain

8. The performance varies greatly across fallen angel issues, so there are no clear decision rules as to the best time to sell or the type of fallen angels to hold or sell. However, we did find an overall improvement in the risk-adjusted forward performance of fallen angels as the seasoning period increased.

general categories of tools that are necessary to carry out those functions. In a typical portfolio management cycle, forward-looking, or *ex-ante,* analytics are applied at the start of each period to create and ascertain the desired portfolio positioning. At the end of the period, backward-looking, or *ex-post,* analysis serves to review and explain the achieved performance and decide on the adjustments that might be needed in the portfolio.

Analyzing Portfolio Risk: A Cell-Based Approach

The most obvious way to analyze the portfolio-versus-benchmark risk is a structural comparison of the two by partitioning them into a matrix of cells. Different choices of partition variables put the focus on different aspects of portfolio composition. Corporate portfolios, for example, are likely to be divided by quality and industry category (e.g., basic industry, consumer cyclical, energy, etc.). Segmenting by duration highlights the yield-curve exposure. The amount and quality of information a portfolio manager can derive from such reports depend on the appropriateness of the chosen risk dimensions and on the portfolio and benchmark attributes (beyond market-value percentages) available for comparison.

The fundamental assumption behind the use of structural reports is, of course, that the contribution of a mismatch in a given cell to the overall portfolio-versus-benchmark risk is primarily a function of the magnitude of the mismatch and the weight of the cell. This assumption is not unreasonable. Certainly, a portfolio that matches its benchmark in all cells (along all possible dimensions) is risk-neutral to the benchmark.

While the simplicity of such analysis is attractive, there are two major problems with its basic assumption. First, the risk consequences of a particular mismatch depend not only on its apparent magnitude but also on its nature, i.e., the historical, and potential future volatility of the underlying exposure. A mismatch in spread duration contribution of 1 in Aa financials has a very different risk prospect than the same-size mismatch in Baa telecom. Granted, experienced portfolio managers usually have a feel for the more consequential mismatches, even if only in a qualitative way.

The second problem is equally important and, arguably, more difficult to compensate for with experience. The cross-correlation among the usually multiple sources of risk in a portfolio makes the task of judging the overall risk a daunting one without special quantitative tools. Indeed, it is easy to imagine two mismatches in two different cells, with each entailing significant risk in isolation. Yet low (or even negative) correlation between them may reduce their joint contribution to risk to a negligible level. Conversely, a few mismatches that could be ignored individually easily may prove to represent a serious risk if the correlations among them are high. Needless to say, when the number of mismatches reaches dozens, as it does easily even in relatively simple portfolios, an attempt to find the common risk denominator by "eyeballing" the structural mismatches is unrealistic.

Analyzing Portfolio Risk: Multifactor Risk Models

One time-tested approach to the multidimensional task of quantifying the portfolio active risk (risk versus benchmark) is multifactor risk analysis. Its primary goal is to help managers to structure portfolios with desired risk exposures relative to the benchmark. As such, it is generally used not as an *ex-post* control tool but rather as an *ex-ante* tool for portfolio structuring. One obvious need is to measure the expected risk of return deviation in portfolios that track a benchmark. Another is being able to form a reliable estimate of risk for active managers with a particular outperformance, or "alpha," target. There is a well-established consensus among investment professionals on the realistically achievable levels of *information ratio,* or risk-adjusted outperformance, versus the benchmark. A realized information ratio above 0.5 generally is considered to be quite high, with 1.0 often seen as a practical upper limit. As a result, quantifying active risk allows managers to test the feasibility of the alpha target specified for them. For example, a portfolio with a required alpha of 50 basis points per year should be allowed an active risk somewhere in the range of 50 to 100 basis points per year. If, as a result of policy constraints, the projected risk is estimated to be much lower, the manager should make a case for either relaxing portfolio constraints or revising the alpha target.

Active risk has *systematic* and *nonsystematic* components. The former results from the differences between the portfolio and benchmark sensitivities to common market *risk factors* (e.g., movements of the key rates, credit sector spreads, or volatility). The latter, sometimes referred to as "diversifiable risk," reflects unequal exposures (usually overweights in the portfolio) to individual issuers and can be present even when all systematic exposures are eliminated. This type of risk reflects idiosyncratic (or residual) spread movements of individual issuers not explained by anything that happens to their peer group. Apart from the risk of idiosyncratic spread movements, there is default risk, particularly important in lower-quality credit portfolios. Conceptually, it contains both systematic and nonsystematic parts. Correlated defaults create a systematic risk component. To the extent that defaults are uncorrelated and reflect events specific only to a particular issuer, this is a form of nonsystematic risk. Separating the two is quite difficult. In the current Lehman model, default risk is modeled and reported separately from both the market risk and the residual mark-to-market spread volatility.

To quantify the systematic risk, multifactor risk models use historical volatilities and correlations of a relatively small set of risk factors. These are processed into a *covariance matrix* that becomes the cornerstone of the model. Nonsystematic risk is quantified by measuring the differences between the portfolio and benchmark concentrations in a specific issue or issuer. These weight differentials are then multiplied by nonsystematic spread volatilities specific to a given issuer or its peer group.

The two components of the risk are combined to produce the key output of such models—*tracking-error volatility* (TEV), defined as the projected standard deviation of the monthly return differential between the portfolio and the benchmark. TEV is an extremely useful measure because it provides a common unit for many different sources of risk, enhancing comparisons of diverse exposures and greatly facilitating portfolio risk management and risk budgeting. Well-developed models not only compute TEV but also provide other useful information. The Lehman multifactor risk model, for example, offers detailed analysis of the TEV sources, their relative contribution to the total, and their interdependence.[9]

Of course, the reliance on historical observations exposes the multifactor analysis to an often-heard criticism that risk-factor correlations are unstable and depend (as do volatilities) on the economic cycle. These concerns, however, have been shown to be exaggerated.

Different historical periods can be viewed as more or less relevant to the current environment. Some asset classes evolve over time, and their risk characteristics change. For example, the dramatically increased refinancing efficiency in the U.S. residential mortgage market made the prepayment history up to the early 1990s largely irrelevant. Economic and market conditions also may justify emphasizing a particular historical period while downplaying the others. The mechanism for reflecting such preferences can be time decay imposed on the historical data series, which gives greater weight to more recent data.

The nonsystematic component of active risk presents a bigger challenge to history-based risk models. To quantify the issuer-specific risk, a model needs estimates of residual spread volatility in all market segments. These estimates can be derived only from the historical time series of individual securities' residual returns, that is, parts of each bond's return unexplained by all the systematic risk factors. This requires a large body of individual security-level historical data.

Just as with systematic risk, there is also an issue of choosing a more relevant historical period for the nonsystematic risk estimation. At times following a spike in issuer-specific volatility, such as the one that happened in the U.S. credit market in 2001 and 2002, a model needs to "learn" quickly from recent experience. Applying time decay to the historical data accomplishes this and makes the model produce higher estimates of nonsystematic risk going forward. The opposite is also true. After a long period of calm, the model should revert to the equal weighting of historical data to avoid underestimating issuer risk.

History-Based Scenario Analysis

In one form or another, scenario analysis is used widely by portfolio managers to study portfolio (and benchmark) behavior in various yield-curve, spread, volatility, prepayment, or exchange-rate environments. Managers may focus on what they consider to be the most likely scenarios or unlikely but potentially adverse scenarios. Scenario analysis complements multifactor risk analysis. It allows managers to stress-test benchmarked portfolios by subjecting them to extreme conditions ("three-standard-deviation events") not necessarily consistent with the

9. "A Portfolio Manager's Guide to the Lehman Brothers Global Multi-Factor Risk Model," Lehman Brothers, New York, January 2005.

history underlying the risk model. Such analysis may highlight potential sources of return deviations that do not manifest themselves under normal (by historical standards) circumstances.

When using scenario analysis, investors usually make explicit forecasts for specific, observable market dimensions: key interest rates, credit spreads for certain market sectors, particular exchange rates, and such. It is very difficult, however, to formulate scenarios that are consistent in both direction and magnitude across many different market sectors and to estimate the probability of such scenarios. This problem is very similar to that of analyzing risk simultaneously along many dimensions. Thus the solution also can be the same as in multifactor risk models. A covariance matrix estimated from historical observations can be used to build "maximum-likelihood scenarios." Such scenarios incorporate a few explicit forecasts provided by the investor and then infer historically consistent realizations (forecasts) for all other factors in the matrix. Then the full set of stated and derived factor forecasts is translated into expected returns for individual securities.

Explicit forecasts may represent unlikely scenarios. For example, the projection of a one-month yield change of 50 basis points represents a roughly 2% probability event if the historical yield volatility is only 25 basis points per month (assuming a normal distribution). Similarly, historical correlation patterns would not support an expectation of credit-spread widening at the same time with an increase in yield because yield and spread changes typically are negatively correlated. A scenario-generation model can be made to assess the likelihood of an explicit forecast in light of the covariances that underlie the analysis and to allow a rescaling of forecasts to meet prespecified likelihood targets. The views can be relative as well as absolute. A yield-curve slope forecast is an example of a relative forecast because it does not express an opinion on the overall direction of interest rates. Individual forecasts can be accompanied by degrees of confidence in them. For example, investors usually are more confident in their views on credit-spread movements than on currency and interest-rate changes. A robust scenario-analysis framework should be able to incorporate this information.

Attribution of Portfolio Performance Relative to a Benchmark

A comprehensive performance-attribution framework must account for all potential sources of portfolio performance and quantify the contribution from each of these sources. Performance attribution of past returns is perhaps the most important tool that asset managers can use to substantiate their claims on expertise in a given style of investment. If, for example, a fund claims to be adept at finding undervalued credits, performance attribution can be used to determine what share of the fund's past outperformance was due to credit picks. Unless there is hard proof that the generated returns came from the advertised source, investors may worry that any superior performance that might have been achieved in the past was due to luck rather than skill and may, in fact, be a sign of imprudent risk taking.

Asset management companies also benefit from using performance attribution in the internal analysis of portfolio performance to help determine their skill in managing different kinds of exposures and the areas that may require improvement. Sources of achieved outperformance should be matched with sources of ex-ante risk. Quantitative analysis of return deviations from the benchmark may point out unintended portfolio exposures that need to be corrected. This is particularly important for large funds with decentralized decision making in which separate groups or individuals are responsible for yield-curve positioning, sector and quality allocations, and name selection. Needless to say, performance-attribution analysis often is a key determinant of compensation levels.

Flexibility is critical in this analysis. A performance-attribution framework will only be useful (and used) if it is aligned with the actual decision-making process behind the portfolio investments. This process differs across firms and may vary over time within a single firm.

For multicurrency portfolios, the analysis normally starts at the global level, where outperformance results from two basic sources: unhedged exchange-rate exposures and currency-hedged exposures to different markets. For an example of the second source, consider a portfolio that has a higher exposure to currency-hedged JPY assets than the benchmark and a lower exposure to currency-hedged EUR assets relative to the benchmark. If the local returns of the yen fixed income market exceed market expectations and the local returns of the euro fixed income market fall short of expectations, this global allocation generates outperformance that is unrelated to currency movements.

After multicurrency outperformance is assessed, portfolio positions generally should be segregated by currency, and the performance of each single-currency portfolio evaluated separately (versus appropriate single-currency benchmarks). In a developed fixed income market, such as the United States, local returns usually comprise one or more of the three main components: Treasury (yield curve), volatility, and spread.

The Lehman performance-attribution system relies on the key-rate durations[10] methodology to compute outperformance owing to the Treasury curve positioning. Essentially, both the portfolio and the benchmark are replaced by hypothetical portfolios of Treasuries with exactly the same yield-curve exposures, that is, with matching key-rate durations profiles. Then the returns of these "Treasury-matched" portfolios are compared. The difference is clearly due exclusively to the disparate curve exposures of the portfolio and the benchmark. The bonds in the Treasury-matched portfolios usually are not real securities but rather points from the par yield curve, and contribute no pricing noise (such as owing to the richness of on-the-run issues). The Lehman model breaks down this component of outperformance even further to individual key-rate exposures.

10. While a single duration number measures price sensitivity to a parallel shift of the entire yield curve, key-rate durations measure sensitivity to changes in various points (key rates) along the curve.

A shift in implied volatility affects prices of bonds with embedded optionality. Quantifying outperformance owing to differences in volatility exposure requires a good term-structure model that can estimate the implied volatility of the Treasury curve and the analytics to compute volatility sensitivity (or vega) for all securities in the portfolio and in the benchmark.

Outperformance owing to spread exposure can be broken into an asset allocation part (asset class, sector, industry, quality, etc.) and a security-selection part. The former occurs when the portfolio had larger allocations to winning asset classes (or smaller to losing) than the benchmark. Security-selection outperformance comes from picking names that outperform their peers. Both measures depend strongly on the definition of asset classes or security peer groups.

Performance attribution is arguably one of the most complex elements in a suite of methodologies and tools that modern asset managers need. There are many technical points and subtleties, such as aggregating daily results, accounting for intraday trading, or dealing with pricing and return conventions that differ between the portfolio and the benchmark.

QUANTITATIVE APPROACHES TO BENCHMARK REPLICATION

Besides index funds whose investment mandates explicitly call for tracking benchmarks with the minimum possible deviation, "buying the benchmark" is often a reasonable tactic even for managers who normally pursue active strategies. In times when managers have no definite views on particular segments of the market, matching index returns in those segments is a sensible and safe strategy. Quite often, when managers have accrued significant outperformance before the year is over, they decide to switch to passive benchmarking for the rest of the year to preserve their gains. Finally, investors sometimes use so-called proxy portfolios that replicate broad market indexes for modeling purposes rather than for direct investment. The main reason usually is to apply the same in-house models to both the portfolio and the benchmark, eliminating "model noise," which can be quite significant. Sometimes it is not feasible to include the actual benchmark in the analysis because of constraints on either processing time or data availability. Computer-based analysis gets simpler and faster when applied to a small set of well-priced securities as opposed to potentially thousands of bonds in an index. Hence the term *proxy portfolios*.

As we pointed out earlier, the replication of a diverse market index that has multiple sources of return deviation is not a trivial task and sometimes requires complicated techniques and tools. There are two main categories into which all such techniques fall: replication with actual, or "cash," securities and replication with derivative instruments (e.g., futures and swaps). The replication strategies vary greatly, reflecting diverse characteristics of various fixed income markets, as well as objectives and constraints of different investors. For example, in markets with high idiosyncratic risk, it is relatively more important to match the issuer distribution of the benchmark. Where systematic risks dominate, the replication techniques should pay close attention to matching benchmark allocations along the important risk dimensions. For portfolios experiencing very dynamic cash inflows and outflows, derivatives strategies may be preferred because of their liquidity and low costs. Replication with derivatives is also popular with investors engaged in "portable alpha" strategies, that is, structuring liquid derivatives baskets to replicate index returns and investing cash outside the index to gain alpha.

Of course, the simplest way to replicate an index is to buy most of its securities. However, this method is practical only for the few largest index funds. In typical portfolios, maintaining the required proportions of a large number of bonds would lead to buying and selling odd lots and overwhelming transaction costs. Furthermore, this strategy is appropriate only for portfolios that intend to remain neutral versus the benchmark for a long time.

The problem of selecting the right subset of index securities is solved by one of two basic approaches: cell matching (stratified sampling) and tracking error minimization using a risk model. The relationship between the two parallels closely that between the sampling and the risk-model approaches to measuring portfolio risk.

Stratified Sampling

Sampling is the "common sense" approach. To replicate an index, one attempts to match its contribution to each important segment with a few securities. In the simplest case, the total market-value weight of holdings in a particular segment is set to match the index weight. More often, holdings are selected and scaled so that, collectively, they match the segment's contribution to the index duration. To improve tracking further, the manager may target other characteristics of each individual segment, such as convexity or credit quality. Of course, the more securities purchased in each segment, the more closely the portfolio will track the index.

This approach may work quite satisfactorily in homogeneous markets, such as U.S. governments or MBS. One very simple but effective approach we have used to replicate governments requires just six securities. The index is partitioned into three market-specific maturity segments. The choice of these segments may reflect such market characteristics as auction cycles, maturity distribution, or refunding policies. Within each segment, the bonds are divided into two groups: one with durations above the segment's average and one below. One liquid bond is selected from each half-segment. These two bonds are weighted in such a way that the total duration of the pair matches the duration of the segment they represent. The three pairs of bonds are then given appropriate weights to match the contributions of their segments to the index. This simple procedure ensures sufficiently close matching of the term-structure allocation that is the primary source of risk in government markets.

Stratified sampling works well for the U.S. MBS market that has virtually no idiosyncratic risk. Depending on the size of the replicating portfolio (which determines the number of securities that can be bought), it may be sufficient to sample the index along just three dimensions: program (GNMA 30-year, conventional 30-year, all 15-year, and balloons), seasoning (seasoned, unseasoned), and price (premium, cusp, and discount).[11]

Sometimes stratified sampling is simply the only available method—for example, in markets where multifactor risk models are not available. The actual techniques, while still based conceptually on sampling, may get quite sophisticated. First of all, special rules may be used for selecting individual bonds in each segment (e.g., starting from the largest issuer), as well as for setting the level of diversification in each segment (e.g., based on the segment's historical volatility). The sampling process may be performed within an optimization context. In this case, satisfying constraints is the main goal, with the objective function being a secondary consideration (yield, spread, or liquidity may be maximized, for example). The number of securities that end up in the replicating portfolio can be regulated by tightening or relaxing constraints.

The fundamental issues with replication techniques based on stratified sampling are the same as with the cell-based approach to analyzing risk. Matching some cells may be more critical than matching others because return volatility associated with these cells is higher. And sampling-based techniques ignore the all-important correlations among cells.

Tracking-Error Minimization

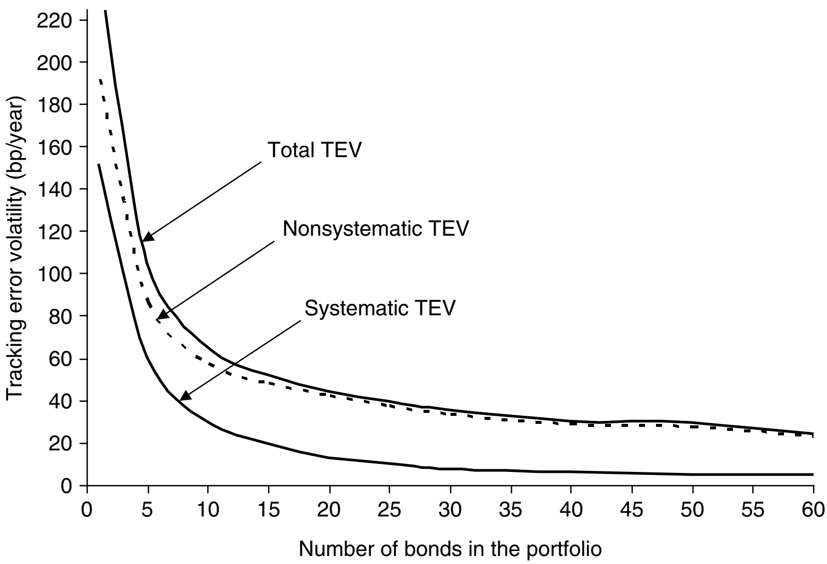
As we pointed out earlier, multifactor risk models usually provide more accurate estimates of portfolio risk than sampling techniques that attempt to match the index risk parameters "naively," often ignoring historical variances and correlations of risk factors. Besides performing their primary function of measuring risk, multifactor models can be augmented with optimization capabilities. Given a set of securities representing the investable universe, a benchmark, and a set of constraints, an optimizer based on a multifactor model can pick a sample of bonds (a portfolio) with the minimum projected tracking error versus the benchmark. This may be done in one step, with the model being essentially a "black box" cranking out a solution. Or it may be done one transaction at a time, leaving the manager who uses the optimizer fully in control. From a practical standpoint, stepwise optimization may be preferable. The optimizer in the Lehman model, for example, helps the user select transactions that lead to the steepest decline in TEV while leaving her free to pick a different security or change the transaction amounts.

The stepwise approach to tracking-error minimization has been applied successfully to construct replicating portfolios for broad benchmarks of the U.S. and global government and credit markets. This method also has proved very

11. Partitioning the MBS universe by price is essentially equivalent to partitioning by coupon. The advantage of using price is that the cutoff levels defining the boundaries do not change over time.

EXHIBIT 44–4

Tracking-Error Volatility versus the Lehman Corporate Index as a Function of the Number of Bonds in the Portfolio



effective in replicating the Lehman MBS Index.[12] The realized performance of most actual replicating portfolios has been within the model-projected range. The level of tracking achieved by a replicating portfolio depends, of course, on the number of bonds it contains. As more bonds are added to the portfolio, risk decreases. Exhibit 44–4 illustrates this process by showing how the annualized projected TEV of a corporate replicating portfolio versus the Lehman Corporate Index declines with the increase in the number of securities. At first, adding more securities to the portfolio reduces tracking error quickly, but gradually, the rate of decline slows. The explanation lies in the difference between systematic and non-systematic risk. The systematic risk declines quite rapidly. In fact, it takes surprisingly few bonds to effectively match systematic risk exposures of such a broad market index as the Lehman corporate. As we see from the exhibit, at the 30- to 35-bond level, the systematic risk is virtually gone. Then the nonsystematic risk starts to dominate. This type of risk is much harder to diversify away, and the tracking-error decline slows down.

Multifactor risk models rely on historical experience over the calibration period. Such models may ignore a significant structural mismatch that historically

12. Lev Dynkin, Vadim Konstantinovsky, and Bruce Phelps, "Tradable Proxy Portfolios for an MBS Index," *Journal of Fixed Income* 11 (2001), pp. 70–87.

did not result in return volatility. There is always a chance that historical patterns will not hold over the next month and that a mismatch will prove more consequential than the model thought. This is why stratified sampling analysis may be useful even in the presence of a powerful risk model. It may alert the portfolio manager to structural mismatches ignored by the model. In such cases, managers may use their judgment in deciding whether to rely on historical patterns.

Replication with Derivatives

Derivatives effectively reduce the number of dimensions in the portfolio management problem and simplify asset allocation shifts and deployment of cash inflows. Because of this, derivatives can be particularly useful in replicating the benchmark at the start-up phase, when diversified cash investments in tradable sizes are not feasible. Derivatives can also be used in portable alpha strategies, in which a manager's value-added from one strategy is "transported" into another strategy.

Treasury futures have been widely used as a duration-adjustment tool because of such advantages as no portfolio disruption, ease of establishing and unwinding positions, and low transaction costs. A derivatives version of the cell-matching technique using a proper mix of four Treasury futures contracts (2-, 5-, 10-, and 30-year) can be effective in replicating the term structure exposure of any fixed-income index. In the Lehman replicating methodology,[13] the index is divided into four maturity/duration cells, and the market value allocations and dollar durations of each are matched with a combination of cash and an appropriate futures contract. The cash can be invested in Treasury bills or other short-term instruments. For an added benefit, cash may be invested more aggressively into riskier and higher-yielding instruments such as commercial paper or floating-rate asset-backed securities. For the funds with frequent and significant cash inflows and outflows, replication of benchmark returns with exchange-traded futures is often a strategy of choice. Similarly, a large asset allocation shift may be initiated with futures because of their liquidity and low-cost trading. Less liquid cash assets can then be deployed gradually as opportunities arise.

While the term-structure exposure can be matched effectively with Treasury futures alone, spread risk needs to be hedged separately. The next level in derivatives replication techniques introduces Eurodollar futures and swaps to replicate indexes with credit spread exposure. Replication strategies based on these instruments rely on the positive correlation between credit or MBS/ABS spreads on the one hand, and the Treasury-Eurodollar (TED) and swap spreads on the other. These strategies can be used successfully to replicate such spread benchmarks as the Lehman Credit and Mortgage indexes.

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13. Lev Dynkin, Jay Hyman, and Peter Lindner, "Hedging and Replication of Fixed-Income Portfolios," *Journal of Fixed Income* 11 (2002), pp. 43–63.

A further enhancement introduces TBAs to replicate the mortgage component and portfolio credit default swaps to replicate the credit component. TBAs offer two key advantages over mortgage pools in replication strategies: They are suitable for an unfunded strategy since no cash outlay is required; and the back-office aspects of investing in mortgages are much simpler because monthly interest payments and principal paydowns are avoided. Portfolio credit default swaps (CDS) are very liquid instruments which investors can use to take a long (or short) position in credit. Credit yields can be broken down into two parts: The swap yield and a credit spread to swaps. Accordingly, the exposure of credit to movements in swap yields can be matched using interest-rate swaps, while the exposure to movements in LIBOR credit spreads by using CDS. For example, such widely traded products as CDX.NA.IG represent baskets of equally-weighted CDS in 5- and 10-year maturities and can be very useful in replicating credit indexes. The use of TBAs and CDX baskets has been shown recently[14] to reduce TEV for the U.S. Aggregate Index below 10 basis points per month.

Finally, derivatives can be employed to replicate the broadest, multicurrency fixed income benchmarks, such as the Lehman Global Aggregate Index. The Global Aggregate Index presents investors with a portfolio management problem involving multiple yield curves, exchange rates, as well as credit and issuer risk in several markets. As a matter of fact, this diversity of exposures makes global indexes particularly good candidates for replication with derivatives.

Typically, the single-market components of a global index are replicated separately and then combined into the resulting tracking portfolio. The greater number of risk dimensions in a global index provides diversification of the TEV for each subcomponent of the index. For example, the risk associated with replicating the U.S. MBS component of the Lehman Global Aggregate Index is not likely to be highly correlated with the risk in replicating the Euro-credit component and so will reduce the overall portfolio's TEV.

CONTROLLING ISSUER-SPECIFIC RISK IN THE PORTFOLIO

Credit crises like the one of 2001–2002 usually compel portfolio managers to adopt a more disciplined approach to diversifying portfolio risk (although a few years of calm often erode this discipline). At the simplest level, managers try to avoid large exposures to single issuers and hold as many different issuers in their portfolios as practical. A more sophisticated approach, described next, reflects the well-known but often forgotten fact that the event risk is more significant in lower credit strata both in frequency and in severity of losses.

14. "Replicating the Lehman Brothers Aggregate Bond Index with Liquid Instruments," Lehman Brothers, New York, October 2003.

Managers who do not pursue alpha via name selection may not buy cash securities at all, choosing alternative ways of getting credit exposure. Such "bondless" portfolios assume the net issuer risk of the benchmark. For sufficiently broad market indexes, such risk is usually much smaller than the issuer risk of a typical cash portfolio. Well-developed and liquid swap markets in several currencies provide a viable means of getting credit exposure without acquiring actual securities and the associated exposure to their issuers. The relatively new but rapidly developing credit derivatives markets, particularly credit default swaps, provide managers with even more flexibility in controlling credit exposures in their portfolios.

Sufficient Diversification in Credit Portfolios

The need to reduce issuer-specific risk by diversification is obvious to any credit manager. Very often, though, the diversification is pursued in a simplistic way, for example, by setting issuer or security allocation limits without regard for credit quality. On the other hand, diversification should not be viewed as unqualified benefit because there is a downside to it as well, from increased transaction costs to the dilution of the value of credit research. This issue has been addressed in a study of optimal diversification levels in credit portfolios.[15] A simple model of downgrade risk was proposed, based on the observed historical underperformance of downgraded bonds and transition probabilities published by rating agencies.

The study helped to answer the following question: for a portfolio of a given number of bonds, how many bonds of each credit quality should be held to achieve the lowest tracking error due to downgrade risk? The optimal allocations were found to be rather heavily skewed in their diversification levels (i.e., in maximum allowed position sizes) across qualities. In fact, for the study period that started in 1988 and included the credit events of 2002, the optimal ratio of position sizes for the three major investment-grade credit categories was found to be 10:3:1. In other words, the optimal position size in Baa-rated bonds was one-tenth the position size of Aaa/Aa-rated bonds and one-third the position size of A-rated bonds. This ratio is somewhat extreme for two reasons. First, it is based on downgrade data that include the extremely turbulent period of 2000–2002. The inclusion of subsequent, much calmer months undoubtedly would make it less asymmetric. Second, the ratio reflects only one type of idiosyncratic risk—the risk of a downgrade. Of course, issuer-specific events may be quite significant but not accompanied by a downgrade (at least not for a long time). Indeed, this type of volatility dominates in the higher-quality segment of the market. When one takes into account the spread volatility not caused by rating transitions, the position size ratio tends to become less dramatic but still indicates the use of smaller

15. Lev Dynkin, Jay Hyman, and Vadim Konstantinovsky, "Sufficient Diversification in Credit Portfolios," *Journal of Portfolio Management* 29 (2002), pp. 89–114.

position limits in lower qualities. For example, for the same volatile period ending in 2002, the "total volatility" ratio was found to be 5:3:1.

Clearly, these ratios should never be used as a literal directive when structuring credit portfolios. As all research conclusions, they depend heavily on the methodology and the historical period covered by the study. Yet the very clear (and enduring) lesson is that to lower the overall issuer-specific risk, it is most important to diversify exposures to lower-rated issuers. This conclusion has implications for plan sponsors as well: portfolio guidelines that establish maximum position limits to force diversification should not do so evenly across credit qualities.

To counterbalance the desire to reduce event risk as much as possible, managers should carefully consider the costs associated with increasing the number of issuers in a portfolio. First, transaction costs increase as the portfolio transacts more and in smaller amounts. Second, there is the overhead of monitoring a larger number of issuers. Finally, as managers push to add issuers for diversification's sake, they will be forced to extend to issuers that are less highly rated by their credit analysts. Consequently, the optimal level of diversification is always determined by the trade-off between the reduction of issuer-specific risk and the dilution of outperformance. The development of quantitative models that pinpoint this optimal level is possible but not trivial. Such models need to consider both the marginal cost and the marginal value of credit research, as well as the portfolio size and many other factors.

Swaps as a Total-Return Investment

Fixed-for-floating swaps have been around since the 1980s. Since that time, the liquidity and market breadth of the swaps market have increased tremendously. Swaps traditionally have been used as a risk-management tool to adjust portfolios' term structure and spread exposures. Lately, though, swaps have received attention as a total-return investment.

Changes in the credit risk premium influence both swap and credit spreads. Expectations of significant changes in future Treasury supply, for example, as well as "specialness" of individual Treasury securities, are among the factors that affect the spreads over Treasuries of both swaps and other spread product. Lehman Brothers publishes swap indexes whose total returns are based on receive-fixed swaps of various maturities augmented with a cash investment in three-month LIBOR. Such indexes help investors to analyze and use swaps as just another asset class, complete with pricing, returns, and analytics.

As we mentioned earlier, among the published swap indexes are so-called mirror indexes that match the term-structure exposure of various popular fixed income benchmarks. Over the period from July 1992 through March 2004, the cash components of the Lehman Aggregate Index underperformed their mirror swap indexes. Even though this performance pattern is not guaranteed and may well be reversed in the future, it is clear that swaps have the outperformance potential that puts them on par with other spread asset classes.

EXHIBIT 44–5

Correlation Matrix: Excess Returns over Treasuries, July 1992–March 2004

	Aggregate	Credit	Agency	MBS	ABS	5-Year Swaps
Aggregate	1.00	0.86	0.62	0.76	0.64	0.55
Credit		1.00	0.40	0.35	0.58	0.38
Agency			1.00	0.55	0.56	0.76
MBS				1.00	0.42	0.43
ABS					1.00	0.44
5-year swaps						1.00

Swap spreads usually are aligned with credit spreads, although certain factors can cause dichotomy between them. For example, in a steep yield-curve environment, swapping activity by corporations intensifies, leading to the tightening of swaps spreads unaccompanied by the corresponding tightening of credit spreads. Although such factors diminish the value of swaps as a credit proxy, they promote the role of swaps as a means to diversify systematic risk in total return portfolios. Exhibit 44–5 shows that for the period from July 1992 through March 2004, five-year swaps had a lower excess return correlation with the Lehman Aggregate index than any of the index's five main components. The low excess return correlation implies that adding five-year swaps to a diversified portfolio of agencies, credit, mortgage-backed, and asset-backed securities may produce risk-reducing benefits.

The treatment of swaps as a total-return investment should be considered from a tactical as well as a strategic asset allocation perspective. The outperformance and diversification properties that swaps have demonstrated over the recent years make them a valuable tool for total-return portfolio managers.

Credit Default Swaps as Protection against Issuer Risk

After the recent rapid growth, the global credit derivatives market now exceeds $2 trillion. This growth reflects the expanded number of applications that market participants find for these instruments. Today, credit default swaps (CDS) have a permanent place in total-return and insurance companies' portfolios. CDS are used to hedge existing credit exposures in the portfolio and to create new exposures that could not be created otherwise, for example, taking short positions to express a negative view. A conventional corporate "cash" instrument, for example, a regular corporate bond, bundles together exposures to interest rates, swap spread, credit spread (over swaps), and possibly, currency risk as well. CDS allow investors to pick from this bundle of exposures only the desired one. With CDS, investors can separate their views on a particular credit (issuer) from views on the market segment to which that issuer belongs.

Investors became more comfortable with CDS after a number of prominent corporate defaults in 2001 and 2002 proved the utility of these new credit derivative structures. Besides their primary function of hedging out the default risk of particular issuers, CDS are now being used in a number of creative ways.[16] Some investors place bets on the "default swap basis," that is, the spread between a CDS and corporate debt of the same issuer, or express relative views on two issuers. Finally, CDS are often more liquid than the underlying corporate issues, providing an easier and cheaper way to get the desired exposure.

QUANTITATIVE METHODS FOR PORTFOLIO OPTIMIZATION

Optimization has been an important part of investment practice since the introduction of mean-variance analysis more than 50 years ago. The asset management problem lends itself quite naturally to optimization techniques. Almost always, it is a multivariable, multiconstraint task with a well-defined objective. A portfolio of financial assets has two essential characteristics: investment return and risk (i.e., uncertainty about the magnitude of return). Therefore, the countless optimization methods and tools developed over the last few decades by finance practitioners and academics target one of these two characteristics while controlling the other.

Historically, the usual objective function of portfolio optimization has been to maximize expected return relative to risk. This requires upfront estimates for expected returns of every asset considered in the optimization. As we discuss below, historical data, whether longterm or recent, is a very poor predictor of future performance. Analysts' forecasts have proven to be imperfect as well. In this section we look at two examples of optimization techniques that do not rely on explicit predictions of asset performance.

Optimal Risk Budgeting Based on Skill

Managing large, multiasset portfolios is usually a collective effort. Various managers, analysts, or teams form opinions relevant to particular segments of the overall portfolio. Then all these opinions are considered by some central decision-making authority. This may be a committee of the very same portfolio managers responsible for individual portfolio segments, often supervised by a chief investment officer. Multiple recommendations have to be reconciled: "go long duration," "overweight the 10-year segment of the curve," "short industrials," "buy current coupon mortgages," etc. How can the decision makers establish the

16. Lehman Brothers started publishing a corporate CDS index in July 2003.

magnitudes of exposures along all these dimensions? They need to consider the interaction among all the intended exposures and the resulting overall portfolio risk. But first and foremost, they estimate (explicitly or implicitly) the degree of trust in each particular recommendation, which depends on the perceived skill of those who made that recommendation.

The manager's skill is a critical factor that largely determines portfolio performance. While this is apparent to everybody, the notion of skill is rarely used formally in any practical context, for example, when allocating risk within a portfolio or projecting expected outperformance. Even more surprisingly, skill rarely is measured in any disciplined way.

We performed several studies where skill was central in the historical simulation of various investment strategies.[17] These skill-based historical simulations produced an interesting conclusion. The information ratios of very diverse strategies were very similar for a given skill level. Apparently, when performance is measured on a risk-adjusted basis, the particular nature of an investment strategy plays a minor role. Performance is essentially determined by the skill and dimensionality (the number of independent decisions) of a strategy.

These empirical results confirm the "fundamental law of active management" defined by Grinold and Kahn.[18] This law states that the information ratio of an investment strategy is determined by two factors: the "information coefficient" based on correlation between predictions and realizations (and closely related to the probability-based skill) and "breadth," or the number of independent decisions made by the strategy.

Because the information ratio is outperformance (alpha) divided by risk (tracking-error volatility), we can express the law slightly differently by stating that a strategy's alpha is proportional to risk, skill, and the number of independent decisions.

This idea has fundamental implications for portfolio optimization. Asset managers traditionally have used the mean-variance approach to find the optimal asset allocation that maximizes expected outperformance, or alpha, for a given level of risk (or minimizes risk for a given alpha). The Achilles' heel of this approach is the expected returns of asset classes (or strategies) used in the optimization. Historical returns are poor predictors of future returns, and scenario- or consensus-based projections present their own problems.

The Lehman Brothers proprietary risk-budgeting methodology—*ORBS* (*O*ptimal *R*isk *B*udgeting with *S*kill)—relies on skill levels, breadth, and directional views to allocate the total risk budget among macro strategies to maximize portfolio alpha. The risk allocated to an individual strategy is then translated into the size of active position that corresponds to that risk. At the core of this

17. See, for example, "Value of Skill in Macro Strategies for Global Fixed Income Investing," Lehman Brothers, New York, June 2003.
18. Richard Grinold and Ronald N. Kahn, *Active Portfolio Management* (New York, McGraw-Hill, 1999).

risk-budgeting methodology is a covariance matrix of returns for the asset classes underlying all considered strategies. This framework is very flexible and can be applied to essentially any set of asset classes and investment strategies with any number of different constraints.

Asset Allocation for Buy-and-Hold Investors

A corporate bond provides investors with a relatively small spread over Treasuries during its lifetime in compensation for the risk of a large, albeit unlikely, loss from default. While default risk is issuer-specific and can be reduced via diversification, correlation of defaults among issuers makes it impossible to eliminate it completely. This asymmetric view of credit investing corresponds most closely with the considerations of a long-term investor who intends to hold bonds to maturity. In contrast, most total-return investors have a much shorter time frame and perceive a very different, less asymmetric risk/return profile. For a total-return investor, the dominant risks are spread volatility (essentially symmetric) and possible loss of liquidity. At least in investment-grade markets, credit-quality deterioration typically occurs gradually, so the primary risk for a total-return investor is not default but rather downgrade (and the accompanying spread widening).

This difference in perspective has major implications for buy-and-hold investors. The spreads observed in the market result from interactions among all market participants, many of whom are total-return investors. If these investors expect high short-term spread volatility or liquidity risk, they can drive spreads much wider than would be justified by long-term default risk alone. This action can work to the benefit of long-term credit investors unaffected by short-term risks.

The asymmetric nature of the risk/return profile for long-term investors should be reflected in their asset allocation process. The most common approach to asset allocation, mean-variance optimization, generally is not suitable for buy-and-hold investors. In mean-variance optimization, risk is represented by the standard deviation of asset returns, which implies a symmetric distribution. For very asymmetric return profiles, standard deviation is not a particularly helpful measure of risk. In fact, no single measure of risk is universally appropriate for dealing with extreme, or "tail," events. The treatment of this "tail risk" must be customized to the needs and risk tolerance of each investor. One approach to asset allocation focuses on the downside risk, that is, the part of the return distribution that is below a certain minimum required return. This approach, though, requires a fuller description of the return distribution. When symmetry cannot be assumed, mean and standard deviation are not sufficient.

The central problem in the buy-and-hold asset allocation process is the fundamental trade-off between current credit spreads and expected horizon defaults. When is credit "cheap" from a buy-and-hold perspective? The answer depends on the level of default risk in the portfolio. To what extent can the default risk be reduced by issuer diversification, that is, how many issuers should a portfolio contain to limit default loss to a certain threshold with a given level of confidence? Or what allocation among different credit qualities will maximize spread within a given limit of the tail risk? Sophisticated quantitative models and techniques have been developed to address these matters.[19] There is an extensive body of research literature dealing with modeling default risk and particularly with default correlation.

TOOLS FOR QUANTITATIVE PORTFOLIO MANAGEMENT

The challenge for building a good quantitative portfolio-level system comes from the simultaneous need for wide asset class coverage and consistency of analytics across all asset classes. Specialized systems usually offer advanced analytics for specific asset classes. The objective for a portfolio system is to treat a wide range of asset classes within a single consistent framework without giving up too much accuracy.

At the foundation of a powerful analytical suite are basic security-level analytics, such as cash-flow projection, spread-to-price conversion, or duration calculation. The word *basic* belies the enormous complexity of this task. The variety of financial assets available to investors is ever-expanding and necessitates powerful underlying yield-curve, mortgage-prepayment, option-pricing, and volatility models.

Building on the security pricing models is a broad set of portfolio-level analytics, that is, portfolio management tools that help managers analyze portfolio risk exposures, estimate the effect of various changes to portfolio structure, construct optimal portfolios, attribute achieved performance, and deal with many other important issues. An important part of this analytical suite is a multifactor risk model. When such a model is enhanced with optimization capabilities, it becomes a powerful tool for portfolio construction.

A useful complement for history-based risk modeling is flexible scenario analysis. An advanced scenario analysis engine is able to expand a few user-provided inputs into a complete set of maximum-likelihood scenarios for all relevant risk factors. A flexible performance attribution model is another essential component of the analytical suite. Various portfolio optimization tools, such as the risk-budgeting framework described earlier, complete the picture. Each of these building blocks requires sophisticated financial modeling and computer implementation effort. The added challenge is to ensure consistency among all these various tools. The conclusions a manager derives from the risk model should not contradict those from scenario analysis. The ex-post return analysis should attribute the achieved outperformance to the risk exposures highlighted in the ex-ante risk analysis.

19. "Optimal Credit Allocation for Buy-and-Hold Investors," Lehman Brothers, New York, January 2004.

CONCLUSION

Portfolio management entails two essential functions: forming market views at a macro and/or security level and optimally implementing those views in the portfolio. Portfolio managers are constantly focused on the first task. Success in finding relative value by market timing, sector, or name selection requires experience and intuition and usually is equated with portfolio management talent. Yet the second part, that is, constructing an actual portfolio that reflects the desired views, is just as vital for ultimate performance. It is this second part that is greatly aided by quantitative methods and requires all the methodologies, tools, and studies described in this chapter.

Portfolio management always will remain an art, but market practitioners increasingly will benefit from embracing quantitative techniques in their daily work.

CHAPTER

FORTY-FIVE

FINANCING POSITIONS IN THE BOND MARKET

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Leveraging strategies require that an investor borrow funds. There are several well-established arrangements in the bond market for borrowing funds. The most common practice is to use the securities as collateral for a loan. In such instances, the transaction is referred to as a *collateralized loan*. In this chapter we will look at the four types of collateralized loans in which the collateral is a bond: repurchase agreement, dollar roll, securities lending, and margin buying.

A collateralized loan is not the only mechanism available to an investor for creating leverage. Derivative contracts are instruments that allow an investor to synthetically create leverage. This is so because a derivative contract allows an investor to obtain greater exposure to a specific bond issuer per dollar invested than the same dollar amount invested in the cash-market instrument. For example, the initial futures margin that an investor must make to obtain a long position in a Treasury bond futures contract creates an exposure to Treasury bonds much greater than the exposure if that initial futures margin were used to purchase Treasury bonds. In the case of an interest-rate swap, consider the fixed-rate receiver's position. This party is effectively borrowing on a floating-rate basis to obtain exposure to a fixed-rate bond position where the par value of that bond position is equal to the swap's notional amount. Similarly, there are cash-market instruments that have embedded leverage. For example, an inverse floater position is equivalent to borrowing funds on a floating-rate basis in order to obtain a fixed rate.

REPURCHASE AGREEMENT

A *repurchase agreement*, or simply *repo agreement* or *repo*, is the sale of a security with a commitment by the seller to buy the same security back from the purchaser at a specified price at a designated future date. The price at which the seller subsequently must repurchase the security is called the *repurchase price,* and the date that the security must be repurchased is called the *repurchase date*. Basically, a repurchase agreement is a collateralized loan where the collateral is the security sold and subsequently repurchased.

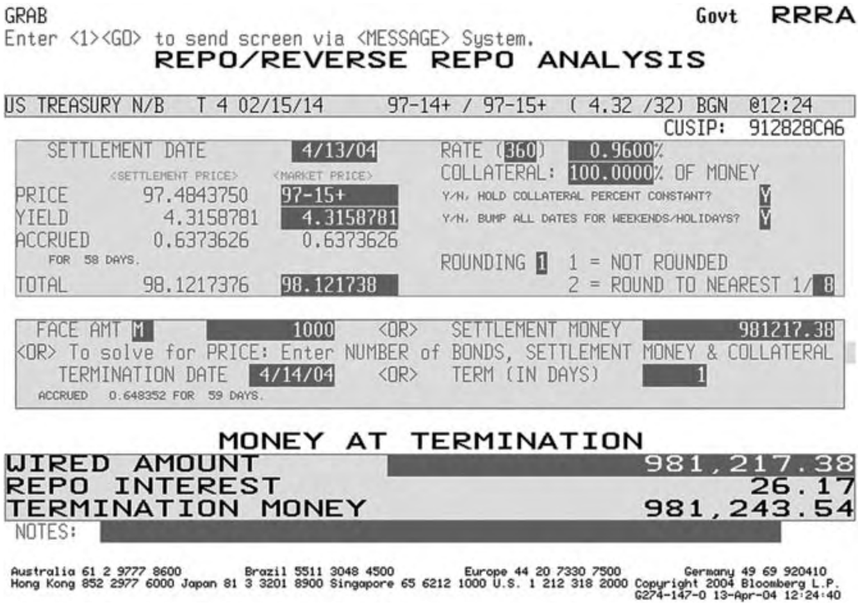
Suppose that a government securities dealer purchases a 4% coupon Treasury note that matures on February 15, 2014 on Tuesday, April 13, 2004. The face amount of the position is $1 million, and the note's full price is $981,217.38. Further, suppose that the dealer wants to hold the position overnight. Where does the dealer obtain the funds to finance this position? Of course, the dealer can finance the position with its own funds or by borrowing from a bank. Typically, the dealer uses a repurchase agreement or "repo" market to obtain financing. In the repo market, the dealer can use the purchased Treasury note as collateral for a loan. The term of the loan and the interest rate a dealer agrees to pay are specified. The interest rate is called the *repo rate*. When the term of a repo is one day, it is called an *overnight repo*. Conversely, a loan for more than one day is called a *term repo*. The transaction is referred to as a "repurchase agreement" because it calls for the security's sale and its repurchase at a future date. Both the sale price and the purchase price are specified in the agreement. The difference between the purchase (repurchase) price and the sale price is the loan's dollar interest cost.

Let us return now to the dealer who needs to finance the Treasury note that it purchased and plans to hold for one day. We will illustrate this transaction using Bloomberg's Repo/Reverse Repo Analysis (RRRA) screen that appears in Exhibit 45–1. The settlement date is the day that the collateral must be delivered and the money lent to initiate the transaction. Likewise, the termination date of the repo agreement is April 14, 2004 and appears in the lower left-hand corner. At this point we need to ask, who is the dealer's counterparty (i.e., the lender of funds). Suppose that one of the dealer's customers has excess funds in the amount of $981,217.38, called the *settlement money,* and is the amount of money loaned in the repo agreement.[1] On April 13, 2004, the dealer would agree to deliver ("sell") $981,217.38 worth of Treasury notes to the customer and buy the same Treasury security for an amount determined by the repo rate the next day on April 14, 2004.[2] Suppose that the repo rate in this transaction is 0.96%, which is

1. For example, the customer might be a municipality with tax receipts that it has just collected and no immediate need to disburse the funds.
2. We are assuming in this illustration that the borrower will provide collateral that is equal in value to the money that is loaned. In practice, lenders require borrowers to provide collateral in excess of the value of money that is loaned. We will illustrate how this is accomplished shortly when we discuss repo margins.

EXHIBIT 45–1

Bloomberg's Repo/Reverse Repo Analysis Screen



Source: Bloomberg LP.

indicated in the upper right-hand corner of the screen. Then, as will be explained below, the dealer would agree to deliver the Treasury notes for \$981,217.38 and repurchase the same securities for \$981,243.54 the next day. The \$26.17 difference between the "sale" price of \$981,217.38 and the repurchase price of \$981,243.54 is the dollar interest on the financing.

The following formula is used to calculate the dollar interest on a repo transaction:

$$\text{Dollar interest} = (\text{dollar principal}) \times (\text{repo rate}) \times (\text{repo term}/360)$$

Notice that the interest is computed using a day-count convention of actual/360 like most money market instruments. In our illustration, using a repo rate of 0.96% and a repo term of one day, the dollar interest is \$26.17, as shown below:

$$\$26.17 = \$981{,}217.38 \times 0.0096 \times (1/360)$$

This calculation agrees with repo interest as calculated in the lower right-hand corner of Exhibit 45–1.

The advantage to the dealer of using the repo market for borrowing on a short-term basis is that the borrowing rate (i.e., the repo rate) is less than the cost of bank financing. (The reason for this is explained below.) From the perspective of the entity lending funds, the repo market offers an attractive yield on a short-term secured transaction that is highly liquid.

The repo market can be used not only to finance a position in the market but also to cover a short position. For example, suppose that a dealer shorted a bond issue two weeks ago and must now cover the position—that is, deliver the bond issue. The dealer can do a *reverse repo* (i.e., agree to buy the bond issue and sell it back). Of course, the dealer eventually would have to buy the bond issue in the market in order to cover its short position. In this case, the dealer is actually making a collateralized loan to the counterparty.

There is a good deal of Wall Street jargon describing repo transactions. To understand it, remember that one party is lending money and accepting a security as collateral for the loan; the other party is borrowing money and providing collateral to borrow the money. When someone lends securities in order to receive cash (i.e., borrows money), that party is said to be "reversing out" securities. A party that lends money with the security as collateral is said to be "reversing in" securities. The expressions "to repo securities" and "to do repo" are also used. The former means that someone is going to finance securities using the security as collateral; the latter means that the party is going to invest in a repo. Finally, the expressions "selling collateral" and "buying collateral" are used to describe a party financing a security with a repo, on the one hand, and lending on the basis of collateral, on the other.

Most participants in the United States use the Bond Market Association (BMA) Master Repurchase Agreement. In Europe, the TBMA/ISMA Global Master Repurchase Agreement has become widely accepted. In these agreements, the borrower of funds is referred to as the "seller" because that party has sold the securities, and the lender of funds is referred to as the "buyer" because that party has purchased the securities.

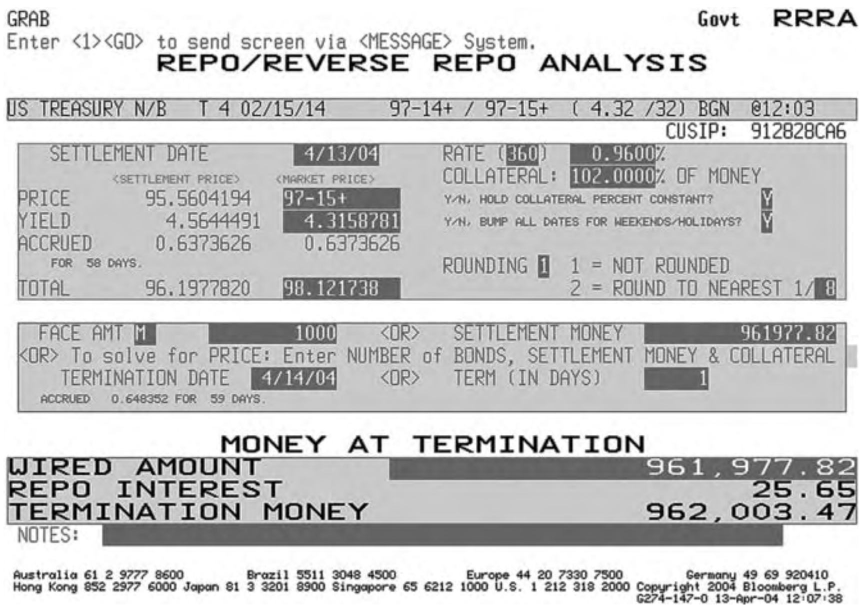
Credit Risks

Despite the fact that there may be high-quality collateral underlying a repo transaction, both parties to the transaction are exposed to credit risk. Credit risk in a repo agreement, popularly referred to as "counterparty risk," occurs because if the borrower fails to repay the loan, the market value of the collateral may fall below the amount owed. There is also counterpart risk from the perspective of the borrower of funds. If the market value of the collateral is greater than the borrowed amount, there is the risk that the lender will fail to return the collateral.

Repos should be structured carefully to reduce credit risk exposure. The amount lent should be less than the market value of the security used as collateral, thereby providing the lender with some cushion should the market value of the security decline. The amount by which the market value of the security used as collateral exceeds the value of the loan is called *repo margin* or, simply, *margin*. Margin is also referred to as the "haircut." Repo margin is generally between 1% and 3%. For borrowers of lower creditworthiness and/or when less liquid securities are used as collateral, the repo margin can be 10% or more.

EXHIBIT 45–2

Bloomberg's Repo/Reverse Repo Analysis Screen



Source: Bloomberg LP.

To illustrate the role of a haircut in a repurchase agreement, let us once again return to the government securities dealer who purchases a 4% coupon Treasury note and needs financing overnight. Recall that the face amount of the position is \$1 million, and the note's full price is \$981,217.38. As before, we will use Bloomberg's RRRA screen to illustrate the transaction in Exhibit 45–2. When a haircut is included, the amount the customer is willing to lend is reduced by a given percentage of the security's market value. In this case, the collateral is 102% of the amount being lent. This percentage appears in the box labeled "COLLATERAL" in the upper right-hand corner of the screen. Accordingly, to determine the amount being lent, we divide the note's full price of \$981,217.38 by 1.02 to obtain \$961.977.82, which is labeled "SETTLEMENT MONEY" and is located on the right-hand side of the screen. Suppose that the repo rate in this transaction is 0.96%. Then the dealer would agree to deliver the Treasury notes for \$961,977.82 and repurchase the same securities for \$962,003.47 the next day. The \$25.65 difference between the sale price of \$961,977.82 and the repurchase price of \$962,003.47 is the dollar interest on the financing. Using a repo rate of 0.96% and a repo term of one day, the dollar interest is calculated as shown below:

$$\$25.65 = \$961.977.82 \times 0.0096 \times (1/360)$$

This calculation agrees with repo interest as shown in the lower right-hand corner of Exhibit 45–2.

Another practice to limit credit risk is to mark the collateral to market on a regular basis. (Marking a position to market means recording the value of a position at its market value.) When market value changes by a certain percentage, the repo position is adjusted accordingly. The decline in market value below a specified amount will result in a margin deficit. The BMA Master Repurchase Agreement gives the borrower the option to cure the margin deficit by either providing additional cash or by transferring additional securities that are reasonably acceptable to the lender. Suppose instead that the market value rises above the amount required for margin. This results in a margin excess. In such instances, the BMA Master Repurchase Agreement grants the lender of funds the option to give the borrower cash equal to the amount of the margin excess or to transfer purchased securities to the borrower.

Since the BMA Master Repurchase Agreement covers all transactions where a party is on one side of the transaction, the margin maintenance is not looked at from an individual transaction or security perspective but as all repo transactions with the same counterparty.

The price to be used to mark positions to market is defined in the agreement. The market value is defined as one "obtained from a generally recognized source agreed to by the parties or the most recent closing bid quotation from such a source."

One concern in structuring a repo is delivery of the collateral to the lender. The most obvious procedure is for the borrower to deliver the collateral to the lender or to the cash lender's clearing agent. In such instances, the collateral is said to be "delivered out." At the end of the repo term, the lender returns the collateral to the borrower in exchange for the principal and interest payment. This procedure may be too expensive, though, particularly for short-term repos, because of the costs associated with delivering the collateral. The cost of delivery would be factored into the transaction by a lower repo rate that the borrower would be willing to pay. The risk of the lender not taking possession of the collateral is that the borrower may sell the security or use the same security as collateral for a repo with another party.

As an alternative to delivering out the collateral, the lender may agree to allow the borrower to hold the security in a segregated customer account. Of course, the lender still faces the risk that the borrower may use the collateral fraudulently by offering it as collateral for another repo transaction. If the borrower of the cash does not deliver out the collateral but instead holds it, then the transaction is called a *hold-in-custody repo* (HIC repo). Despite the credit risk associated with an HIC repo, it is used in some transactions when the collateral is difficult to deliver (such as in whole loans) or the transaction amount is small and the lender of funds is comfortable with the reputation of the borrower of the cash.

Another method is for the borrower to deliver the collateral to the lender's custodial account at the borrower's clearing bank. The custodian then has possession of the collateral that it holds on behalf of the lender. This practice reduces the cost of delivery because it is merely a transfer within the borrower's clearing bank. If, for example, a dealer enters into an overnight repo with customer A, the next day the collateral is transferred back to the dealer. The dealer can then enter into a repo with customer B for, say, five days without having to redeliver the collateral. The clearing bank simply establishes a custodian account for customer B and holds the collateral in that account. This specialized type of repo arrangement is called a *triparty repo*. In fact, for some regulated institutions, for example, federally chartered credit unions, this is the only type of repo arrangement permitted.

The agreement covers the events that will trigger a default of one of the parties (i.e., "events of default") and the options available to the nondefaulting party. In the case of a bankruptcy by the borrower, the bankruptcy code in the United States affords the lender of funds in a qualified repo transaction a special status. It does so by exempting certain types of repos from the stay provisions of the bankruptcy law. This means that the lender of funds can liquidate the collateral immediately to obtain cash.

Determinants of the Repo Rate

There is not one repo rate. The rate varies from transaction to transaction depending on a variety of factors: quality of collateral, term of the repo, delivery requirement, availability of collateral, and the prevailing federal funds rate.

The higher the credit quality and liquidity of the collateral, the lower is the repo rate. The effect of the term of the repo on the rate depends on the shape of the yield curve. As noted earlier, if delivery of the collateral to the lender is required, the repo rate will be lower. If the collateral can be deposited with the bank of the borrower, a higher repo rate is paid.

The more difficult it is to obtain the collateral, the lower is the repo rate. To understand why this is so, remember that the borrower (or, equivalently, the seller of the collateral) has a security that lenders of cash want, for whatever reason. Such collateral is referred to as "hot" or "special" collateral. Collateral that does not have this characteristic is referred to as "general" collateral. The party that needs the hot collateral will be willing to lend funds at a lower repo rate in order to obtain the collateral.

While these factors determine the repo rate on a particular transaction, the federal funds rate determines the general level of repo rates. The repo rate generally will be a rate lower than the federal funds rate because a repo involves collateralized borrowing, whereas a federal funds transaction is unsecured borrowing.

In certain circumstances, a borrower of funds via a repo transaction can generate an arbitrage opportunity. This occurs when it is possible to borrow funds at a lower rate than the rate that can be earned by reinvesting those funds. Such opportunities arise when a portfolio includes securities that are hot or special and the manager can reinvest at a rate higher than the repo rate. For example, suppose that a manager has hot collateral in a portfolio, bond X, that lenders of funds are willing to take as collateral for two weeks charging a repo rate of 3%. Suppose further that the manager can invest the funds in a two-week Treasury bill (the maturity date being the same as the term of the repo) and earn 4%. Assuming that the repo is properly structured so that there is no credit risk, then the manager has locked in a spread of 1% for two weeks. This is a pure arbitrage. The manager faces no risk. Of course, the manager is exposed to the risk that bond X may decline in value, but this risk would exist as long as the manager intended to hold that security in the portfolio anyway.

DOLLAR ROLLS

In the mortgage-backed securities (MBS) market, a special type of collateralized loan has developed because of the characteristics of these securities and the need of dealers to borrow these securities to cover short positions. This arrangement is called a *dollar roll,* so-called because the dealer is said to "roll in" securities borrowed and "roll out" securities when returning the securities to the investor.

As with a repo agreement, it is a collateralized loan that calls for the sale and repurchase of a security. Unlike a repo agreement, the dealer who borrows the securities need not return the identical securities. Specifically, the dealer need only return "substantially identical securities." This means that the security returned by the dealer that borrows the security must match the coupon rate and security type (i.e., issuer and mortgage collateral). This provides flexibility to the dealer. In exchange for this flexibility, the dealer provides 100% financing. That is, there is no overcollateralization or overmargin required. Moreover, the financing cost may be cheaper than in a repo because of this flexibility. Finally, unlike in a repo, the dealer keeps the coupon and any principal paid during the period of the loan.

Determination of the Financing Cost

Determination of the financing cost is not as simple as in a repo. The key elements in determining the financing cost, assuming that the dealer is borrowing securities/lending cash, are

1. The sale price and the repurchase price
2. The amount of the coupon payment
3. The amount of the principal payments due to scheduled principal payments
4. The projected prepayments of the security sold (i.e., rolled in to the dealer)
5. The attributes of the substantially identical security that is returned (i.e., rolled out by the dealer)
6. The amount of under- or overdelivery permitted

Let's look at these elements. In a repo agreement, the repurchase price is greater than the sale price; the difference represents interest and is called the *drop*. In the case of a dollar roll, the repurchase price need not be greater than the sale price. In fact, in a positively sloped yield-curve environment (i.e., long-term rates exceed short-term rates), the repurchase price will be less than the purchase price. The reason for this is the second element, the coupon payment. The dealer keeps the coupon payment.

The third and fourth elements involve principal repayments—scheduled principal and prepayments. As with the coupon payments, the dealer retains the principal payments during the period of the agreement. A gain will be realized by the dealer on any principal repayments if the security is purchased by the dealer at a discount and a loss if purchased at a premium. Because of prepayments, the principal that will be paid is unknown and, as will be seen, represents a risk in determination of the financing cost.

The fifth element is another risk because the effective financing cost will depend on the attributes of the substantially identical security that the dealer will roll out (i.e., the security it will return to the lender of the securities) at the end of the agreement. Finally, delivery tolerances allowing for a small amount of under- or overdelivery are permitted. In a dollar roll, the investor and the dealer have the option to under- or overdeliver: the investor when delivering the securities at the outset of the transaction and the dealer when returning the securities at the repurchase date. The variance is the amount by which the delivery may deviate from the original trade amount. At one time, the variance permitted could have a significant impact on the effective financing cost. Today, the impact is minimal because for TBA trades of Ginnie Mae, Fannie Mae, and Freddie Mac pass-throughs, the variance is only ±0.01% of the dollar amount of the original transaction agreed on by the parties. No allowance for variance is permitted for specified pool trades.

To illustrate how the financing cost for a dollar roll is calculated, suppose that an investor enters into an agreement with a dealer in which it agrees to sell \$10 million par value (i.e., unpaid aggregate balance) of Ginnie Mae 8s at $101^7/_{32}$ and repurchase substantially identical securities a month later at 101 (the repurchase price). The drop is therefore $^7/_{32}$. While under- or overdelivery is permitted, we will assume that \$10 million par value will be delivered to the dealer by the investor and that the same amount of par value will be returned to the investor by the dealer. Since the sale price is $101^7/_{32}$, the investor will receive in cash \$10,121,875 (101.21875 × \$10 million). At the repurchase date, the investor can repurchase substantially identical securities for 101, or \$10,100,000. Therefore, the investor can sell the securities for \$10,121,875 and buy them back for \$10,100,000. The difference, which is the drop, is \$21,875.

To offset this, the investor forfeits the coupon interest during the period of the agreement to the dealer. Since the coupon rate is 8%, the coupon interest forfeited is \$66,666 (8% × \$10 million/12). The dealer is also entitled to any principal repayments, both regularly scheduled and prepayments. Since the dealer purchases the securities from the investor at $101 7/32, any principal repayments will result in a loss of $1 7/32 per $100 of par value of principal repaid. From the investor's perspective, this is a benefit and effectively reduces the financing cost. While the regularly scheduled amount can be determined, prepayments must be projected based on some Public Securities Association (PSA) speed. In our illustration, for simplicity, let's assume that the regularly scheduled principal payment for the month is $6,500 and that the prepayment is projected to be $20,000 based on some PSA speed. Since $1 7/32 is lost per $100 par value repaid, the dealer loses $79 due to the regularly scheduled principal payment (1 7/32 × $6,500/100) and $244 from prepayments (1 7/32 × $20,000/100).

The monthly financing cost is then

Lost coupon interest	$66,666
Offsets	22,198
Drop (gain from repurchase)	21,875
Principal repayment premium gained	323
Due to regularly scheduled principal	79
Due to prepayments	244
Total financing cost	$44,468
Monthly financing cost	0.00439
Annual financing cost (monthly rate × 12)	5.27%

The financing cost as calculated, 5.27%, must be compared with alternative financing opportunities. For example, funds can be borrowed via a repo agreement using the same Ginnie Mae collateral. In comparing financing costs, it is important that the dollar amount of the cost be compared with the amount borrowed. For example, in our illustration, we annualized the cost by multiplying the monthly rate by 12. The convention in other financing markets may be different for annualizing.

Risks in a Dollar Roll from the Investor's Perspective

Because of the unusual nature of the dollar roll transaction as a collateralized borrowing vehicle, it is only possible to estimate the financing cost. From our illustration, it can be seen that when the transaction prices are above par value, then the speed of prepayments affects the financing cost. The maximum financing cost can be determined by assuming no prepayments. In this case, the total financing cost would be $244 greater, or $44,712. This increases the monthly financing cost from 5.27% to 5.29%, or 2 basis points. In practice, an investor can perform sensitivity analysis to determine the effect of prepayments on the financing cost.

In addition to the uncertainty about prepayments, the dealer can select the securities to deliver as long as they are substantially identical. However, even among substantially identical securities, there are some pools that perform worse than others. The risk is that the dealer will deliver poorly performing pools.

MARGIN BUYING

Investors can borrow cash to buy securities and use the securities themselves as collateral in a standard margin agreement with a brokerage firm. The funds borrowed to buy the additional securities will be provided by the broker, and the broker gets the money from a bank. The interest rate that banks charge brokers for these transactions is known as the *call money rate* (also called the *broker loan rate*). The broker charges the investor the call money rate plus a service charge.

The broker is not free to lend as much as it wishes to the investor to buy securities. The Securities and Exchange Act of 1934 prohibits brokers from lending more than a specified percentage of the market value of the securities. The initial margin requirement is the proportion of the total market value of the securities that the investor must pay for in cash. The 1934 act gives the Board of Governors of the Federal Reserve the responsibility to *set initial margin requirements,* which it does under Regulations T and U. The initial margin requirement varies for stocks and nongovernment/nonagency bonds and is currently 50%, although it has been below 40%. There are no restrictions on government and government agency securities.

The Fed also establishes a *maintenance margin requirement*. This is the minimum amount of equity needed in the investor's margin account as compared with the total market value. If the investor's margin account falls below the minimum maintenance margin, the investor is required to put up additional cash. The investor receives a margin call from the broker specifying the additional cash to be put into the investor's margin account. If the investor fails to put up the additional cash, the securities are sold.

SECURITIES LENDING

A security lending transaction involves two parties. The first is the owner of a security who agrees to lend that security to another party. This party is called the *security lender* or the *beneficial owner*. The second party is the entity that agrees to borrow the security, called the *security borrower*. A *security lending transaction* is one in which the security lender loans the requested security to the security borrower at the outset, and the security borrower agrees to return the identical security to the security lender at some time in the future. The loan may be terminated by the security lender on notice to the security borrower, typically of not more than five business days.

To protect against credit risk, the security lender will require that the security borrower provide collateral. Collateral can take the form of (1) cash, (2) a letter of credit, or (3) a security whose value is at least equal in value to the securities loaned. In the United States, the most common form of collateral is cash. Outside the United States, all types of securities have been used as collateral, including common stock and convertible securities. Typically, if the collateral is a security, it is marked-to-market on a daily basis.

When cash is the collateral, the proceeds are reinvested by the security lender. The security lender faces the risks associated with reinvesting the cash. The income generated from reinvesting the cash is given to the security borrower less an amount retained by the security lender for loaning the security because the fee earned by the security lender is then the difference between the income earned from reinvesting the cash and the amount the security lender agrees to pay the security borrower. The security lender's fee is called an *embedded fee* when there is cash collateral. The agreed-on amount that the security lender pays to the security borrower is called a *rebate*. The security lender only earns a fee if the amount earned on reinvesting the cash collateral exceeds the rebate. In fact, if the amount earned is less than the rebate, the security lender incurs this cost.

When the collateral is a letter of credit or a security, the security borrower compensates the security lender by a predetermined fee. This fee is called a *borrow fee,* and it is based on the value of the security borrowed. Notice that while the security lender knows what the fee will be in the case of noncash collateral, this is not the case when there is cash collateral. The fee is a function of the performance of the portfolio or security in which the cash collateral is reinvested.

During the period in which the security is loaned to the borrower, there may be an interest payment (dividend payment in the case of stock). The security lender is entitled to a payment from the security borrower equal in amount to any such payment. The payment made by the security borrower to the security lender for this purpose is called a *substitute payment* or *in-lieu-of payment*.

A party with a portfolio of securities to lend can either (1) lend directly to counterparties that need securities, (2) use the services of an intermediary, or (3) employ a combination of the first two. If a party decides to lend directly, it must have the in-house capability of assessing counterparty risk. When an intermediary is engaged, the intermediary receives a fee for its services. The intermediary could be an agent (i.e., acts on behalf of a security lender but does not take a principal risk position) or a principal (i.e., takes a principal risk position). Possible agents include the current domestic/global custodian of the securities or a third-party specialist in securities lending.

When cash collateral must be reinvested, a securities lender must decide on whether it will reinvest the cash or use the services of an external money manager. As noted earlier, securities lenders may realize a return on the cash collateral that is less than the rebate.

Comparison to Repurchase Agreements

It is worthwhile to compare a security lending transaction in which the collateral is cash to a repurchase agreement because both transactions represent a secured borrowing. We will do this with an illustration. The parties are as follows:

- Manager X, who is the beneficial owner of security A
- Manager Y, who needs security A to cover a short position

Also suppose that security A is a debt instrument that pays coupon interest.

The following agreement is entered into by manager X and manager Y:

1. Manager X agrees to transfer security A to manager Y.
2. Manager Y agrees to give cash to manager X.
3. At some future date, manager Y agrees to return security A to manager X.
4. Manager X agrees to return the cash to manager Y when manager Y returns security A to manager X.

The economics of this transaction are simple: it is a secured loan of cash with the lender of cash being manager Y and the borrower of cash being manager X. The collateral for this loan is security A. This transaction can be structured as a security lending or a repurchase agreement. No matter what it is called, the economics are unchanged.

If this transaction is structured as a security lending agreement, then

1. Manager X is the security lender (beneficial owner).
2. Manager Y is the security borrower.
3. Manager X invests the cash received from manager Y and at the end of the transaction rebates part of the income earned to manager Y.
4. The amount earned by manager X from security lending is uncertain and, in fact, can be negative.
5. Manager Y pays manager X any interest income that manager X would have received from the issuer of the security.
6. At some future time, manager X requests the return of security A and returns the cash collateral to manager Y.

If this transaction is structured as a repurchase agreement, then

1. Manager X is the seller of collateral or, equivalently, the borrower of funds using security A as collateral.
2. Manager Y is the buyer of collateral or, equivalently, the lender of funds.

3. Manager X invests the cash received from manager Y and at the repurchase date pays interest to manager Y based on the repo rate.
4. The amount earned by manager X from the repurchase agreement is uncertain and, in fact, can be negative.
5. Manager Y pays manager X any interest income that manager X would have received from the issuer of the security.
6. At the repurchase date, manager X buys back security A from manager Y at the repurchase price (which includes interest).

Whether the transaction is a repo or reverse repo depends on the perspective of the parties, as discussed earlier in this chapter. Notice that unlike a repurchase agreement, which has a repurchase date—which can be rolled over—there is no repurchase price in a security lending transaction.

CHAPTER

FORTY-SIX

GLOBAL CREDIT BOND PORTFOLIO MANAGEMENT

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Managing Director
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Corporate bonds are the second oldest and, for most asset managers, the most demanding and fascinating subset of the global debt capital markets. The label, "corporate," understates the scope of this burgeoning asset class. As commonly traded and administered within the context of an overall debt portfolio, the "corporate asset class" actually encompasses much more than pure corporate entities. Instead of the title, "corporate asset class," this segment of the global bond market really should be classified as the "credit asset class," including any nonagency mortgage-backed securities (MBS), commercial mortgage-backed securities (CMBS), and asset-backed securities (ABS). Sovereigns and government-controlled entities with foreign currency debt issues thought to have more credit risk than the national government also should be included. In keeping with conventional practice in the fixed income market, however, the application of the term *credit asset class* in this chapter will pertain only to corporate bonds, sovereigns, and government-controlled entities.

From six continents, thousands of organizations (corporations, government agencies, projects, and structured pools of debt securities) with different credit "stories" have sold debt to sustain their operations and to finance their expansion. These borrowers use dozens of different types of debt instruments (first mortgage bonds, debentures, equipment trust certificates, subordinated debentures, medium-term notes, floating-rate notes, private placements, preferred stock) and in multiple currencies (dollars, yen, euros, Swiss francs, pounds) from maturities ranging from one year to even a thousand years. Sometimes these debt structures carry embedded options, which may allow for full or partial redemption prior to maturity at the option of either the borrower or the investor. Sometimes the coupon payment floats with short-term interest rates or resets to a higher rate after a fixed interval or a credit-rating change.

This chapter is adapted from "Relative-Value Methodologies for Global Credit Bond Portfolio Management," Chapter 5 in Frank J. Fabozzi (ed.), *Fixed Income Readings for the Chartered Financial Analyst Program* (New Hope, PA: Frank J. Fabozzi Associates, 2004).

Investors buy credit assets because of the presumption of higher long-term returns despite the assumption of credit risk. Except near and during recessions, credit products usually outperform U.S. Treasury securities and other higher-quality "spread sectors" like U.S. agency securities, mortgage-backed securities, and asset-backed securities. In the 30-year period since the beginning of the Lehman indexes (1973 through 2003), investment-grade credit outperformed U.S. Treasuries by 47 basis points (bp) per year on average (9.36% versus 8.89%).[1] As usual, an average masks the true daily, weekly, monthly, and annual volatility of credit assets relative performance. Looking at the rolling five-year excess returns of U.S. investment-grade credit from 1926 through early 2003 in Exhibit 46–1, there have been extended periods of generous and disappointing returns for credit assets. Perhaps more meaningful, an examination of volatility-adjusted (Sharpe ratio) excess returns over Treasuries over a rolling five-year period shown in Exhibit 46–2 further underscores the oscillations in relative credit performance.

Global credit portfolio management presents a complex challenge. Each day hundreds of credit portfolio managers face thousands of choices in the primary (new issue) and secondary markets. In addition to tracking primary and secondary flows, investors have to keep tabs on ever-varying issuer fundamentals, creditworthiness, acquisitions, earnings, ratings, etc. The task of global credit portfolio management is to process all this rapidly changing information about the credit markets (issuers, issues, dealers, and competing managers) and to construct the portfolio with the best return for a given risk tolerance. This discipline combines the qualitative tools of equity analysis with the quantitative precision of fixed income analysis.

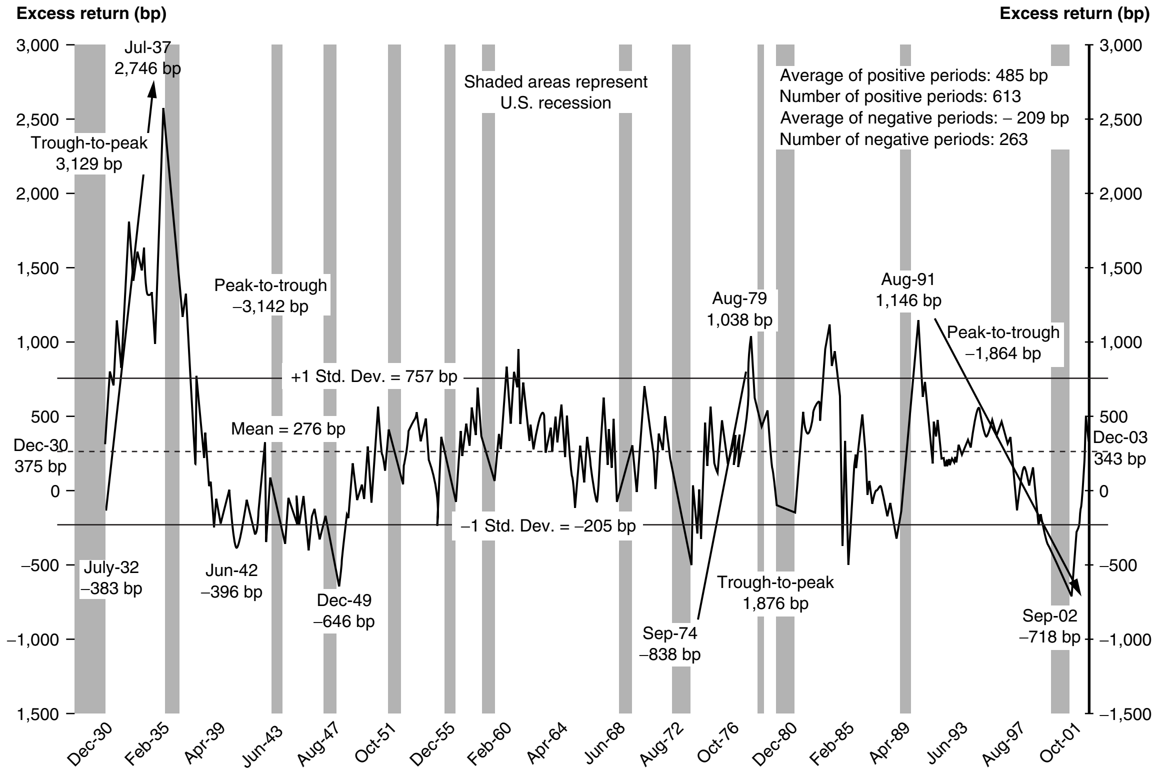
Exhibit 46–3 illustrates the magnitude of this information-processing challenge. From a set of 5,000 different issuers, investors can assemble 4 × 10 (55) different combinations of 20-bond portfolios. The number of potential portfolio combinations of 20 bonds expands to the infinity neighborhood with the inclusion of additional variables such as rating (20 choices), issues (100,000), and currencies (at least 20). Incredibly, the number of potential combinations of this 20-bond credit portfolio exceeds the neutrons in the known universe. In turn, this begs the question of whether credit portfolio "optimization" is truly achievable given the current state of technology. Although "perfect optimization" may prove elusive, the ''optimization goal'' remains a worthy pursuit for asset managers.

Despite this apparent limitation on the perfection of corporate portfolio optimization, broad demand exists for corporate debt. Investors in corporate debt consist of individuals in the pursuit of high yields, central banks aiming to extract a higher yield and return on their considerable holdings of fixed income assets, commercial banks arbitraging the difference between the higher yields on floating-rate notes and their lower cost of funding, mutual funds attempting to maximize both yield and total return, insurers and state pension funds seeking to fund their projected long-term liabilities, "pure" total-return maximizers competing against each other on a monthly, quarterly, and annual basis to satisfy their clients (public

1. Based on absolute returns of key Lehman indexes from 1973.

EXHIBIT 46–1

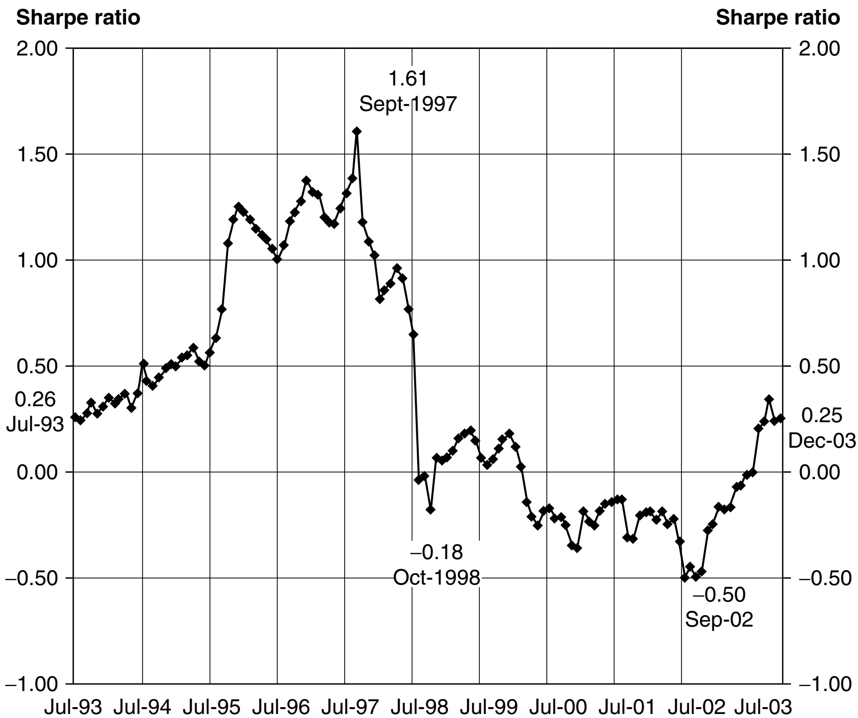
Rolling Five-Year U.S. Investment-Grade Credit Index Excess Returns* (bp), January 1926 through December 31, 2003



*Excess returns represent the difference, positive or negative, between the total return of all credit securities and Treasury securities along a set of key rate duration points across the term structure. This single statistic, excess return, therefore normalizes for the duration differential among debt asset classes, in this case between longer-duration credit and shorter-duration Treasuries.
Source: Data series from Ibbotson Associates prior to August 1988, Lehman Brothers data thereafter.

EXHIBIT 46–2

U.S. Credit Five-Year Rolling Sharpe Ratio, July 1993 through December 31, 2003



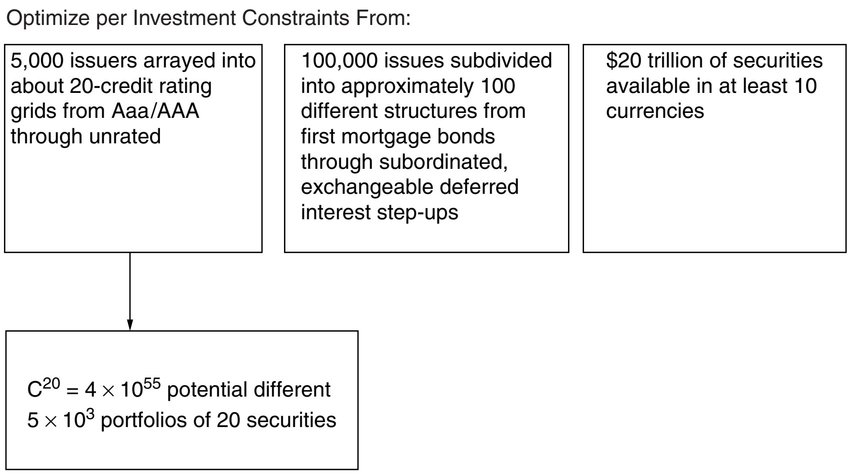
Source: Lehman Brothers U.S. Investment-Grade Credit Index.

or private pension fund plan sponsors) or risk their loss, and hedge funds staking out leveraged long or short positions in credits with short-term potential for major spread movements. Portfolio investment choices are driven also by the existing security population of the corporate market (sector, issuer, structure, and currency), by the psychology of the portfolio managers (overall risk tolerance, shortfall risk aversion, and internal politics of the investment-management institution), and the state of market liquidity.

Borrowers and investors intersect mainly through dealers in both the classic telephone form and increasingly through "e-market techniques" such as Web sites and e-mails. Each day a few dozen credit bond dealers convey information about secondary positions and new issue offerings from any of the thousands of corporate borrowers to the hundreds of corporate bond portfolio managers. Through their investment banking and syndicate operations, dealers also advise issuers on when and how to sell new debt. Through their fixed income research, sales, and trading arms, dealers relay investment recommendations to portfolio managers.

EXHIBIT 46–3

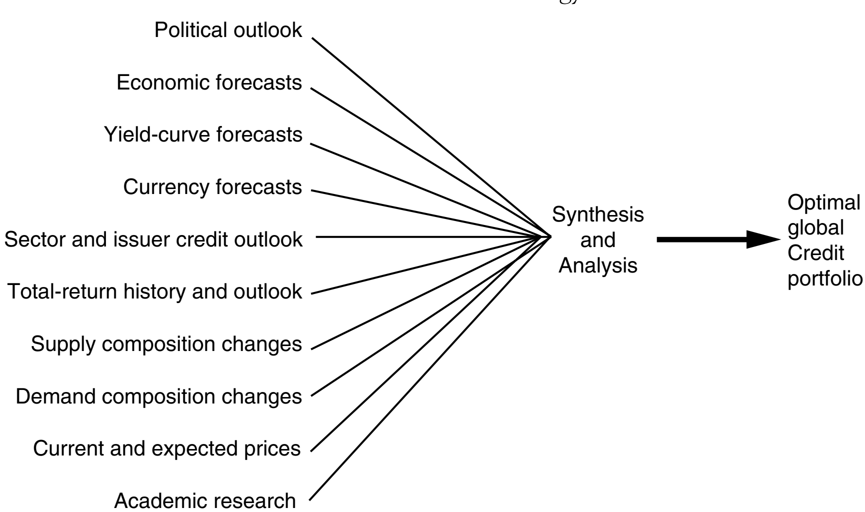
The Global Portfolio Management Challenge: Enormous Information Processing Problem



As shown in Exhibit 46–4, the task of global corporate bond portfolio management is to process all this rapidly changing information about the credit bond market (issuers, issues, dealers, and competing managers) and to construct the portfolio with the best return for a given risk tolerance.

EXHIBIT 46–4

Global Credit Sector Asset Allocation Methodology



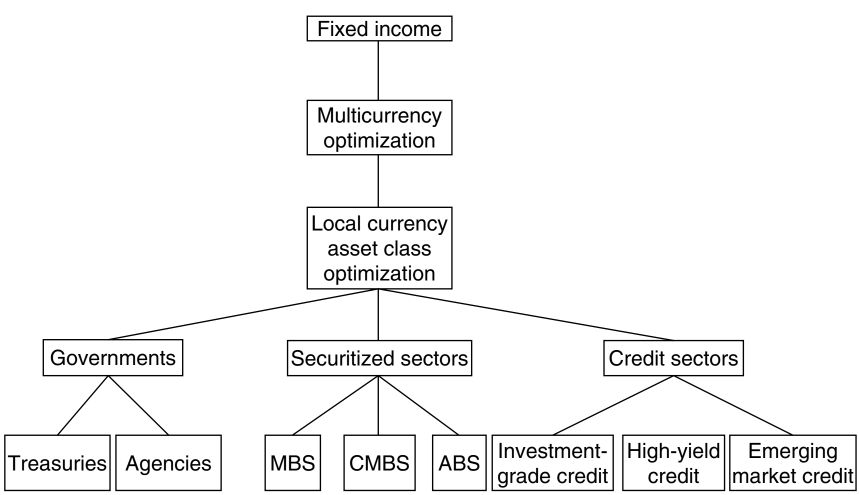
CREDIT RELATIVE-VALUE ANALYSIS

Credit portfolio management represents a major subset of the multiasset global portfolio management process illustrated in Exhibit 46–5. After setting the currency allocation (in this case, dollars were selected for illustration convenience) and distribution among fixed income asset classes, bond managers are still left with a lengthy list of questions to construct an optimal credit portfolio. Some examples are

- Should U.S. investors add U.S. dollar–denominated bonds of non-U.S. issuers?
- Should central banks add high-quality euro-denominated corporate bonds to their reserve holdings?
- Should LIBOR-funded London-based portfolio managers buy fixed-rate U.S. industrial paper and swap into floating-rate notes?
- Should Japanese mutual funds own euro-denominated telecommunications debt swapped back into dollars or yen using currency swaps?
- Should U.S. insurers buy perpetual floaters (i.e., floaters without a maturity date) issued by British banks and swap back into fixed-rate coupons in dollars using a currency/interest rate swap?
- When should investors reduce their allocation to the credit sector and increase allocation to governments, pursue a "strategic upgrade trade" (sell Baa/BBBs and buy higher-rated Aa/AA credit debt), rotate from industrials into utilities, switch from consumer cyclicals to noncyclicals,

EXHIBIT 46–5

Fixed Income Portfolio Management Process



overweight airlines and underweight telephones, or deploy a credit derivative (e.g., short the high-yield index or reduce a large exposure to a single issuer by selling an issuer-specific credit default swap) to hedge their portfolios?

To respond to such questions, managers need to begin with an analytical framework (relative-value analysis) and to develop a strategic outlook for the global credit markets.

Relative Value

Economists have long debated the concept and measurement of "value." But fixed income practitioners, perhaps because of the daily pragmatism enforced by the markets, have developed a consensus about the definition of value. In the bond market, *relative value* refers to the ranking of fixed income investments by sectors, structures, issuers, and issues in terms of their expected performance during some future period of time.

For a day trader, relative value may carry a maximum horizon of a few minutes. For a dealer, relative value may extend from a few days to a few months. For a total-return investor, the relative-value horizon typically runs from one to three months. For a large insurer, relative value usually spans a multiyear horizon. Accordingly, *relative-value analysis* refers to the methodologies used to generate such rankings of expected returns.

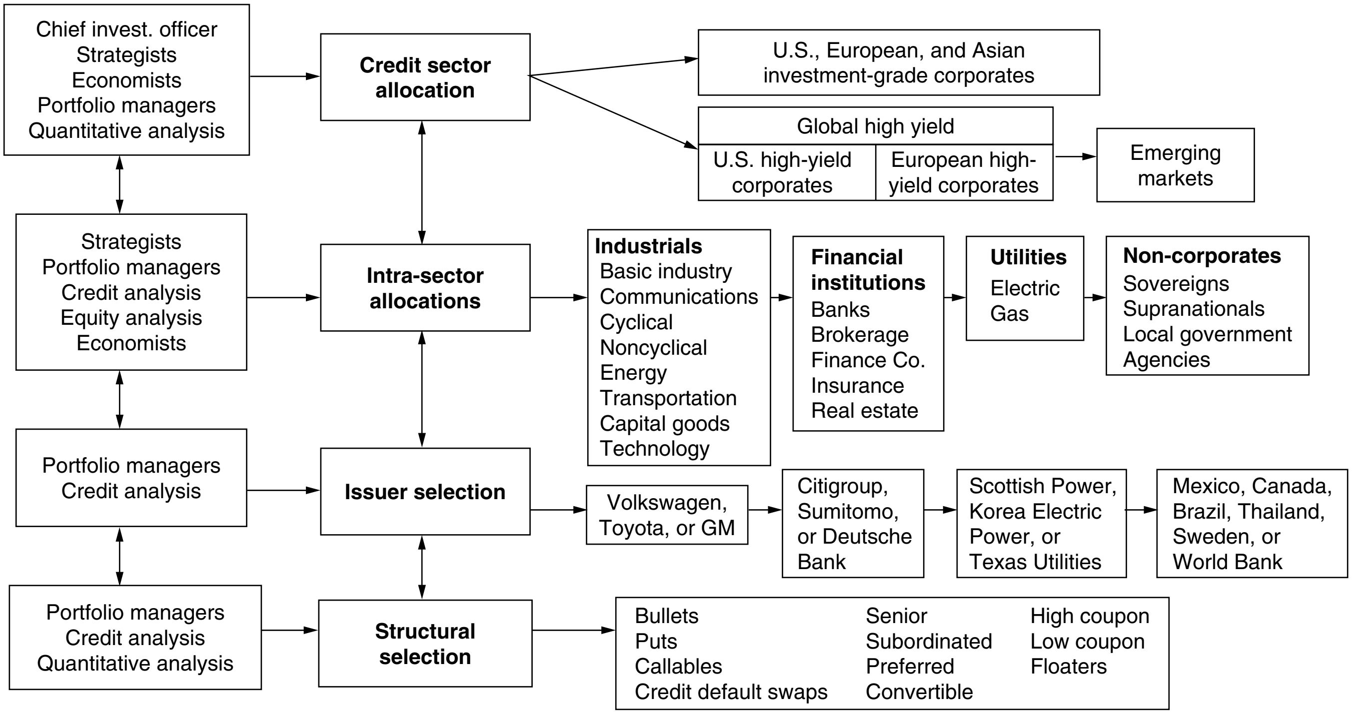
Classic Relative-Value Analysis

There are two basic approaches to global credit bond portfolio management—*top-down approach* and *bottom-up approach*. The top-down approach focuses on high-level allocations among broadly defined credit asset classes. The goal of top-down research is to form views on large-scale economic and industry developments. These views then drive asset allocation decisions (overweight certain sectors, underweight others). The bottom-up approach focuses on individual issuers and issues that will outperform their peer groups. Managers follow this approach hoping to outperform their benchmark owing to superior security selection while maintaining neutral weightings to the various sectors in the benchmark.

Classic relative-value analysis is a dialectic process combining the best of top-down and bottom-up approaches as shown in Exhibit 46–6. This process blends the macro input of chief investment officers, strategists, economists, and portfolio managers with the micro input of credit analysts, quantitative analysts, and portfolio managers. The goal of this methodology is to pick the sectors with the most potential upside, populate these favored sectors with the best representative issuers, and select the structures of the designated issuers at the yield-curve points that match the investor's for the benchmark yield curve.

EXHIBIT 46–6

Credit-Sector Portfolio Management Process: Classic, Dialectic Relative-Value Analysis



For many credit investors, using classic relative-value analysis provides a measure of portfolio success. Although sector, issuer, and structural analyses remain the core of superior relative-value analysis, the increased availability of information and technology has transformed the analytical process into a complex discipline. Credit portfolio managers have far more data than ever on the total returns of sectors, issuers, and structures; quantity and composition of new-issue flows; investor product demand; aggregate credit-quality movements; multiple sources of fundamental and quantitative credit analyses on individual issuers; and yield-spread data to assist them in their relative-value analysis.

Relative-Value Methodologies

The main methodologies for credit relative-value maximization are

- Total-return analysis
- Primary market analysis
- Liquidity and trading analysis
- Secondary trading rationales and constraints analysis
- Spread analysis
- Structure analysis
- Credit-curve analysis
- Credit analysis
- Asset allocation/sector analysis

In the sections that follow, we discuss each of these methodologies.

TOTAL-RETURN ANALYSIS

The goal of global credit portfolio management for most investors is to optimize the risk-adjusted total return of their credit portfolio. The best place to start is naturally total-return analysis. Accordingly, credit relative-value analysis begins with a detailed dissection of past returns and a projection of expected returns. For the entire asset class and major contributing subsectors (such as banks, utilities, pipelines, Baa/BBBs, etc.), how have returns been formed? How much is attributed to credit-spread movements, sharp changes in the fundamental fortunes of key issuers, and yield-curve dynamics? If there are macro determinants of credit returns (the total return of the credit asset class), then credit markets may display regular patterns. For instance, the macroeconomic cycle is the major determinant of overall credit spreads. During recessions, the escalation of default risk widens spreads [which are risk premiums over underlying, presumably default-free government securities (or swaps)] and reduces credit returns relative to Treasuries. Conversely, economic prosperity reduces bankruptcies and enhances overall credit fundamentals of most issuers. Economic prosperity usually leads to tighter credit spreads and boosts credit returns relative to Treasuries. For brief intervals, noncyclical technical factors can offset fundamentals. For example, the inversion of the U.S. Treasury yield curve in 2000 actually led to wider credit spreads and credit underperformance despite solid global economic growth and corporate profitability.

Thanks to the development of total-return indexes for credit debt (databases of prices, spreads, issuer, and structure composition), analyses of monthly, annual, and multiyear total returns have uncovered numerous patterns (i.e., large issue versus small issue performance variation, seasonality, election-cycle effects, and government benchmark auction effects) in the global credit market. Admittedly, these patterns do not always recur, but an awareness and understanding of these total-return patterns are essential to optimizing portfolio performance.

PRIMARY MARKET ANALYSIS

The analysis of primary markets centers on new-issue supply and demand. Supply is often a misunderstood factor in tactical relative-value analysis. Prospective new supply induces many traders, analysts, and investors to advocate a defensive stance toward the overall corporate market, as well as toward individual sectors and issuers. Yet the premise, "supply will hurt spreads," which may apply to an individual issuer, does not generally hold up for the entire credit market. Credit spreads are determined by many factors; supply, although important, represents one of many determinants. During most years, increases in issuance (most notably during the first quarter of each year) are associated with market-spread contraction and strong relative returns for credit debt. In contrast, sharp supply declines are accompanied frequently by spread expansion and a major fall in both relative and absolute returns for credit securities. For example, this counterintuitive effect was most noticeable during the August–October 1998 interval when new issuance nearly disappeared in the face of the substantial increase in credit spreads. (This period is referred to as the "great spread-sector crash.")

In the investment-grade credit market, heavy supply often compresses spreads and boosts relative returns for credit assets as new primary valuations validate and enhance secondary valuations. When primary origination declines sharply, secondary traders lose reinforcement from the primary market and tend to reduce their bid spreads. Contrary to the normal supply–price relationship, relative credit returns often perform best during periods of heavy supply. For example, 2001 will be recalled for both the then all-time record for new credit origination and the best relative performance for U.S. credit securities in nearly two decades.

The Effect of Market-Structure Dynamics

Given their immediate focus on the deals of the day and week, portfolio managers often overlook short- and long-term market-structure dynamics in making portfolio decisions. Because the pace of change in market structure is often gradual, market dynamics have less effect on short-term tactical investment decision making than on long-term strategy.

The composition of the global credit bond market has shifted markedly since the early 1980s. Medium-term notes (MTNs) dominate issuance in the front end of the credit yield curve. Structured notes and swap products have heralded the introduction of derivative instruments into the mainstream of the credit market. The high-yield corporate sector has become an accepted asset class. Global origination has become more popular for U.S. government agencies, supranationals (e.g., The World Bank), sovereigns, and large corporate borrowers.

Although the ascent of derivatives and high-yield instruments stands out during the 1990s, the true globalization of the credit market was the most important development. The rapid development of the Eurobond market since 1975, the introduction of many non-U.S. issuers into the dollar markets during the 1990s, and the birth of the euro on January 1, 1999 have led to the proliferation of truly transnational credit portfolios.

These long-term structural changes in the composition of the global credit asset class arise owing to the desire of issuers to minimize funding costs under different yield curves and yield spreads, as well as the needs of both active and asset/liability bond managers to satisfy their risk and return objectives. Portfolio managers will adapt their portfolios either in anticipation of or in reaction to these structural changes across the global credit markets.

The Effect of Product Structure

Partially offsetting this proliferation of issuers since the mid-1990s, the global credit market has become structurally more homogeneous. Specifically, bullet and intermediate-maturity structures have come to dominate the credit market. A *bullet maturity* means that the issue is not callable, putable, or sinkable prior to its scheduled final maturity. The trend toward bullet securities does not pertain to the high-yield market, where callables remain the structure of choice. With the hope of credit-quality improvement, many high-yield issuers expect to refinance prior to maturity at lower rates.

There are three strategic portfolio implications for this structural evolution. First, the dominance of bullet structures translates into scarcity value for structures with embedded call and put features. That is, credit securities with embedded options have become rare and therefore demand a premium price. Typically, this premium (price) is not captured by option-valuation models. Yet this "scarcity value" should be considered by managers in relative-value analysis of credit bonds.

Second, bonds with maturities beyond 20 years are a small share of outstanding credit debt. This shift reduced the effective duration of the credit asset class and cut aggregate sensitivity to interest-rate risk. For asset/liability managers with long time horizons, this shift of the maturity distribution suggests a rise in the value of long-credit debt and helps to explain the warm reception afforded, initially at least, to most new offerings of issues with 100-year maturities in the early and mid-1990s.

Third, the use of credit derivatives has skyrocketed since the early 1990s. The rapid maturation of the credit derivative market will lead investors and issuers to develop new strategies to match desired exposures to credit sectors, issuers, and structures.

LIQUIDITY AND TRADING ANALYSIS

Short- and long-term liquidity needs influence portfolio management decisions. Citing lower expected liquidity, some investors are reluctant to purchase certain types of issues such as small-sized issues (less than $1.0 billion), private placements, MTNs, and nonlocal corporate issuers. Other investors gladly exchange a potential liquidity disadvantage for incremental yield. For investment-grade issuers, these liquidity concerns often are exaggerated.

The liquidity of credit debt changes over time. Specifically, liquidity varies with the economic cycle, credit cycle, shape of the yield curve, supply, and the season. As in all markets, unknown shocks, such as a surprise wave of defaults, can reduce credit debt liquidity as investors become unwilling to purchase new issues at any spread and dealers become reluctant to position secondary issues except at very wide spreads. In reality, these transitory bouts of illiquidity mask an underlying trend toward heightened liquidity across the global credit asset class. With a gentle push from regulators, the global credit asset class is well along in converting from its historic "over-the-counter" domain to a fully transparent, equity/U.S. Treasury-style marketplace. In the late 1990s, new technology led to creating ECNs (electronic communication networks), essentially electronic trading exchanges. In turn, credit bid-ask spreads generally have trended lower for very large, well-known corporate issues. This powerful twin combination of technological innovation and competition promises the rapid development of an even more liquid and efficient global credit market during the early twenty-first century.

SECONDARY TRADE RATIONALES

Capital market expectations constantly change. Recessions may arrive sooner rather than later. The yield curve may steepen rather than flatten. The auto and paper cycles may be moving down from their peaks. Higher oil and natural gas prices may benefit the credit quality of the energy sector. An industrial may have announced a large debt-financed acquisition, earning an immediate ratings rebuke from the rating agencies. A major bank may plan to repurchase 15% of its outstanding common stock (great for shareholders but leading to higher financial leverage for debtholders). In response to such daily information flows, portfolio managers amend their holdings. To understand trading flows and the real dynamics of the credit market, investors should consider the most common rationales of whether to trade and not to trade.

Popular Reasons for Trading

There are dozens of rationales to execute secondary trades when pursuing portfolio optimization. Several of the most popular are discussed below.

Yield-Spread Pickup Trades

Yield-spread pickup trades represent the most common secondary transactions across all sectors of the global credit market. Historically, at least half of all secondary swaps reflect investor intentions to add additional yield within the duration and credit-quality constraints of a portfolio. If five-year Baa1/BBB General Motors paper trades at 150 basis points, 10 basis points more than five-year Baa1/BBB– Ford Motor, some investors will determine the rating differential irrelevant and purchase the General Motors bond and sell the Ford Motor (an issue swap) for a spread gain of 10 basis points per annum.

This "yield-first psychology" reflects the institutional yield need of long-term asset/liability managers. Despite the passage of more than three decades, this investor bias toward yield maximization also may be a methodologic relic left over from the era prior to the introduction and market acceptance of total-return indexes in the early 1970s.

Credit-Upside Trades

Credit-upside trades take place when the debt asset manager expects an upgrade in an issuer's credit quality that is not already reflected in the current market yield spread. In the illustration of the General Motors and Ford Motor trade described above, some investors may swap based on their view of potential credit-quality improvement for General Motors. Obviously, such trades rely on the credit analysis skills of the investment management team. Moreover, the manager must be able to identify a potential upgrade before the market; otherwise, the spread for the upgrade candidate will already exhibit the benefits of a credit upgrade.

Credit-upside trades are particularly popular in the crossover sector—securities with ratings between Ba2/BB and Baa3/BBB– by two major rating agencies. In this case, the portfolio manager is expressing an expectation that an issue of the highest speculative grade rating (Ba1/BB+) has sufficiently positive credit fundamentals to be upgraded to investment grade (i.e., Baa3/BBB–). If this upgrade occurs, not only would the issue's spread narrow based on the credit improvement (with an accompanying increase in total return, all else equal), but the issue also would benefit from improved liquidity because managers prohibited from buying high-yield bonds could then purchase that issue. Further, the manager would expect an improvement in the portfolio's overall risk profile.

Credit-Defense Trades

Credit-defense trades become more popular as geopolitical and economic uncertainty increase. Secular sector changes often generate uncertainties and induce defensive positioning by investors. In anticipating greater competition, in the mid-1990s some investors reduced their portfolio exposures to sectors such as electric utilities and telecommunications. As some Asian currencies and equities swooned in mid-1997, many portfolio managers cut their allocation to the Asian debt market. Unfortunately, because of yield-maximization needs and a general reluctance to realize losses by some institutions (i.e., insurers), many investors reacted more slowly to credit-defensive positioning. But after a record number of "fallen angels" in 2002, which included such major credit bellwether issuers as WorldCom, investors became more quick to jettison potential problem credits from their portfolios. Ironically, once a credit is downgraded by the rating agencies, internal portfolio guidelines often dictate security liquidation immediately after the loss of single-A or investment-grade status. This is usually the worst possible time to sell a security and maximizes losses incurred by the portfolio.

New-Issue Swaps

New-issue swaps contribute to secondary turnover. Because of perceived superior liquidity, many portfolio managers prefer to rotate their portfolios gradually into more current and usually larger sized on-the-run issues. This disposition, reinforced by the usually superior market behavior of newer issues in the U.S. Treasury market (i.e., the on-the-run issues), has become a self-fulfilling prophecy for many credit issues. In addition, some managers use new-issue swaps to add exposure to a new issuer or a new structure.

Sector-Rotation Trades

Sector-rotation trades, within credit and among fixed income asset classes, have become more popular since the early 1990s. In this strategy, the manager shifts the portfolio from a sector or industry that is expected to underperform to a sector or industry that is believed will outperform on a total-return basis. With the likely development of enhanced liquidity and lower trading transaction costs across the global bond market in the early twenty-first century, sector-rotation trades should become more prevalent in the credit asset class.

Such intraasset class trading already has played a major role in differentiating performance among credit portfolio managers. For example, as soon as the Fed launched its preemptive strike against inflation in February 1994, some investors correctly exchanged fixed-rate corporates for floating-rate corporates. In 1995, the specter of U.S. economic weakness prompted some investors in high-yield corporates to rotate from consumer-cyclical sectors such as autos and retailing into consumer noncyclical sectors such as food, beverage, and health care. Anticipating slower U.S. economic growth in 1998 induced a defensive tilt by some portfolio managers away from other cyclical groups such as paper and energy. The resurrection of Asian and European economic growth in 1999 stimulated increased portfolio interest in cyclicals, financial institutions, and energy debt. Credit portfolio managers could have avoided a great deal of portfolio performance disappointment in 2002 by underweighting utilities and many industrial sectors.

Curve-Adjustment Trades

Yield-curve-adjustment trades, or simply, *curve-adjustment trades,* are taken to reposition a portfolio's duration. For most credit investors, their portfolio duration is typically within a range from 20% below to 20% above the duration of the benchmark index. If credit investors could have predicted U.S., euro, and yen yield-curve movements perfectly in 2002, then they would have increased their credit portfolio duration at the beginning of 2002 in anticipation of a decrease in interest rates. Although most fixed income investors prefer to alter the duration of their aggregate portfolios in the more-liquid Treasury market, strategic portfolio duration tilts also can be implemented in the credit market.

This is also done with respect to anticipated changes in the credit term structure or credit curve. For example, if a portfolio manager believes that credit spreads will tighten (either overall or in a particular sector), with rates in general remaining relatively stable, she might shift the portfolio's exposure to longer-spread-duration issues in that sector.

Structure Trades

Structure trades involve swaps into structures (e.g., callable structures, bullet structures, and putable structures) that are expected to have better performance given expected movements in volatility and the shape of the yield curve. Here are some examples of how different structures performed in certain periods in the 1990s.

- During the second quarter of 1995, the rapid descent of the U.S. yield curve contributed to underperformance of high-coupon callable structures because of their negative convexity property.
- When the yield curve stabilized during the third quarter of 1995, investors were more willing to purchase high-quality callable bonds versus high-quality bullet structures to earn an extra 35 basis point of spread.
- The sharp downward rotation of the U.S. yield curve during the second half of 1997 contributed to poor relative performance by putable structures. The yield investors had sacrificed for protection against higher interest rates instead constrained total return as rates fell.
- The plunge in U.S. interest rates and escalation of yield-curve volatility during the second half of 1998 again restrained the performance of callable structures compared to bullet structures.
- The upward rebound in U.S. interest rates and the fall in interest-rate volatility during 1999 contributed to the relative outperformance of callable structures versus bullet structures.

Cash-Flow Reinvestment

Cash-flow reinvestment forces investors into the secondary market on a regular basis. During 2003, the sum of all coupon, maturity, and partial redemptions (via tenders, sinking funds, and other issuer prepayments) equaled approximately 100% of all new gross issuance across the dollar bond market. Before the allocation of any net new investment in the bond market, investors had sufficient cash-flow reinvestment to absorb nearly all new bond supply. Some portfolio cash inflows occur during interludes in the primary market, or the composition of recent primary supply may not be compatible with portfolio objectives. In these periods, credit portfolio managers must shop the secondary market for investment opportunities to remain fully invested or temporarily replicate the corporate index by using financial futures. Portfolio managers who incorporate analysis of cash-flow reinvestment into their valuation of the credit market can position their portfolios to take advantage of this cash-flow reinvestment effect on spreads.

Trading Constraints

Portfolio managers also should review their main rationales for not trading. Some of the best investment decisions are not to trade. Conversely, some of the worst investment decisions emanate from stale views based on dated and anachronistic constraints (e.g., avoid investing in bonds rated below Aa/AA). The best portfolio managers retain very open minds, constantly self-critiquing both their successful and unsuccessful methodologies.

Portfolio Constraints

Collectively, portfolio constraints are the single biggest contributor to the persistence of market inefficiency across the global credit market. Here are some examples:

- Because many asset managers are limited to holding securities with investment-grade ratings, they are forced to sell immediately the debt of issuers who are downgraded to speculative gradings (Ba1/BB+ and below). In turn, this selling at the time of downgrade provides an opportunity for investors with more flexible constraints to buy such newly downgraded securities at a temporary discount (provided, of course, that the issuer's creditworthiness stabilizes after downgrade).
- Some U.S. state employee pension funds cannot purchase credit securities with ratings below A3/A– owing to administrative and legislative guidelines.
- Some U.S. pension funds also have limitations on their ownership of MTNs and non-U.S. corporate issues.
- Regulators have limited U.S. insurance companies investment in high-yield corporates.
- Many European investors are restricted to issues rated at least single-A and sometimes Aa3/AA– and above, created originally in annual-pay Eurobond form.

- Many investors are confined to their local currency market—yen, sterling, euro, U.S. dollar. Often the same issuer, such as Ford, will trade at different spreads across different geographic markets.
- Globally, many commercial banks must operate exclusively in the floating-rate realm; all fixed-rate securities, unless converted into floating-rate cash flows via an interest-rate swap, are prohibited.

"Story" Disagreement

"Story" disagreement can work to the advantage or disadvantage of a portfolio manager. Traders, salespersons, sell-side analysts and strategists, and buy-side credit researchers have dozens of potential trade rationales that supposedly will benefit portfolio performance. The proponents of a secondary trade may make a persuasive argument, but the portfolio manager may be unwilling to accept the "shortfall risk" if the investment recommendation does not provide its expected return. For example, in early 1998, analysts and investors alike were divided equally on short-term prospects for better valuations of Asian sovereign debt. After a very disappointing 1997 for Asian debt performance, Asia enthusiasts had little chance to persuade pessimists to buy Asian debt at the beginning of 1998. Technically, such lack of consensus in the credit market signals an investment with great outperformance potential. Indeed, most Asian debt issues recorded exceptional outperformance over the full course of 1998 and 1999. After a difficult 2002, the same "rebound effect" was observed in electric utilities during 2003. Of course, "story" disagreement also can work in the other direction. For example, Enron was long viewed as a very solid credit before its sudden bankruptcy in late 2001. An asset manager wedded to this long-term view might have been reluctant to act on the emergence of less favorable information about Enron in the summer of 2001.

Buy-and-Hold

Although many long-term asset/liability managers claim to have become more total-return-focused in the 1990s, accounting constraints (cannot sell positions at a loss compared with book cost or take too extravagant a gain compared with book cost) often limit the ability of these investors to trade. Effectively, these investors (mainly insurers) remain traditional "buy-and-hold" investors. Some active bond managers have converged to quasi-"buy-and-hold" investment programs at the behest of consultants to curb portfolio turnover. In the aftermath of the "Asian Contagion" in 1997–1998, this disposition toward lower trading turnover was reinforced by the temporary reduction in market liquidity provided by more wary bond dealers. As shown in 2000–2002, however, a buy-and-hold strategy can gravely damage the performance of a credit portfolio. At the first signs of credit trouble for an issuer, many credit portfolios would have improved returns by reducing their exposure to a deteriorating credit.

Seasonality

Secondary trading slows at month ends, more so at quarter ends, and the most at the conclusion of calendar years. Dealers often prefer to reduce their balance sheets at fiscal year-end [November 30, December 31, or March 31 (Japan)]. Also, portfolio managers take time to mark their portfolios, prepare reports for their clients, and chart strategy for the next investment period. During these intervals, even the most compelling secondary offerings can languish.

SPREAD ANALYSIS

By custom, some segments of the high-yield and emerging (EMG) debt markets still prefer to measure value by bond price or bond yield rather than spread. But for the rest of the global credit market, nominal spread (the yield difference between corporate and government bonds of similar maturities) has been the basic unit of both price and relative-value analysis for more than two centuries.

Alternative Spread Measures

Many U.S. practitioners prefer to value investment-grade credit securities in terms of option-adjusted spreads (OAS) so that they can be compared more easily to the volatility ("vol") sectors (mortgage-backed securities and U.S. agencies).[2] But given the rapid reduction of credit structures with embedded options since 1990 (see structural discussion above), the use of OAS in primary and secondary pricing has diminished within the investment-grade credit asset class. Moreover, the standard one-factor binomial models[3] do not account for credit-spread volatility. Given the exclusion of default risk in OAS option-valuation models, OAS valuation has seen only limited extension into the higher-risk markets of the quasi-equity, high-yield corporate, and EMG-debt asset classes.

Starting in Europe during the early 1990s and gaining momentum during the late 1990s, interest-rate swap spreads have emerged as the common denominator to measure relative value across fixed- and floating-rate note credit structures. The U.S. investment-grade and high-yield markets eventually may switch to swap spreads to be consistent with Europe and Asia.

Other U.S. credit-spread calculations have been proposed, most notably using the U.S. agency benchmark curve. These proposals emanate from the assumption of a persistent U.S. budgetary surplus and significant liquidation of

2. These sectors are referred to as "vol" sectors because the value of the securities depends on expected interest rate volatility. These "vol" securities have embedded call options and the value of the options, and hence the value of the securities, depends on expected interest rate volatility.

3. The model is referred to as a "one-factor model" because only the short-term rate is the factor used to construct the tree.

outstanding U.S. Treasury securities during the first decade of the twenty-first century. As again demonstrated by 2002, history teaches that these budget assumptions unfortunately may prove to be faulty. Although some practitioners may choose to derive credit-agency spreads for analytical purposes, this practice will be unlikely to become standard market convention.

Credit-default swap spreads have emerged as the latest valuation tool during the great stresses in the credit markets of 2000–2002. Most likely, credit-default swap spreads will be used as a companion valuation reference to nominal spreads, OAS, and swap spreads. The market, therefore, has an ability to price any credit instrument using multiple spread references. These include the spread measures—nominal spread, static or zero-volatility spread, OAS, credit-swap spreads (or simply swap spreads), and credit-default spreads. The spread measures used the Treasury yield curve or Treasury spot-rate curve as the benchmark. Given the potential that swap spreads will become the new benchmark, these same measures can be performed relative to swaps rather than relative to U.S. Treasuries. However, using swap rates as a benchmark has been delayed by the decoupling of traditional credit spreads (credit yield minus government yield) from swap spreads over 2000–2003. Effectively, credit risk during a global recession and its aftermath superseded the countervailing influence of strong technical factors such as lower and steeper yield curves that affected the interest-rate swap market differently.

Closer Look at Swap Spreads

Swap spreads became a popular valuation yardstick for credit debt in Europe during the 1990s. This practice was enhanced by the unique nature of the European credit asset class. Unlike its American counterpart, the European credit market has been consistently homogeneous. Most issuance was of high quality (rated Aa3/AA– and above) and intermediate maturity (10 years and less). Consequently, swap spreads are a good proxy for credit spreads in such a uniform market. Most issuers were financial institutions, natural swappers between fixed-rate and floating-rate obligations. And European credit investors, often residing in financial institutions like commercial banks, have been much more willing to use the swap methodology to capture value discrepancies between the fixed- and floating-rate markets.

Structurally, the Asian credit market more closely resembles the European than the U.S. credit market. As a result, the use of swap spreads as a valuation benchmark also became common in Asia.

The investment-grade segment of the U.S. credit market may well be headed toward an embrace of swap spreads. The U.S. MBS, CMBS, agency, and ABS sectors (accounting for about 55% of the U.S. fixed income market) made the transition to swap spreads as a valuation benchmark during the second half of the 1990s. Classic nominal credit spreads derived directly from the U.S. Treasury yield curve were distorted by the special effects of U.S. fiscal surpluses and buybacks of U.S.

Treasury securities in 2000 and 2001. Accordingly, many market practitioners envision a convergence to a single global spread standard derived from swap spreads.

Here is an illustration of how a bond manager can use the interest-rate swap-spread framework. Suppose that a hypothetical Ford Motor Credit 7½s of 2008 traded at a bid price (i.e., the price at which a dealer is willing to buy the issue) of 113 basis point over the five-year U.S. Treasury yield of 6.43%. This equates to a yield-to-maturity of 7.56% (6.43% + 113 basis points). On that date, five-year swap spreads were 83 basis point (to the five-year U.S. Treasury). Recall that swaps are quoted where the fixed-rate payer pays the yield on a Treasury with a maturity equal to the initial term of the swap plus the swap spread. The fixed-rate payer receives LIBOR flat—that is, no increment over LIBOR. Thus, if the bond manager invests in the Ford Motor Credit issue and simultaneously enters into this five-year swap, the following would result:

Receive from Ford Motor Credit (6.43% + 113 basis point)	7.56%
– Pay on swap (6.43% + 83 basis point)	7.26%
+ Receive from swap	LIBOR
Net	LIBOR + 30 basis points

Thus a bond manager could exchange this Ford Motor Credit bond's fixed coupon flow for LIBOR + 30 basis points. On the trade date, LIBOR was 6.24%, so the asset swapper would earn 6.54% (= 6.24% + 30 basis points) until the first reset date of the swap. A total-return manager would want to take advantage of this swap by paying fixed and receiving floating if he expects interest rates to increase in the future.

The swaps framework allows managers (as well as issuers) to more easily compare securities across fixed-rate and floating-rate markets. The extension of the swap-spread framework may be less relevant for speculative-grade securities, where default risk becomes more important. In contrast to professional money managers, individual investors are not comfortable using bond valuation couched in terms of swap spreads. The traditional nominal spread framework is well understood by individual investors, has the advantages of long-term market convention, and works well across the entire credit-quality spectrum from Aaa's to B's. However, this nominal spread framework does not work very well for investors and issuers when comparing the relative attractiveness between the fixed-rate and floating-rate markets.

Spread Tools

Investors also should understand how best to evaluate spread levels in their decision making. Spread valuation includes mean-reversion analysis, quality-spread analysis, and percent yield spread analysis.

Mean-Reversion Analysis

The most common technique for analyzing spreads among individual securities and across industry sectors is *mean-reversion analysis*. The *mean* is the average value of some variable over a defined interval (usually one economic cycle for the credit market). The term *mean reversion* refers to the tendency for some variable's value to revert (i.e., move toward) its average value. Mean-reversion analysis is a form of relative-value analysis based on the assumption that the spread between two sectors or two issuers will revert back to its historical average. This would lead investors to buy a sector or issuer identified as "cheap" because historically the spread has been tighter and will eventually revert back to that tighter spread. Also, this would lead investors to sell a sector or issuer identified as "rich" because the spread has been wider and is expected to widen in the future.

Mean-reversion analysis involves the use of statistical analysis to assess whether the current deviation from the mean spread is significant. For example, suppose that the mean spread for an issuer is 80 basis points over the past six months and the standard deviation is 12 basis points. Suppose that the current spread of the issuer is 98 basis points. The spread is 18 basis points over the mean spread or, equivalently, 1.5 standard deviations above the mean spread. The manager can use that information to determine whether or not the spread deviation is sufficient to purchase the issue. The same type of analysis can be used to rank a group of issuers in a sector.

Mean-reversion analysis can be instructive as well as misleading. The mean is highly dependent on the interval selected. There is no market consensus on the appropriate interval, and "persistence" frequents the credit market, meaning that cheap securities, mainly a function of credit uncertainty, often tend to become cheaper. Rich securities, usually high-quality issues, tend to remain rich.

Quality-Spread Analysis

Quality-spread analysis examines the spread differentials between low- and high-quality credits. For example, portfolio managers would be well advised to consider the "credit upgrade trade" when quality spreads collapse to cyclical troughs. The incremental yield advantage of lower-quality products may not compensate investors for lower-quality spread expansion under deteriorating economic conditions. Alternatively, credit portfolio managers have long profited from overweighting lower-quality debt at the outset of an upward turn in the economic cycle.

Percent Yield-Spread Analysis

Dating from the early twentieth century, *percent yield-spread analysis* (the ratio of credit yields to government yields for similar-duration securities) is another popular technical tool used by some investors. This methodology has serious drawbacks that undermine its usefulness. Percent yield spread is more a derivative than an explanatory or predictive variable. The usual expansion of credit percent yield spreads during low-rate periods like 1997, 1998, and 2002 overstates the risk as well as the comparative attractiveness of credit debt. And the typical contraction of credit percent yield spreads during upward shifts of the benchmark yield curve does not necessarily signal an imminent bout of underperformance for the credit asset class. Effectively, the absolute level of the underlying benchmark yield is merely a single factor among many factors (demand, supply, profitability, defaults, etc.) that determine the relative value of the credit asset class. These other factors can offset or reinforce any insights derived from percent yield spread analysis.

STRUCTURAL ANALYSIS

As explained earlier in this chapter, there are bullet, callable, putable, and sinking fund structures. *Structural analysis* is simply analyzing the performance of the different structures discussed throughout this chapter. While evaluating bond structures was extremely important in the 1980s, it has become less influential in the credit bond market since the mid-1990s for several reasons. First, the European credit bond market almost exclusively features intermediate bullets. Second, as can be seen in Exhibit 46–7, the U.S. credit and the global bond markets have moved to embrace this structurally homogeneous European bullet standard. Plenty of structural diversity still resides within the U.S. high-yield and EMG debt markets, but portfolio decisions in these speculative-grade sectors understandably hinge more on pure credit differentiation than the structural diversity of the issue-choice set.

Still, structural analysis can enhance risk-adjusted returns of credit portfolios. Leaving credit aside, issue-structure analysis and structural allocation decisions usually hinge on yield-curve and volatility forecasts, as well as interpretation of option-valuation model outputs (see the discussion below). This is also a key input in making relative-value decisions among structured credit issues, mortgage-backed securities, and asset-backed securities. In the short run and assuming no change in the perceived creditworthiness of the issuer, yield-curve and volatility movements largely will influence structural performance. Investors also should take into account long-run market dynamics that affect the composition of the market and, in turn, credit index benchmarks.

Specifically, callable structures have become rarer in the U.S. investment-grade credit bond market with the exception of the 2000 inversion. This is due to an almost continuously positively sloped U.S. term structure since 1990 and the

EXHIBIT 46–7

Changing Composition of the U.S. Investment-Grade Credit Markets*

	1990 (%)	2003 (%)
Bullets	24	94
Callables	72	3
Sinking funds	32	1
Putables	5	2
Zeros	4	N/A

*Figures in table do not add to 100% given that some structures may have contained multiple options (e.g., a callable corporate bond also may have a sinking fund and put provision).
Source: Lehman Brothers U.S. Investment-Grade Credit Index.

yield curve's intermittent declines to approximately multidecade lows in 1993, 1997, 1998, and 2002. As a result, the composition of the public U.S. corporate bond market converged toward the intermediate-bullet Eurobond and euro-denominated bond market. To see this, we need only look at the structure composition of Lehman's U.S. Investment-Grade Credit Bond Index. Bullets increased from 24% of this index at the start of 1990 to 94% (principal-value basis) by 2003. Over this interval, callables declined at a remarkable rate from 72% to just a 3% index share. Sinking-fund structures, once the structural mainstay of natural-gas pipelines and many industrial sectors, are on the "structural endangered species list" with a drop from 32% of the public bond market in 1990 to only 1% in 2003. Despite several brief flurries of origination in the mid-1990s and the late-1990s introduction of callable/putable structures, putable structure market share fell from 5% in 1990 to 2% by 2003. Pure corporate zeros are in danger of extinction with a fall from 4% market share in 1990 to negligible by 2003.

Bullets

Here is a review of how different types of investors are using bullet structures with different maturities.

Front-end bullets (i.e., bullet structures with one- to five-year maturities) have great appeal for investors who pursue a "barbell strategy." There are "barbellers" who use credit securities at the front or short end of the curve and Treasuries at the long end of the yield curve. There are non-U.S. institutions who convert short bullets into floating-rate products by using interest-rate swaps. The transactions are referred to as "asset swaps," and the investors who employ this transaction are referred to as "asset swappers."

Intermediate credit bullets (5- to 12-year maturities), especially the 10-year maturity sector, have become the most popular segment of the U.S. and European investment-grade and high-yield credit markets. Fifteen-year maturities, benchmarked off the 10-year bellwether Treasury, are comparatively rare and have been favored by banks that occasionally use them for certain types of swaps. Because new 15-year structures take five years to descend along a positively sloped yield curve to their underlying 10-year bellwether, 15-year maturities hold less appeal for many investors in search of return through price appreciation emanating from benchmark rolldown. In contrast, rare 20-year structures have been favored by many investors. Spreads for these structures are benched off the 30-year Treasury. With a positively sloped yield curve, the 20-year structure provides higher yield than a 10- or 15-year security and less vulnerability (lower duration) than a 30-year security.

The 30-year maturity is the most popular form of long-dated security in the global credit market. In 1992, 1993, late 1995, and 1997, there was a minor rush to issue 50-year (half-centuries) and 100-year (centuries) securities in the U.S. credit bond market. These longer-dated securities provide investors with extra positive convexity for only a modest increase in effective (or modified-adjusted) duration. In the wake of the "Asian contagion" and especially the "great spread-sector crash" of August 1998, the cyclic increases in risk aversion and liquidity premiums greatly reduced both issuer and investor interest in these ultralong maturities.

Callables

Typically after a 5- or 10-year wait (longer for some rare issues), credit structures are callable at the option of the issuer at any time. Call prices usually are set at a premium above par (par + the initial coupon) and decline linearly on an annual basis to par by 5 to 10 years prior to final scheduled maturity. The ability to refinance debt in a potentially lower-interest-rate environment is extremely valuable to issuers. Conversely, the risk of earlier-than-expected retirement of an above-current market coupon is bothersome to investors.

In issuing callables, issuers pay investors an annual spread premium (about 20 to 40 basis points for high-quality issuers) for being long (from an issuer's perspective) the call option. Like all security valuations, this call premium varies through time with capital market conditions. Given the higher chance of exercise, this call option becomes much more expensive during low-rate and high-volatility periods. Since 1990, this call premium has ranged from approximately 15 to 50 basis points for investment-grade issuers. Callables significantly underperform bullets when interest rates decline because of their negative convexity. When the bond market rallies, callable structures do not fully participate given the upper boundary imposed by call prices. Conversely, callable structures outperform bullets in bear bond markets as the probability of early call diminishes.

Sinking Funds

A sinking-fund structure allows an issuer to execute a series of partial calls (annually or semiannually) prior to maturity. Issuers also usually have an option to retire an additional portion of the issue on the sinking-fund date, typically ranging from one to two times the mandatory sinking-fund obligation. Historically, especially during the early 1980s, total-return investors favored the collection of sinking-fund structures at subpar prices. These discounted sinking funds retained price upside during interest-rate rallies (provided the indicated bond price remained below par), and given the issuers' requirement to retire at least annually some portion of the issue at par, the price of these sinking-fund structures did not fall as much compared with callables and bullets when interest rates rose. It should be noted that astute issuers with strong liability management skills sometimes can satisfy such annual sinking-fund obligations in whole or in part through prior open-market purchases at prices below par. Nonetheless, this annual sinking-fund purchase obligation by issuers does limit bond price depreciation during periods of rising rates.

Putables

Conventional put structures are simpler than callables. Yet, in trading circles, put bond valuations often are the subject of debate. American-option callables grant issuers the right to call an issue at any time at the designated call price after expiration of the non-callable or nonredemption period. Put bonds typically provide investors with a one-time, one-date put option (European option) to demand full repayment at par. Less frequently, put bonds include a second or third put option date. A very limited number of put issues afford investors the privilege to put such structures back to the issuers at par in the case of rating downgrades (typically to below investment-grade status).

Thanks to falling interest rates, issuers shied away from new put structures as the 1990s progressed. Rather than incur the risk of refunding the put bond in 5 or 10 years at a higher cost, many issuers would prefer to pay an extra 10 to 20 basis points in order to issue a longer-term liability.

Put structures provide investors with a partial defense against sharp increases in interest rates. Assuming that the issuer still has the capability to meet its sudden obligation, put structures triggered by a credit event enable investors to escape from a deteriorating credit. Perhaps because of its comparative scarcity, the performance and valuation of put structures have been a challenge for many portfolio managers. Unlike callable structures, put prices have not conformed to expectations formed in a general volatility-valuation framework. Specifically, the implied yield volatility of an option can be computed from the option's price and a valuation model. In the case of a putable bond, the implied volatility can be obtained using a valuation model such as the binomial model. The implied volatility should be the same for both puts and calls, all factors constant. Yet, for putable structures, implied volatility has ranged between 4% to 9% since 1990, well below the 10% to 20% volatility range associated with callable structures for the same time period. This divergence in implied volatility between callables (high) and putables (low) suggests that asset managers, often driven by a desire to boost portfolio yield, underpay issuers for the right to put a debt security back to the issuer under specified circumstances. In other words, the typical put bond should trade at a lower yield in the market than is commonly the case.

Unless put origination increases sharply, allowing for greater liquidity and the creation of more standardized trading conventions for this rarer structural issue, this asymmetry in implied volatility between putable and corporate structures will persist. Meanwhile, this structure should be favored as an outperformance vehicle only by investors with a decidedly bearish outlook for interest rates.

CREDIT-CURVE ANALYSIS

The rapid growth of credit derivatives since the mid-1990s has inspired a groundswell of academic and practitioner interest in the development of more rigorous techniques to analyze the term structure (1 to 100 years) and credit structure (Aaa/AAA through B2/B's) of credit-spread curves (higher-risk, higher-yield securities trade on a price rather than a spread basis).

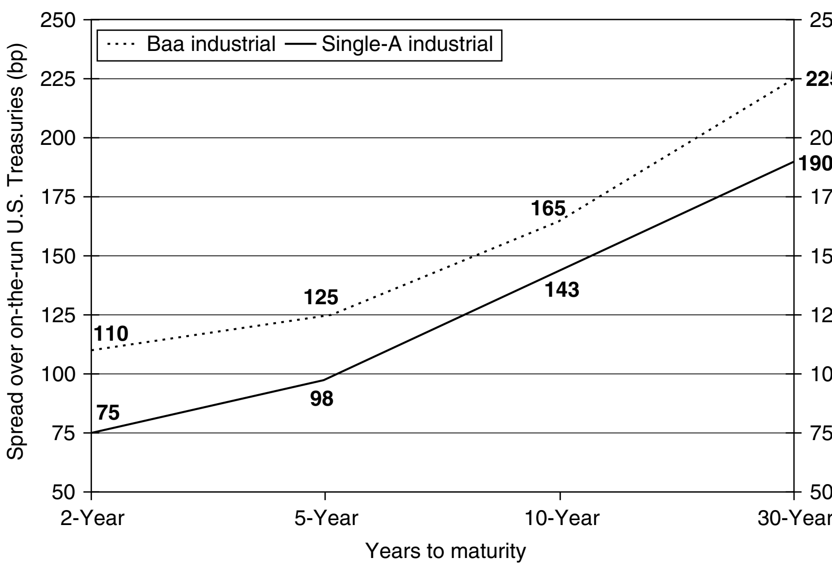
Credit curves, both term structure and credit structure, are almost always positively sloped. In an effort to moderate portfolio risk, many portfolio managers take credit risk in short and intermediate maturities and substitute less-risky government securities in long-duration portfolio buckets. This strategy is called a *credit barbell strategy*. Accordingly, the application of this strategy diminishes demand for longer-dated credit risk debt instruments by many total-return, mutual fund, and bank portfolio bond managers. Fortunately for credit issuers who desire to issue long maturities, insurers and pension plan sponsors often meet long-term liability needs through the purchase of credit debt with maturities that range beyond 20 years.

Default risk increases nonlinearly as creditworthiness declines. The absolute risk of issuer default in any one year remains quite low through the investment-grade rating categories (Aaa/AAA to Baa3/BBB–). But investors constrained to high-quality investments often treat downgrades like quasi-defaults. In some cases, such as a downgrade from single-A to the Baa/BBB category, investors may be forced to sell securities under rigid portfolio guidelines. In turn, investors justifiably demand a spread premium for the increased likelihood of potential credit difficulty as rating quality descends through the investment-grade categories.

Credit spreads increase sharply in the high-yield rating categories (Ba1/BB+ through D). Default, especially for weak single-Bs and CCCs, becomes a major possibility. The credit market naturally assigns higher and higher risk premia (spreads) as credit and rating risk escalate. Exhibit 46–8 shows the credit curve for

EXHIBIT 46–8

Illustration of Two Typical U.S. Investment-Grade Credit Curves



Source: Lehman Brothers U.S. Investment-Grade Credit Index, based on average corporate curves 1990–2003.

two credit sectors (Baa and single-A industrials) and also illustrates that a higher spread is required as maturity lengthens.

In particular, the investment-grade credit market has a fascination with the slope of issuer credit curves between 10- and 30-year maturities. Like the underlying Treasury benchmark curve, credit-spread curves change shape over the course of economic cycles. Typically, spread curves steepen when the bond market becomes more wary of interest-rate and general credit risk. Spread curves also have displayed a minor propensity to steepen when the underlying benchmark curve flattens or inverts. This loose spread-curve/yield-curve linkage reflects the diminished appetite for investors to assume both curve and credit risk at the long end of the yield curve when higher total yields may be available in short and intermediate credit products.

CREDIT ANALYSIS

In the continuous quest to seek credit upgrades and contraction in issuer/issue spread resulting from possible upgrades and, more important, to avoid credit downgrades resulting in an increase in issuer/issue spread, superior credit analysis has been and will remain the most important determinant of credit bond portfolio relative performance. Credit screening tools tied to equity valuations, relative spread movements, and the Internet (information available tracking all related news on portfolio holdings) can provide helpful supplements to classic credit research and rating agency opinions. But self-characterized credit models, relying exclusively on variables such as interest-rate volatility and binomial processes imported from option-valuation techniques, are not especially helpful in ranking the expected credit performance of individual credits such as IBM, British Gas, Texas Utilities, Pohang Iron & Steel, Sumitomo, and Brazil.

Credit analysis is both nonglamorous and arduous for many top-down portfolio managers and strategists, who focus primarily on macro variables. Genuine credit analysis encompasses actually studying issuers' financial statements and accounting techniques, interviewing issuers' managements, evaluating industry issues, reading indentures and charters, and developing an awareness of (not necessarily concurrence with) the views of the rating agencies about various industries and issuers.

Unfortunately, the advantages of such analytical rigor may clash with the rapid expansion of the universe of issuers of credit bonds. There are approximately 5,000 different credit issuers scattered across the global bond market. With continued privatization of state enterprises, new entrants to the high-yield market, and expected long-term growth of the emerging-debt markets, the global roster of issuers could swell to 7,500 by 2010. The sorting of this expanding roster of global credit issues into outperformers, market performers, and underperformers demands establishing and maintaining a formidable credit-valuation function by asset managers.

ASSET ALLOCATION/SECTOR ROTATION

Sector rotation strategies have long played a key role in equity portfolio management. In the credit bond market, "macro" sector rotations among industrials, utilities, financial institutions, sovereigns, and supranationals also have a long history. During the last quarter of the twentieth century, there were major variations in investor sentiment toward these major credit sectors. Utilities endured market wariness about heavy supply and nuclear exposure in the early to mid-1980s. U.S. and European financial institutions coped with investor concern about asset quality in the late 1980s and early 1990s. Similar investor skittishness affected demand for Asian financial institution debt in the late 1990s. Industrials embodied severe "event risk" in the middle to late 1980s, recession vulnerability during 1990–1992, a return of event risk in the late 1990s amid a general boom in corporate mergers and acquisitions, and a devastating series of accounting and corporate governance blows during 2001–2002. Sovereigns were exposed to periodic market reservations about the implications of independence for Quebec, political risk for various countries (i.e., Russia), the effects of the "Asian contagion" during 1997–1998, and outright defaults such as Argentina (2001).

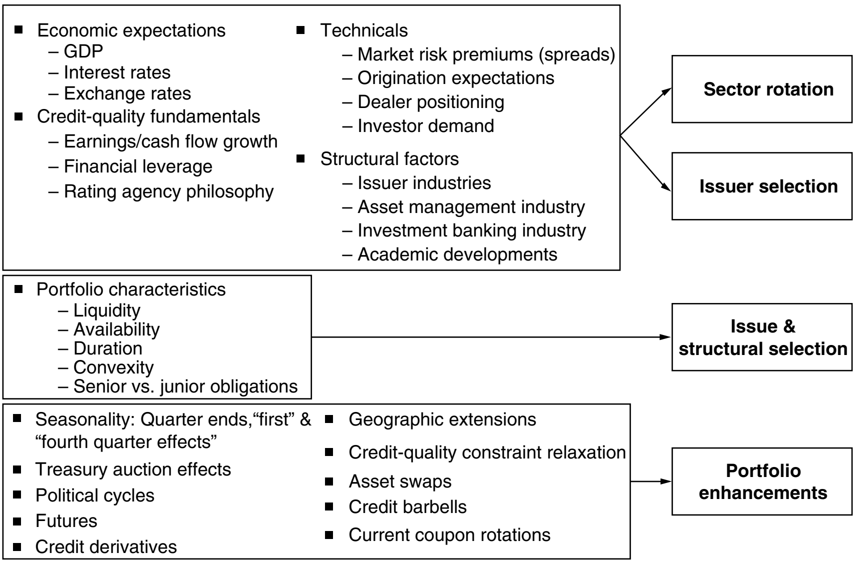
In contrast, "micro" sector rotation strategies have a briefer history in the credit market. A detailed risk/return breakdown (i.e., average return and standard deviation) of the main credit subsectors (i.e., banks, brokerage, energy, electrics, media, railroads, sovereigns, supranationals, and technology) was not available from credit index providers until 1993 in the United States and until 1999 in Europe. Beginning in the mid-1990s, these "micro" sector rotation strategies in the credit asset class have become much more influential as portfolio managers gain a greater understanding of the relationships among intracredit sectors from these statistics.

Exhibit 46–9 illustrates the main factors bearing on sector rotation and issuer selection strategies. For example, an actual or perceived change in rating agency philosophy toward a sector and a revision in profitability expectations for a particular industry represent just two of many factors that can influence relative sectoral performance.

Common tactics to hopefully enhance credit portfolio performance are also highlighted in Exhibit 46–9. In particular, seasonality deserves comment. The annual rotation toward risk aversion in the bond market during the second half of most years contributes to a "fourth-quarter effect"—that is, there is underperformance of lower-rated credits, B's in high-yield and Baa's in investment-grade, compared with higher-rated credits. A fresh spurt of market optimism greets nearly every New Year. Lower-rated credit outperforms higher-quality credit—this is referred to as the "first-quarter effect." This pattern suggests a very simple and popular portfolio strategy: underweight low-quality credits and possibly even credit products altogether until the mid-third quarter of each year, and then move to overweight lower-quality credits and all credit product in the fourth quarter of each year.

EXHIBIT 46–9

Some Outperformance Methodologies



CONCLUSION

As prescribed in capital market theory, investors should be rewarded for the assumption of incremental risk. Reality conforms to theory in the global bond market. Credit products such as corporate bonds provide higher long-term returns than government securities.

Global bond management philosophy has evolved rapidly over the past two decades. The arrival of the euro in 1999 curbed the use of currency strategies. Major portfolio-duration bets (more than 10% above or below the duration of an index benchmark) have become less common by asset managers because of duration-timing disappointments in the middle to late 1990s. In conjunction with the demonstrably higher long-term returns of corporates and an ongoing migration from "government-only index benchmarks" to "government plus corporate and securitized index benchmarks," this reduction in currency and curve timing has propelled investor interest in global credit portfolio optimization as a path to more consistent overall portfolio outperformance in an increasingly competitive asset management industry.

Corporate bond portfolio management requires more work and asset management firm infrastructure than other fixed income asset classes. There are thousands of credit choices, dozens of security forms, and multiple structures, and the evolution of the global corporate asset class will accelerate during the early twenty-first century.

Although destined to become more structurally homogeneous with intermediate bullets as the instrument of choice, this asset class will become more heterogeneous in terms of credit quality (lower-quality credits) and geography (more European, Asian, and emerging market corporates). Over this interval, the eventual arrival of real-time credit indexes as well as improved analytics, will lead to a proliferation in the use of credit derivatives to enhance risk-adjusted returns. The long-run portfolio returns should justify this considerable effort. As a result, credit debt is unlikely to relinquish its return leadership within the global bond realm during the early twenty-first century.

CHAPTER
FORTY-SEVEN

BOND IMMUNIZATION: AN ASSET/LIABILITY OPTIMIZATION STRATEGY

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The purpose of this chapter is to review the mechanics and applications of the bond immunization strategy. In the first section we define immunization as a duration-matching strategy, and then compare it with maturity-matching as an alternative approach to locking in rates. To hedge the reinvestment risk present in maturity-matching, we then explain the single-period immunization strategy and the rebalancing procedures that accompany it. Following single-period immunization, we discuss multiperiod immunization and its applications for the pension, insurance, and thrift markets. Finally, we review variations on the strategy, including combination matching, contingent immunization, immunization with futures, and immunization with options.

WHAT IS AN IMMUNIZED PORTFOLIO?

Single-period immunization is usually defined as locking in a fixed rate of return over a prespecified horizon, such as locking in a 10% return for a five-year period. It also can be defined as generating a minimum future value at the end of a specified horizon, such as generating $100 million from a $70 million investment five years earlier. With multiperiod immunization, the horizon over which rates are locked in is extended to include multiple periods (such as a schedule of monthly payouts to retirees of a pension plan). Multiperiod immunization is a duration-matching strategy that permits funding of a fixed schedule of multiple future payouts at a minimum cost (such as funding a $500 million schedule of payouts at a cost of $200 million).

Previous versions of this chapter appearing in prior editions of the *Handbook* were coauthored with Peter Christensen and Anthony LoFaso.

The actuary generally credited with pioneering the immunization strategy, F. M. Reddington, defined immunization in 1952 as "the investment of the assets in such a way that the existing business is immune to a general change in the rate of interest."[1] He also specified a condition for immunization: The average duration of assets must be set equal to the average duration of the liabilities. He thought that by matching the durations of assets and liabilities he would then immunize a portfolio from the effects of small changes in interest rates. By matching durations on both sides of the balance sheet, he felt that assets and liabilities would be equally price-sensitive to changes in the general level of interest rates. For any change in yield, both sides of the ledger should be equally affected; therefore, the relative values of assets and liabilities would not be changed.

Much later, Lawrence Fisher and Roman Weil defined an immunized portfolio as follows:[2]

> A portfolio of investments is immunized for a holding period if its value at the end of the holding period, regardless of the course of rates during the holding period, must be at least as large as it would have been had the interest rate function been constant throughout the holding period.
>
> If the realized return on an investment in bonds is sure to be at least as large as the appropriately computed yield to the horizon, then that investment is immunized.

Fisher and Weil demonstrated that to achieve the immunized result, the average duration of the bond portfolio must be set equal to the remaining time in the planning horizon, and the market value of assets must be greater than or equal to the present value of the liabilities discounted at the internal rate of return of the portfolio.

Before reviewing the logic of this portfolio strategy, let's look at maturity-matching as an early approach to locking in a current level of interest rates.

MATURITY-MATCHING: THE REINVESTMENT PROBLEM

Suppose that an investor wishes to lock in prevailing interest rates for a 10-year period. Should she buy 10-year bonds?

By purchasing 10-year bonds and holding them to maturity, an investor can be certain of receiving all coupon payments over the 10-year period, as well as the principal repayment at redemption (assuming that no default occurs). These two sources of income are fixed in dollar amounts. The third and final source of income is the interest earned on the semiannual coupon payments. "Interest on coupon" is not fixed in dollar amounts; rather, it depends on the many interest-rate environments at the various times of payment.

1. F. M. Reddington, "Review of the Principle of Life-Office Valuations," *Journal of the Institute of Actuaries* 78(1952), pp. 286–340.
2. Lawrence Fisher and Roman Weil, "Coping with the Risk of Interest-Rate Fluctuations: Returns to Bondholders from Naive and Optimal Strategies," *Journal of Business* (October 1971), pp. 408–431.

A reinvestment problem occurs when the reinvestment of coupon income occurs at rates below the yield-to-maturity of the bond at the time of purchase. Note from Exhibit 47–1 that as interest rates shift instantaneously and remain at the new levels for a 10-year period, the total "holding period" return on a 9% par bond due in 10 years will vary considerably. The initial effect will appear in the value of the asset. The immediate result will be a capital gain if rates fall (or loss, if rates rise).

As the holding period increases after a change in rates, the interest-on-coupon component of total return begins to exert a stronger influence. At 10 years, we note that interest on coupon (reinvestment income) exerts a dominance over capital gain (or loss) in determining holding-period returns.

Intuitively, we know that these relationships make sense. Capital gains appear instantly, whereas changes in reinvestment rates take time to exert their effect on the total holding-period return on a bond.

If rates were to jump immediately from 9% to 15% and a capital loss were to appear today, at what point will that capital loss be made up because the reinvestment of coupon payments is occurring at a higher (15%) rate? As illustrated in Exhibit 47–2, the two "offsetting forces" of market value and reinvestment return equally offset at 6.79 years. This is the duration of the 10-year, 9% bond. To earn the original 9% target return (the yield-to-maturity at the time of purchase), it is necessary to hold that bond for the period of its duration—6.79 in our example. If we wish to lock in a market rate of 9% for a 10-year period, we would select a bond with a duration of 10 (not a maturity of 10 years). The maturity for such a par bond in a 9% yield environment is roughly 23 years.

From Exhibit 47–1, we note that regardless of the immediate, one-time interest-rate shift, we are still able to earn a 9% total return if our holding period is 6.79 years—the duration of the bond. By targeting the duration of a portfolio rather than specific maturities to the prescribed investment horizon of 6.79, we see the equal offsets of capital gain with lower reinvestment return occurring in the portfolio. This principle of duration-matching together with rebalancing procedures that are used over time allow us to lock in rates and minimize the reinvestment risk that is associated with the maturity-matching strategy.

SINGLE-PERIOD IMMUNIZATION

The most straightforward approach to funding a single-period liability five years from today is to purchase a five-year, zero-coupon bond maturing on the liability payment date. Regardless of future fluctuations in interest rates, the bond, or portfolio of bonds, will be price insensitive (or immune) to changes in rates as the zero-coupon securities mature at par on the payment date. Because zero coupons have durations equal to their maturities, the five-year zero-coupon bonds both cash-match and duration-match the single-period liability payment.

If zero-coupon bonds have insufficient yield, a portfolio of *coupon-bearing* Treasury, agency, and corporate bonds can be immunized to fund the same single-period payment only if three conditions are met: (1) the duration of the portfolio

EXHIBIT 47–1

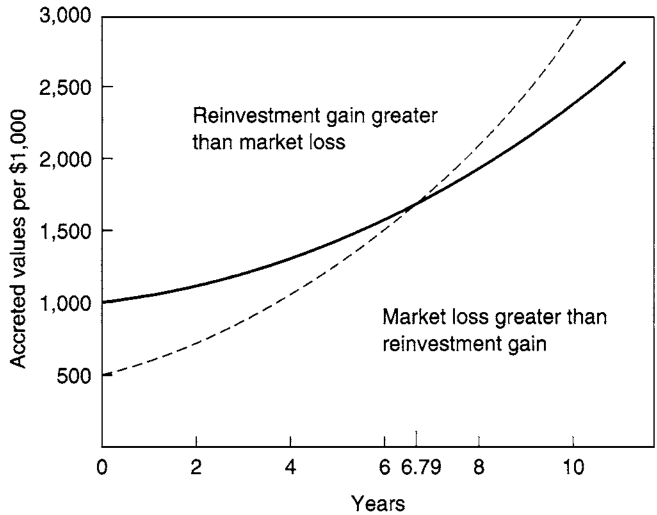
Total Return on a 9% Noncallable $1,000 Bond Due in 10 Years and Held through Various Holding Periods

Income Source	Interest Rate at Time of Reinvestment	*Holding Period in Years*					
		1	3	5	6.79[a]	9	10
Coupon income	5%	$90	$270	$450	$611	$810	$900
Capital gain or loss		287	234	175	100	39	0
Interest-on-interest		1	17	54	105	191	241
Total return (and yield)		$378 (37.0%)	$521 (15.0%)	$679 (11.0%)	$816 (9.0%)	$1,040 (8.5%)	$1,141 (8.2%)
Coupon Income	7	$90	$270	$450	$611	$810	$900
Capital gain or loss		132	109	83	56	19	0
Interest-on-interest		2	25	78	149	279	355
Total return (and yield)		$224 (22.0%)	$404 (12.0%)	$611 (10.0%)	$816 (9.0%)	$1,108 (8.6%)	$1,225 (8.5%)
Coupon income	10	$90	$270	$450	$611	$810	$900
Capital gain or loss		0	0	0	0	0	0
Interest-on-interest		2	32	103	205	387	495
Total return (and yield)		$92 (9.0%)	$302 (9.0%)	$553 (9.0%)	$816 (9.0%)	$1,197 (9.0%)	$1,395 (9.0%)
Coupon income	10	$90	$270	$450	$611	$810	$900
Capital gain or loss		–112	–95	–75	–56	–18	0
Interest-on-interest		2	40	129	261	502	647
Total return (and yield)		$20 (2.0%)	$215 (6.7%)	$504 (8.5%)	$816 (9.0%)	$1,294 (9.7%)	$1,547 (9.8%)

[a]Duration of a 9% bond bought at par and due in 10 years.

EXHIBIT 47–2

"Offsetting Forces" Principle (9% Coupon, 30-Year Maturity Bond, Rates Rise Instantly from 9% to 15%, Reinvestment Rate Is 15%)



of coupon bonds must be set equal to the five-year horizon, (2) the market value of assets must be greater than the present value of liabilities, and (3) the dispersion of the assets must be slightly greater than the dispersion of the liabilities. That is,

1. $\text{Duration}_{\text{Assets}} = \text{duration}_{\text{Liabilities}}$
2. $\text{PV}_{\text{Assets}} > \text{PV}_{\text{Liabilities}}$
3. $\text{Dispersion}_{\text{Assets}} > \text{dispersion}_{\text{Liabilities}}$

Immunization requires that the average durations of assets and liabilities are set equal at all times. Unfortunately, simple matching of durations is not a sufficient condition.

Consider both a $200,000 par-value zero-coupon five-year bond in a 9% rate environment and a $1 million five-year single-period liability. Obviously, the durations of both the assets and liabilities are matched because they are both zero-coupon five-year obligations. However, a $200,000 par-value zero-coupon five-year bond (with a market value of $128,787) cannot realistically compound to $1 million in five years. The required annual rate to compound to $1 million in five years is almost 67%. In a 9% rate environment, $643,937 is required in market value of assets to compound to $1 million in five years.

Therefore, a second condition for immunization is necessary: The market value of assets must be greater than or equal to the present value of liabilities, using the internal rate of return (IRR) of the assets as the discount factor in present-valuing the liabilities. The assets, when compounded at the "locked-in" immunized rate of 9%, will grow to equal or exceed the future-value immunized target of $1 million in this example.

To meet a target duration of 6.79, a portfolio could be constructed as either (1) a barbell of roughly equal amounts of bonds with zero and 13 duration, (2) an even ladder of equal amounts of bonds with zero through 13 duration, or (3) a bullet of only 6.79 durations. Because the duration calculation assumes a parallel shift in the yield curve, the barbell structure incorporates the greatest amount of yield-curve risk by concentrating cash flows on both ends of the curve. If the yield curve is positive or inverted, the barbell structure will violate the assumption of a flat curve more than the even ladder or bullet structure. On the other hand, the bullet structure, by concentrating cash flows at a single maturity point, incorporates a flat slope over the relevant range on the yield curve.

For single-period immunization, a bullet maturity structure with tight cash flows around the liability date generally is preferred to an even ladder or barbelled portfolio because of the reduced risk exposure to the yield curve becoming steeper or twisting. In fact, to eliminate the risk of pathologic shifts in yields, the investor could tighten the cash flows still further and purchase a zero-coupon bond to cash-flow-match the single-period liability. Short of that, a bullet structure is the least risky, and the barbell the most risky.

Therefore, for immunization, the third condition of controlling the degree of barbelling must be incorporated into the process of structuring a portfolio. The measure used to control the barbelling is dispersion—a measure of the variance of cash flows around the duration (D) of a bond. The mathematical formula for dispersion is as follows[3]:

$$\text{Dispersion} = \frac{\sum (t_1 - D)^2 \,\text{PV}(\text{CF}_i)}{\sum \text{PV}(\text{CF}_i)}$$

The dispersion of a zero-coupon bond therefore is zero, whereas the dispersion of the long-term coupon U.S. Treasury bond can exceed 100.

REBALANCING PROCEDURES

As time passes, the single-period immunized portfolio must be rebalanced so that the duration of the portfolio is always reset to the remaining life in the planning period to ensure the offsetting effects of capital gains with reinvestment return. This rebalancing procedure requires that the coupon income, reinvestment income, matured principal, and proceeds from possible liquidation of longer bonds be reinvested into securities that maintain the duration equal to the remaining life in the planning period. Because of the multiple rebalancings required throughout the

3. This measure, commonly referred to as M^2, was first developed in H. Gifford Fong and Oldrich Vasicek, "A Risk Minimizing Strategy for Multiple Liability Immunization," *Journal of Finance* (December 1984), pp. 1541–1546.

planning period, the bond portfolio is continually maintained in a duration-matched state and therefore should achieve its target return in spite of periodic shifts in rates.

An immunized bond portfolio therefore can be constructed once a time horizon is established. Because duration is inversely related to both the prevailing yields and the coupon rate, it may not be possible to immunize a portfolio beyond a certain number of years using only coupon-bearing securities. For example, when bond market yields reached their historic highs in 1981, it was not possible to immunize a bullet liability beyond seven years in the taxable markets with current-coupon securities. In an 8% rate environment, the maximum lock-up period would be closer to 12 years. However, the use of zero-coupon securities with long maturities and durations can allow the investor the opportunity to lengthen the planning period over which he or she can lock in rates.

The actual targeted return on an immunized portfolio will depend on the level of interest rates at the time the program is initiated. Though bond values may, for example, decline as interest rates rise, the future value of the portfolio (or security) based on the new higher reinvestment rate and lower principal value should still correspond to the original targeted yield. Duration is the key to controlling the equal offset of reinvestment income with asset value as interest rates fluctuate.

The important point to remember is this: *The standard deviation of return on an immunized portfolio will be much lower over a given horizon than that on a nonimmunized portfolio—whether measured around a sample mean or promised yield.* With interest-rate risk minimized (when held over an assumed time horizon), the performance of the immunized portfolio is virtually ensured, regardless of reinvestment rates.

MULTIPERIOD IMMUNIZATION

In the discussions so far we have explained how the three conditions are required to create a single-period immunized portfolio. These conditions can be extended to create an immunized portfolio that will satisfy the funding requirements of multiple-period liabilities, such as the monthly payouts to the retired-lives portion of a pension plan.

If a liability schedule were composed of 30 annual payments, it would be possible to create 30 single-period immunized portfolios to fund that schedule. If we then analyzed the overall duration of the 30 asset portfolios, it would equal the duration of the liabilities. As long as the dispersions of assets and liabilities are closely matched and the asset value is greater than the present value of liabilities, then the liability schedule should be fully funded and the portfolio immunized.

Calculating the duration of multiperiod liabilities is not as straightforward as calculating the duration of a single-period liability, where the remaining time in the planning horizon is the liability duration. With multiple payout periods, the liability duration is derived by using, as the discount factor, the IRR on the assets. Of course, the IRR of the assets is not determinable unless we know the precise portfolio, its duration, and its dispersion.

As a result of this simultaneity problem, the construction of an immunized portfolio is an iterative process whereby an IRR guess for the portfolio is advanced; the durations and dispersion of the liabilities are then calculated based on the IRR guess; an optimal immunized portfolio is simulated to match the duration and dispersion estimates; the portfolio IRR is then compared with the estimated IRR; and if they differ, a new IRR estimate is advanced and the procedure repeated.

In the absence of strict cash matching, it is anticipated that some liabilities will be met through a combination of asset cash flows *and* asset sales. In this regard, immunization introduces an element of market risk into the asset/liability equation that is only minimally present under a dedicated strategy.

The degree to which market risk can be limited and the cost savings of immunization thereby justified on a risk-adjusted basis depends in large part on one's ability to characterize correctly the price response of the bonds in the portfolio to changes in interest rates. This issue is especially critical when bonds containing embedded options—such as mortgages and callable corporates—are part of the asset mix and is best resolved by appealing to option-adjusted bond analytics for the relevant bond durations.

Rebalancing Procedures for Multiperiod Portfolios

Just as with a single-period immunized portfolio, a multiperiod portfolio must be rebalanced whenever one of the three conditions is violated. If, for example, the asset and liability durations were to wander apart over time, then the portfolio must be rebalanced to return it to a duration-matched state.

In a multiperiod portfolio, the durations will tend to wander whenever a liability payment comes due. An extreme example might be a $10 million bullet liability due in one month (almost zero duration) and a $10 million bullet liability due in 10 years. The average duration of the two liabilities will be about 5.

One month from now, the one-month liability will be extinguished, and the remaining liability will be 9 years and 11 months. Since the asset portfolio has a duration of roughly 5 to match what was an average duration liability of 5, the sudden shift in liability duration from 5 to approximately 10 will cause a major duration mismatch and will need to be rebalanced.

APPLICATIONS OF THE IMMUNIZATION STRATEGY

As indicated in Exhibit 47–3, the major applications of the immunization strategy have been in the pension, insurance, banking, and thrift industries.

The pension market has made widespread use of both single-period and multiperiod immunization. Single-period immunization generally is employed as an alternative to the purchase of a guaranteed investment contract (GIC) from an insurance company. Both vehicles seek to lock in today's prevailing rates over a finite planning horizon. Immunization has the advantage of liquidity, as the portfolio is composed of

EXHIBIT 47–3

Applications for Immunization

	Market		
	Pension	**Insurance**	**Banking and Thrift**
Single period	Asset strategy (GIC alternative)		
Multiperiod	Funding retired-live payouts	Funding GIC and structured settlements	GAP management Matched growth
	Single-premium buyouts	Portfolio insurance	Portfolio insurance
	Portfolio insurance		

marketable securities. GICs are privately written contracts between plan sponsor and insurance company and are not generally traded in the secondary market.

The additional benefit of an immunized portfolio is that the portfolio manager can take advantage of market opportunities in structuring and rebalancing these portfolios by including securities in the portfolio that are attractive on a relative-value basis. Investors can actively position portfolios in sectors and credits they perceive to be cheap or upgrade candidates. By actively positioning the immunized portfolio, investors can add incremental value to the portfolios and potentially outperform the illiquid GIC over a fixed planning horizon.

The pension market also has made widespread use of multiperiod immunization. Multiperiod immunization generally is employed to fund a schedule of expected benefit payouts to the retired-lives portion of a defined-benefit plan. As explained in the next chapter on cash-flow matching, by matching the duration of an immunized portfolio with corresponding liabilities, the plan sponsor can lock in prevailing rates, raise its actuarial interest-rate assumption, and reduce cash contributions to the pension fund.

The insurance market also has made widespread use of the multiperiod immunization strategy for its fixed-liability insurance products such as GICs and structured settlements. Because GIC, structured settlement, and single-premium buyout assets and liabilities generally are segmented from general account assets and liabilities, the entire line of business can be immunized to minimize the interest-rate risk and lock in a spread. Again, these portfolios can be actively positioned to take advantage of market opportunities.

Lastly, banks and thrifts have made extensive use of the multiperiod immunization strategy to assist in the management of their asset/liability gap and to ensure future duration-matched growth of assets and liabilities. *Technical Bulletin 13* (TB-13) mandated for the thrift industry that the interest sensitivity of a company's assets be similar to the interest sensitivity of its liabilities. For thrifts whose durations are not closely matched, their capital requirements will be increased.

VARIATIONS TO IMMUNIZATION

There are several variations or enhancements to the immunization strategy, including combination-matching; contingent immunization; immunization with futures, options, mortgages, or swaps; and stochastic duration-matching.

The most popular variation of the immunization strategy is *combination-matching,* also called *horizon-matching.* A combination-matched portfolio is one that is duration-matched with the added constraint that it be cash-matched in the first few years, usually five years. The advantages of combination-matching over immunization are that liquidity needs are provided for in the initial cash-flow-matched period. Also, most of the positive slope or inversion of a yield curve tends to take place in the first few years. By cash-flow matching the initial portion, we have reduced the risk associated with nonparallel shifts of a sloped yield curve.

The disadvantages of combination-matching over immunization are that the cost is slightly greater and the swapping discretion is constrained. The freedom to swap a combination-matched portfolio is partially hampered not only because the asset durations must be replaced in a swap but also because the cash flows in the initial five-year period must be replaced as well.

A variant strategy to immunization is *contingent immunization.* The contingent immunization strategy is a blend of active management with immunization such that a portfolio is actively managed with a lower floor return ensured over the horizon.[4]

The floor return, or safety net, is a rate set below the immunized rate, allowing managers discretion to actively position their portfolios. If managers incorrectly position their portfolios and the market moves against them, the portfolios can still be actively managed. If the market continues to move against the portfolios and the floor return is violated, then managers must commit to immunized portfolios to ensure the floor return over the remainder of the horizon.

Contingent immunization requires an abrupt change in management strategy at the moment the floor return is violated. With dynamic asset allocation (portfolio insurance), the change in strategy is gradual. In this instance, managers gradually shift out of risky assets into riskless assets to avoid violating minimum return requirements. An actively managed bond portfolio or equity portfolio is the risky asset. An immunized portfolio, with duration matched to the holding period, can serve as the riskless asset. Overall, the performance of the portfolio of risky and riskless assets replicates the performance that would be obtained were a put option added to the risky portfolio. This synthetic put

4. See Martin L. Leibowitz and Alfred Weinberger, "The Uses of Contingent Immunization," *Journal of Portfolio Management* (Fall 1981), pp. 51–55.

gives the portfolio maximum upside potential consistent with a prespecified level of protection on the downside.

Immunized portfolios also can be created with the use of futures contracts to replicate the interest sensitivity of an immunized duration. In this form, a desired portfolio can be selected without regard to a target duration, and futures contracts can then be used to replicate the price sensitivity of an immunized portfolio at the desired duration.

Options also can be used with immunized portfolios to enhance returns over a specified horizon. Through the use of covered call writing or long put or call positions, managers can enhance returns over a specified horizon.

Finally, CMO PAC bonds sometimes are used in immunized portfolios to enhance returns. Though they are mortgage derivatives, their cash flows are certain across a wide band of interest-rate scenarios (prepayment speeds). As such, they can enhance performance as long as their use is actively monitored.

CONCLUSION

Bond immunization is an important risk-control strategy used by the pension fund, insurance, banking, and thrift industries. In today's volatile markets, it is imperative that all asset/liability gaps be intentional. Immunization provides the tools to measure the interest-rate risk position an institution or a fund is taking with respect to its liabilities; it also provides the tools to minimize that risk when a minimum gap is desired.

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CHAPTER

FORTY-EIGHT

DEDICATED BOND PORTFOLIOS

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Dedication is a popular and important portfolio strategy in asset/liability management. The *dedicated bond portfolio,* as it is frequently called, is a strategy that matches monthly cash flows from a portfolio of bonds to a prespecified set of monthly cash requirements of liabilities. Cash matching or prefunding these liabilities leads to the elimination of interest-rate risk and the defeasance of the liability. Applications for the dedicated strategy include pension benefit funding, defeasance of debt service, municipal funding of construction takedown schedules, structured settlement funding, GIC matching, and funding of other fixed insurance products.

THE NEED FOR A BROADER ASSET/LIABILITY FOCUS

For financial intermediaries such as banks and insurance companies, there is a well-recognized need for a complete funding perspective. This need is best illustrated by the significant interest-rate risk assumed by many insurance carriers in the early years of their guaranteed investment contract (GIC) products. A large volume of compound interest (zero-coupon) and simple interest (annual pay) GICs were issued in three- through seven-year maturities in the positively sloped yield-curve environment of the mid-1970s. Proceeds from thousands of the GIC issues were reinvested at higher rates in longer 10- to 30-year private placement, commercial mortgage, and public bond instruments. At the time, the industry expected that the GIC product would be very profitable because of the large positive spread between the higher "earned" rate on the longer assets and the lower "credited" rate on the GIC contracts.

By pricing GICs on a spread basis and investing the proceeds into mismatched assets, companies gave little consideration to the rollover risk they were

Previous versions of this chapter appearing in prior editions of the *Handbook* were coauthored with Peter Christensen.

assuming in volatile markets. As rates rose dramatically in the late 1970s and early 1980s, carriers were exposed to extreme disintermediation as GIC liabilities matured, and the corresponding assets, with 20 years remaining to maturity, were valued at only a fraction of their original cost.

As a result of this enormous risk exposure, insurance carriers were induced to adopt a broader asset/liability focus to control the interest-rate risk associated with writing a fixed-liability product. Dedication and immunization (described in Chapter 47) have become popular matching strategies to control this market risk.

CASH-FLOW MATCHING FOR PENSION FUNDS

The most popular application of the dedicated strategy has been to fund the payout obligations of the retired-lives portion of a pension plan. In the following illustration developed in November 1992, we explain the mechanics of this strategy as it applies to pension funds.

Determining the Liabilities

The first step in establishing a dedicated bond portfolio is to determine the schedule to be funded. For pension funds, usually it is the expected benefit payouts to a closed block of current retirees. Since the benefit payouts to active employees cannot be projected with great accuracy, they are generally not included in the analysis. Since active employees and future retirees are not included in the closed block, the schedule of benefit payments declines over time owing to mortality experience. The second column of Exhibit 48–1 illustrates the annual schedule of benefit payouts that are expected to be paid to current retirees.

The forecast payouts are based on the known benefit payouts at retirement for each employee and a number of variables, including expected cost-of-living increases. As shown in Exhibit 48–1, the payouts over the 35-year time horizon for the retired employees total $283,758,000.

In addition to funding the retired-lives payouts, the dedicated strategy is frequently applied to a somewhat broader universe of participants that includes retirees plus terminated vested participants. Terminated vested participants are former employees who are vested in the pension plan and are entitled to benefit payouts commencing sometime in the future. Since these benefit amounts are relatively fixed, they can be readily match-funded. A retired plus terminated vested liability schedule is illustrated in the last column of Exhibit 48–1.

Several pension plans have extended the dedication strategy to include the funding of "anticipated retiree" pension obligations. That is, in addition to funding the retired and terminated vested liabilities, the cash-flow-matched design is used to offset liabilities associated with active employees aged 50 and greater. Since these benefit payments are not fixed until the employee actually retires, the various mortality, termination, and benefit assumptions must be reviewed periodically to ensure that actual experience tracks the forecast.

EXHIBIT 48–1

Schedule of Expected Benefit Payouts

	Retired-Lives Liabilities	Retired-Lives plus Terminated Vested
Year	Dollar Payout	Dollar Payout
1992*	$ 1,250,000	$ 2,000,000
1993	15,000,000	24,000,000
1994	14,916,015	24,519,000
1995	14,427,473	25,021,000
1996	13,445,985	25,523,000
1997	12,435,248	26,190,000
1998	11,754,199	26,809,000
1999	11,384,959	27,459,000
2000	11,028,026	28,026,000
2001	10,654,684	28,630,000
2002	10,408,523	29,221,000
2003	10,355,190	29,780,000
2004	10,236,214	30,294,000
2005	9,953,126	30,576,000
2006	9,670,039	30,312,000
2007	9,302,164	29,758,000
2008	8,748,308	29,196,000
2009	8,621,160	28,684,000
2010	8,209,594	27,992,000
2011	7,893,578	27,209,000
2012	7,435,436	26,535,000
2013	6,993,713	25,714,000
2014	6,579,349	24,996,000
2015	6,145,834	24,008,000
2016	5,732,824	23,121,000
2017	5,322,551	22,189,000
2018	4,983,398	21,076,000
2019	4,615,526	19,986,000
2020	4,257,221	28,826,000
2021	3,892,088	17,701,000
2022	3,537,881	16,589,000
2023	3,216,510	15,437,000
2024	2,934,788	14,319,000
2025	2,659,900	13,211,000
2026	2,385,026	12,098,000
2027	2,123,504	10,982,000
2028	1,337,297	9,869,000
TOTAL	283,758,000	

*Partial year at $15 million.

Instead of a downward-sloping liability schedule, the profile of expected benefit payouts for this broad population of plan participants would increase dramatically in the first 10 to 15 years, level off for a brief period, and then begin a downward slope. The benefit schedule peaks because the active participants who will be joining the retired population over the next 10 to 15 years are generally greater in number and have higher salaries (due to inflation) compared with the population of retirees, which declines due to mortality. The percentage reduction in actuarial liability and hence in contribution requirements associated with the anticipated retirees, is frequently larger than that for the currently retired population because a higher discount rate applied to larger and longer liabilities results in a bigger savings.

Similarly, one can apply the dedication strategy to insurance company funding, where a liability schedule can represent monthly projections of fixed payouts for products such as GICs, single-premium buyouts, or structured settlements. Once that schedule is derived, the procedures for match-funding an insurance product line are similar to those for creating a dedicated portfolio for a pension fund.

Setting Portfolio Constraints

With the liability schedule determined, the next step in instituting a dedicated portfolio is to specify portfolio constraints on sector, quality, issuer, and lot sizes. To identify the cheapest portfolio possible that funds the fixed schedule of liabilities, the portfolio manager may wish to constrain the optimal or least-cost solution to a universe of government and corporate securities rated single-A or better by one rating agency, as illustrated in Exhibit 48–2. In the illustration that follows, a *minimum* of 20% of the portfolio is constrained to be in U.S. Treasury securities, and a 30% *maximum* is set for the bank and finance, industrial, utility, and telephone sectors; a 30% *maximum* is established collectively for Yankee, Canadian, and World Bank issues; and no Euro- or PAC bonds (CMOs) are allowed in this example.

As a general rule, mortgages are not desirable instruments for dedicated portfolios because uncertain prepayment rates cause uncertainty in monthly cash flows from mortgage securities. Nevertheless, some portfolio managers allow PACs because PAC cash flows are call-protected within a relatively wide band of prepayment speeds.

As seen in the protracted bull markets of the early 1990s, even wide-band PACs have become “busted” as prepayment speeds have pierced through their upper bands. As this occurs, the previously cash-flow-matched portfolio becomes mismatched, compromising the integrity of the dedicated portfolio. Though the PACs can be swapped out as prepayment speeds approach the upper or lower limits of their bands, there is usually a cost associated with that swap; frequently, the plan sponsor is required to “pay in” additional funds to the program to purchase call-protected instruments. It is for these reasons that mortgages in general and PACs in particular are rarely used in the dedicated design.

EXHIBIT 48–2

Portfolio Constraints

	Minimum	Maximum
Quality*		
Treasury	20%	100%
Agency		100
AAA	0	100
AA	0	100
A	0	50
BBB	0	0
Sector		
Treasury	20%	100%
Agency		100
Industrial	0	30
Utility	0	30
Telephone	0	30
Bank and finance	0	30
Canadian		
Yankee	0	30
World Bank		
Euros	0	0
Concentration		
Maximum in one issue		10%
Maximum in one issuer		10
Call constraints on corporate securities	Noncallable only	
Lot size		
Conditional minimum	$2,000,000 (par)	
Increment	$1,000,000 (par)	
Maximum	Unlimited	

*Single-A split-rated securities allowed.

It is also worth noting that the use of corporate securities, although providing higher yields, carries credit and call risks. If corporate securities are used in a dedicated portfolio, care must be taken to select call-protected securities that have a low probability of a credit downgrade. Although downgrades are always undesirable, the actual integrity of the cash-flow match is still preserved with a downgrade (or even a series of downgrades) as long as the issuer does not default.

It is only when the coupon or principal payments are not made on time or in full that the cash-flow match breaks down and the portfolio must be restructured.

Note also from Exhibit 48–2 that constraints on lot size are emphasized. Round-lot solutions (in lots of $2 million or more) are strongly preferred because the actual execution of the portfolio may be accomplished more efficiently without the added costs of odd-lot differentials. Also, as the dedicated portfolio is swapped or reoptimized over time, additional odd-lot premiums on the sale of such assets are avoided.

The Reinvestment Rate

Since the timing of cash receipts does not always exactly match the timing of cash disbursements, surplus funds must be reinvested at an assumed reinvestment rate until the next liability payout date. This reinvestment or rollover rate is vital because it is often preferable to prefund future benefit payments with higher-yielding securities rather than to purchase lower-yielding issues that mature closer to the liability payment dates. The more conservative the reinvestment rate, the greater the penalty for prefunding future benefit payouts and, therefore, the tighter the cash-flow match. The more aggressive the reinvestment rate, the greater the prefunding in optimal portfolios but the greater the risk of not earning that aggressive short-term reinvestment rate in a future period and experiencing a shortfall of cash. Though the current actuarial rates (investment return assumptions) range from 5% to 8%, the illustration that follows assumes a short-term reinvestment rate of only 3%.

Selecting the Optimal Portfolio

Once the liability schedule, the portfolio constraints, and the reinvestment rate(s) are specified, an optimal (least cost) portfolio can be structured for defeasance of the expected benefit payouts. The optimal portfolio is illustrated in Exhibit 48–3.

Assembling a dedicated portfolio that has a high probability of attaining its funding objectives over time requires restricting the universe of available issues. The fund manager must avoid questionable credits and, most important, avoid issues that may be called prior to maturity, have large sinking-fund call risk, or have significant prepayment risk. Retirement of issues prior to their stated maturity, whether through default or call, jeopardizes the funding of the liability schedule. As a result, most current coupon-callable bonds and non-PAC CMO bonds are not appropriate for matched portfolios.

The logic used to select the optimal or least-cost portfolio varies among purveyors of the cash-flow-matching service. Three methods are used to identify an "optimal" portfolio. In order of sophistication, they are stepwise solutions, linear programming, and integer programming. Of the three, integer programming is the most technically advanced and is able to identify the lower-cost round-lot solution.

The Cash-Flow Match

Exhibit 48–4 summarizes the cash-flow match inherent in the dedicated portfolio in our example. Note that in every year the cash flow from the maturing principal

EXHIBIT 48–3

Proposed Optimal Dedicated Portfolio

Par ($000)	Moody	S&P	Security	Coupon	Maturity	Price	Market Yield	WAL	Duration Nominal	Duration Effective	Market Value ($000)
5,000	GOV	GOV	United States	5.000	12/31/1993	101.266	3.849	1.1	1.08	1.08	5,154
5,500	GOV	GOV	United States	7.625	12/31/1994	106.078	4.604	2.1	1.92	1.93	5,986
5,500	GOV	GOV	United States	11.500	11/15/1995	117.406	5.186	3.0	2.48	2.50	6,765
5,000	AGN	AGN	Federal Home L	8.600	11/13/1996	104.406	7.312	4.0	3.23	3.27	5,432
4,500	GOV	GOV	United States	8.875	11/15/1997	111.750	6.118	5.0	3.93	4.01	5,223
4,500	GOV	GOV	Resolution FDG	0.000	10/15/1998	67.753	6.676	5.9	5.74	5.91	3,049
3,000	Aaa	AAA	Southern RY CO	8.350	12/15/1999	105.411	7.356	7.1	5.18	5.30	3,263
3,500	A3	A	Shearson Lehma	9.875	10/15/2000	106.992	8.637	7.9	5.49	5.61	3,769
2,000	A3	A	Westpac BKG CO	9.125	8/15/2001	101.854	8.813	8.8	5.86	5.99	2,080
1,000	A3	A+	Firemans PD MI	8.875	10/15/2001	103.392	8.327	8.9	6.11	6.25	1,040
1,500	A3	A	Skandinaviska	8.450	5/15/2002	99.302	8.558	9.5	6.18	6.34	1,551
2,000	A3	A	Westpac BKG CO	7.875	10/15/2002	93.878	8.809	9.9	6.61	6.79	1,895
3,500	Aa2	AA–	National West M	9.375	11/15/2003	108.579	8.178	11.0	6.70	6.85	3,960
3,500	A2	A–	Svenska Handel	8.350	7/15/2004	97.306	8.719	11.7	7.10	7.26	3,504
5,000	A3	A	Shearson Lehma	11.625	5/15/2005	119.891	8.950	12.5	6.74	6.86	6,277
3,500	Aaa	AAA	General Elec	7.875	12/1/2006	100.378	7.829	14.1	8.14	8.33	3,635
4,000	Aa1	AA	Bell Tel CO PA	7.375	7/15/2007	89.569	8.640	14.7	8.29	8.47	3,677
5,000	A2	A	K Mart Corp	6.000	1/1/2008	80.752	8.893	10.6	6.94	7.08	4,145
4,000	A3	AA–	Berkley W R CO	9.875	5/15/2008	111.226	8.554	15.5	7.92	8.07	4,641
5,000	Aa1	AAA	General RE	9.000	9/12/2009	104.713	8.467	16.8	8.66	8.83	5,308

EXHIBIT 48–3

(Continued)

Par ($000)	Moody	S&P	Security	Coupon	Maturity	Price	Market Yield	WAL	Duration Nominal	Duration Effective	Market Value ($000)
4,500	A2	A	May Dept Store	10.625	11/1/2010	117.564	8.677	18.0	8.66	8.81	5,302
5,000	A1	A+	Hillenbrand In	8.500	12/1/2011	99.225	8.582	19.1	8.98	9.16	5,149
4,500	A3	A–	Norsk Hydro	9.000	4/15/2012	102.500	8.729	19.4	9.17	9.34	4,641
500	Aaa	AAA	General Elec	8.125	5/15/2012	99.184	8.209	19.5	9.32	9.52	514
5,000	AGN	AGN	Financing Corp	0.000	12/27/2013	16.618	8.676	21.1	20.25	22.25	831
4,000	AGN	AGN	Financing Corp	0.000	12/27/2014	15.217	8.691	22.1	21.21	23.56	609
4,000	A3	A–	NCNB Corp	10.200	7/15/2015	111.389	9.010	22.7	9.14	9.29	4,586
5,000	Aa2	AA	Southern Ind G	8.875	6/1/2016	99.740	8.901	23.6	9.43	9.61	5,183
3,000	AGN	AGN	Financing Corp	0.000	11/30/2017	11.808	8.711	25.1	24.01	27.87	354
3,500	AGN	AGN	Financing Corp	0.000	9/26/2018	11.036	8.701	25.9	24.80	29.25	386
3,000	AGN	AGN	Federal Natl M	0.000	10/9/2019	10.281	8.634	26.9	25.80	31.16	308
3,500	A2	A	Ford Hldgs	9.375	3/1/2020	105.244	8.860	27.3	9.98	10.18	3,746
5,000	A3	A	Dayton Hudson	9.700	6/15/2021	109.229	8.810	28.6	9.90	10.10	5,657
5,000	A3	AA–	Berkley W R Co	8.700	1/1/2022	97.752	8.916	29.1	10.05	10.27	5,043
2,500	GOV	GOV	Resolution FDG	0.000	10/15/2024	7.519	8.271	31.9	30.66	40.31	188
3,000	GOV	GOV	Resolution FDG	0.000	10/15/2025	7.000	8.241	32.9	31.63	41.30	210
1,500	GOV	GOV	Resolution FDG	0.000	10/15/2026	6.520	8.211	33.9	32.59	42.28	98
139,000	Aa2	AA+		6.942	16.0 years	86.213	7.835	15.8	7.14	7.37	123,160

when added to the coupon income from all securities in the portfolio and the reinvestment income will almost precisely equal the liability requirements specified by the actuary in Exhibit 48–1. Since almost all cash flow is paid out each month to fund the liability payment, the portfolio has very little cash to reinvest each period and hence assumes very little reinvestment risk. The plan therefore can lock in a rate of over 7.83%—the rate prevailing at the time this analysis was prepared—regardless of the future course of rates.

In this illustration, the computer model has controlled reinvestment risk by structuring relatively small surplus positions in most years. However, the model sometimes prefunds distant payouts by reinvesting the proceeds of high-yielding, shorter-maturity issues at the low reinvestment rate. This is frequently preferable to purchasing bonds with longer maturities and better matching characteristics but with lower yields to maturity. Note from Exhibit 48–4 that the larger amount of prefunding in the years 2021 and 2022 is due to the lack of high-yielding call-protected issues in subsequent years.

Pricing the Bonds

Notice in Exhibit 48–4 that neither prices nor yields appear in the analysis. A dedicated portfolio is concerned only with cash flows. As long as all coupon payments are made in a timely fashion and every bond matures on schedule, the liabilities specified by the actuary will be funded. Though credit ratings on some bonds in a portfolio may deteriorate over time and their market prices drop markedly, the integrity of the dedicated design is preserved as long as cash-flow payments are complete and punctual.

Prices and yields enter the analysis only in determining the initial cost of the optimal portfolio as seen in Exhibit 48–3. In this illustration, all bonds were priced as of November 6, 1992.

The Savings to the Pension Plan

As illustrated in Exhibit 48–5, using the actuarial investment rate assumption of 5%, the plan must have on hand $159,818,000 in order to fully fund the $283,758,000 of payouts to retired lives. On the basis of the November 6, 1992, pricing, the portfolio can, with a yield of 7.83%, fully fund the same $283,758,000 in liability payouts with an initial investment of only $123,160,000. Purchase of this portfolio generally would give the actuary the comfort level necessary to increase the assumed actuarial investment rate on the retired-lives portion of the fund. In many cases, this increase may go all the way to the funding rate of 7.83%.

By raising the assumed rate from 5% to 7.83% on the retired portion of the plan, the plan sponsor has reduced the present value of the accumulated plan benefits by $36,658,000. This long-term actuarial gain or potential savings of $36.7 million represents a 23% reduction from the higher present value required under a 5% actuarial assumption.

EXHIBIT 48–4

Proposed Dedicated Portfolio: Yearly Cash-Flow Summary (Amounts in $000)

Period Ending	Beginning Balance	Maturing Principal	Coupon Income	Reinvestment Income	Cash Flow Available	Liability Schedule	Ending Balance
12/31/1992	0	0	2,740	8	2,748	1,250	1,498
12/31/1993	1,498	5,000	9,661	176	16,335	15,000	1,335
12/31/1994	1,335	5,500	9,399	169	16,403	14,916	1,487
12/31/1995	1,487	5,500	8,979	192	16,158	14,427	1,730
12/31/1996	1,730	5,000	8,347	190	15,268	13,446	1,822
12/31/1997	1,822	4,500	7,917	186	14,424	12,435	1,989
12/31/1998	1,989	4,500	7,517	197	14,204	11,754	2,450
12/31/1999	2,450	3,500	7,502	202	13,654	11,385	2,270
12/31/2000	2,270	4,000	7,222	212	13,703	11,028	2,675
12/31/2001	2,675	3,500	6,846	226	13,247	10,555	2,692
12/31/2002	2,692	4,000	6,482	232	13,406	10,409	2,998
12/31/2003	2,998	4,000	6,231	210	13,439	10,366	3,072
12/31/2004	3,072	4,000	5,873	243	13,188	10,236	2,952
12/31/2005	2,952	5,500	5,260	277	13,989	9,953	4,036
12/31/2006	4,036	4,000	4,939	218	13,193	9,670	3,523
12/31/2007	3,523	4,500	4,634	245	12,902	9,302	3,600
12/31/2008	3,600	4,500	4,111	261	12,471	8,748	3,723
12/31/2009	3,723	5,000	3,899	215	12,836	8,621	4,215
12/31/2010	4,215	4,500	3,449	199	12,363	8,210	4,153

EXHIBIT 48–4

(Continued)

Period Ending	Beginning Balance	Maturing Principal	Coupon Income	Reinvestment Income	Cash Flow Available	Liability Schedule	Ending Balance
12/31/2011	4,153	5,000	2,970	182	12,305	7,894	4,412
12/31/2012	4,412	5,000	2,323	277	12,011	7,435	4,576
12/31/2013	4,576	5,000	2,100	173	11,849	6,994	4,855
12/31/2014	4,855	4,000	2,100	181	11,136	6,579	4,557
12/31/2015	4,557	4,000	2,100	226	10,883	6,146	4,737
12/31/2016	4,737	5,000	1,470	254	11,461	5,733	5,729
12/31/2017	5,729	3,000	1,248	200	10,177	5,323	4,855
12/31/2018	4,855	3,500	1,248	194	9,797	4,983	4,814
12/31/2019	4,814	3,000	1,248	185	9,247	4,616	4,632
12/31/2020	4,632	3,500	1,084	246	9,462	4,257	5,205
12/31/2021	5,205	5,000	677	253	11,135	3,892	7,243
12/31/2022	7,243	5,000	217	377	12,837	3,538	9,299
12/31/2023	9,299	0	0	281	9,581	3,217	6,364
12/31/2024	6,364	2,500	0	208	9,072	2,935	6,137
12/31/2025	6,137	3,000	0	205	9,342	2,660	6,682
12/31/2026	6,682	1,500	0	211	8,393	2,385	6,008
12/31/2027	6,008	0	0	182	6,190	2,124	4,066
12/31/2028	4,066	0	0	123	4,189	1,337	2,852
TOTAL		139,000	139,794	7,817		283,758	

EXHIBIT 48–5

Reduced Funding Requirements

	Percent	Dollar Amount
1. Total liabilities	—	$283,758,000
2. Present value of total liabilities at	5.00	159,818,000
3. Portfolio cost (market value) at	7.83	123,160,000
4. Potential savings (2–3)	—	36,658,000
Percent savings (4/2)	22.94	—
Percent savings (4/3)	29.76	—

Increasing the assumed rate on the retired-lives portion of the pension fund decreases the present value of the funds promised as future payouts, thus reducing the actuarial liability. Reductions in actuarial liability usually translate into reductions in the current contribution requirements. The reduction in current contribution owing to the dedicated strategy can be substantial.

In our example, the reduction in actuarial liability is $36.7 million. This amount cannot be realized in the form of a reduced contribution all in the first year. Pensions and tax legislation require that the gain be spread over 10 to 30 years. With all other factors remaining constant, the reduction in pension contribution might amount to a couple million dollars per year for each of the next 10 years. However, since every pension plan is different, and different actuarial cost methods treat gains differently, the actual savings to a plan may be of a different magnitude than represented by this example.

Reoptimizing a Dedicated Bond Portfolio

It was thought originally that once a dedicated portfolio was structured, it should be managed passively, that is, left untouched as assets roll off in tandem with liabilities. Active management techniques can, however, be applied to dedicated portfolios. In addition to bond-for-bond swapping and active sector positioning of the portfolio, a cash-matched solution can be entirely reoptimized on a periodic basis.

For example, a portfolio that was "optimized" last year, in last year's rate environment, is not an optimal portfolio in today's rate environment, with a new yield curve, new yield spreads, and new available issues. As seen in Exhibit 48–6, a new least-cost portfolio can be created one year later to fund the same liability schedule with the same portfolio constraints. Since the new optimal portfolio will be less expensive than the old, a cash takeout can be generated by selling off a portion of the original portfolio and replacing the cash insufficiencies with a new combination of securities. When the takeout is significant, such trades are usually executed.

EXHIBIT 48–6

Takeout from Reoptimizations

	Market Value (000)	Average Rating	Takeout (000)
Original dedicated portfolio	$100,000	Aaa/AA+	—
Reoptimized dedicated portfolio (marked to market 1 year later)	99,400	Aaa/AA+	$600

The takeout generated by the computer solution can be guaranteed if the reoptimization is executed through a dealer firm. Frequently, money managers and third-party software vendors work in conjunction with dealer firms to obtain a trader-priced database and guaranteed takeouts. On the other hand, if a reoptimization is simulated on a database of matrix (computer-derived) prices, the takeout may disappear when market prices are obtained in the actual execution.

Note that the new optimal portfolio will always be cheaper than the original portfolio. If the computer is not able to find a portfolio that is cheaper than the original, it will select the original portfolio again, establishing that it is still the optimum.

Active Management of Dedicated Portfolios

In addition to the use of comprehensive reoptimizations to add value, bond swaps can be undertaken to pick up yield or to swap out of an undesirable credit. To preserve the integrity of the dedicated portfolio, however, the cash flows associated with the bond being sold must be replaced with those from the bond (or bonds) being purchased. Thus bonds with identical coupons and maturities or bonds with higher coupons and similar maturities can be swapped. Bonds with similar coupons and slightly earlier maturities also can be swapped, provided that an additional cash pay-up is not required.

In addition to swapping, an active manager might add significant value by actively positioning a new dedicated portfolio in cheap sectors of the market. As spreads change, the optimized portfolio automatically will overweight the newly cheapened sectors of the market and underweight the rich ones.

For example, suppose that an existing $100 million dedicated portfolio could be reoptimized, using the same set of constraints, into a $99.4 million portfolio with a $600,000 takeout. Suppose further that the portfolio manager believes that corporate spreads will widen over the next few months. The manager might desire to temporarily upgrade the portfolio from the current average rating of double-A, await the anticipated spread changes, and then reverse the trade at a later date.

EXHIBIT 48–7

Maximize Quality

	Market Value (000)	Average Rating	Takeout (000)
Original dedicated portfolio	$100,000	Aaa/AA+	—
Reoptimized dedicated portfolio (minimum cost)	99,400	Aaa/AA+	$600
Reoptimized dedicated portfolio (maximum quality)	100,000	Treasury/Agency	—

In this situation, the optimal strategy is to spend the $600,000 takeout to buy a higher-quality portfolio. Rather than minimize cost, the portfolio can be optimized to maximize the quality rating, subject to the constraint of spending the full $100 million and cash-flow matching every liability payment. As shown in Exhibit 48–7, the average rating of the portfolio is increased by two rating categories, from double-A to agency.

Similarly, if rates are expected to rise, the portfolio could be positioned as short as possible by minimizing duration. In Exhibit 48–8, the duration of the portfolio has been shortened by almost 0.5 with a cash-flow match maintained. Alternatively, if rates are expected to fall, the $600,000 surplus in the portfolio could be used to maximize duration.

ROLE OF MONEY MANAGER AND DEALER FIRM

Both money managers and dealer firms have played important roles in managing and executing cash-flow-matched portfolios. There are advantages to selecting a

EXHIBIT 48–8

Minimize Duration

	Market Value (000)	Duration	Percent Decrease
Original dedicated portfolio	$100,000	5.4	—
Reoptimized dedicated portfolio (minimum cost)	99,400	5.4	—
Reoptimized dedicated portfolio (minimum duration)	100,000	4.9	8.3

money manager over a dealer firm (and vice versa) in implementing the dedicated strategy. For example, all portfolio optimizations require a database of bonds that is both priced and sized by traders. Most money managers have access only to matrix pricing (computer-derived pricing). When an optimizer is applied to a matrix-priced database of bonds, the optimizer will find the least-cost solution by identifying bonds that are cheap (owing to mispricing) and will select them in large blocks for the optimal solution. Since the computer-derived solution is not executable at the cheap levels specified in the database, the "least cost" solution is not optimal when executed at market rates.

Dealer firms and software vendors with dealer connections are best positioned to simulate, structure, and execute an optimal portfolio owing to the accurate pricing and sizing in their databases. However, because dealer firms are not fiduciaries, money managers are best suited to make the active management decisions about sector positioning, call protection, credit decisions, and spread forecasts. In addition, money managers are best suited to oversee the execution of reoptimizations with dealers.

In short, both dealers and money managers can add value to the process of structuring and reoptimizing dedicated portfolios.

CONCLUSION

Dedication is an important portfolio investment strategy for controlling interest-rate risk and for locking in prevailing market rates. For insurance companies with fixed liability products such as GICs or structured settlements, cash-flow matching and horizon matching (duration matching with cash matching of early payouts) has been a popular approach to lock in a spread (or profit) on the entire line of business.

For pension funds, the motivation has been to control market risk by fully funding or defeasing the more quantifiable retired liabilities of a plan and locking in a market rate that is well in excess of the actuarial investment return assumption. The plan sponsor can eliminate most funding risk (market risk) from a significant part of a plan's liability and eliminate market value fluctuations when reporting surplus asset (or unfunded liability) positions associated with that liability.

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CHAPTER

FORTY-NINE

INTERNATIONAL BOND PORTFOLIO MANAGEMENT

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Management of an international bond portfolio poses more varied challenges than management of a domestic bond portfolio. Differing time zones, local market structures, settlement and custodial issues, and currency management all complicate the fundamental decisions facing every fixed income manager in determining how the portfolio should be positioned with respect to duration, sector, and yield curve.

The fundamental activities in any investment management process are setting investment objectives, developing and implementing a portfolio strategy, monitoring the portfolio, and adjusting the portfolio. The added complexities of cross-border investing magnify the importance of a well-defined, disciplined investment process. This chapter is organized to address these challenges for the investment management process.

To provide a broad overview of the many aspects of international fixed income investing in one chapter implies that many topics do not receive the depth of discussion they deserve. For example, the topic of currency management is extensive, and we provide only the fundamental principles here. However, the

This chapter is adapted from Christopher B. Steward, J. Hank Lynch, and Frank J. Fabozzi, "International Bond Portfolio Management," Chapter 6 in Frank J. Fabozzi (ed.), *Fixed Income Readings for the Chartered Financial Analyst Program* (New Hope, PA: Frank J. Fabozzi Associates, 2004).

same principles involved with currency management also apply to international equity-portfolio management.

While many of the examples and illustrations in this chapter apply to international investing from the perspective of a U.S. manager investing in bond markets outside the United States, it is important to keep in mind that the principles apply to any cross-border manager investing outside her domestic bond market. The same issues faced by U.S. managers regarding currency management apply to managers throughout the world when they invest in bonds in which the cash flows are not denominated in their local currency.

INVESTMENT OBJECTIVES AND POLICY STATEMENTS

Most investors are attracted to global bonds as an asset class because of their historically higher returns than U.S. bonds. Others are drawn to global bonds because of their diversification value in reducing overall portfolio risk.[1] *An investor's rationale for investing in international bonds is central to developing appropriate return objectives and risk tolerances for a portfolio.*

Broadly speaking, investor specifications include return objectives and risk tolerances. Each of these investment objectives has implications for the management of an international bond portfolio and should be reflected in the investment policy statement.

Global bonds usually are a small part of an overall portfolio added for both return and diversification. The strategic asset allocation for the portfolio is made up of benchmarks that both define the asset class and provide a performance target that each investment manager strives to outperform. Return objectives often are expressed in terms of the benchmark return, for example, benchmark return plus 100 basis points over a market cycle. The return objectives and risk tolerances will indicate not only the most appropriate benchmark but also the most suitable investment management style. Investors who are concerned primarily with diversification may wish to place tight limits on the sizes of positions taken away from the benchmark to ensure that diversification is not weakened. A total-return-oriented

1. Some investors were concerned that the diversification benefits of global bond investing would be substantially diminished by the commencement of European Monetary Union (EMU) in 1999. But, in fact, the economies of continental Europe were already very closely tied together before EMU, with most European central banks following the interest-rate policies of the German Bundesbank for several years before the move to a single currency. Thus the impact on diversification of a global bond portfolio caused by EMU has been a small one. EMU, however, has created a much more robust credit market in Europe as issuers and investors, no longer confined to their home markets, have access to a larger, more liquid pan-European bond market. Corporate bond issuance has increased sharply in Europe and seems likely to continue, building toward a broader range of credits and instruments similar to those available in the U.S. bond market.

investor might be far less concerned with diversification and focused on absolute return rather than on benchmark relative return.

Investment policy statements should be flexible enough to allow the portfolio manager sufficient latitude for active management while keeping the portfolio close enough to the benchmark to preserve the desired top-down asset allocation. The policy statements should address allowable investments, including

1. The countries in the investment universe, including emerging markets
2. Allowable instruments, including mortgages, corporate bonds, asset-backed securities, and inflation-adjusted bonds
3. Minimum credit ratings
4. The currency benchmark position and risk limits
5. The use of derivatives such as forwards, futures, options, swaps, and structured notes

The time horizon for investment performance is also important. A short-term time horizon, such as a calendar quarter, may encourage more short-term trading, which could diminish the natural diversification benefit from international bonds as an asset class. Investors who emphasize the risk-reduction or diversification aspect of international bond investing should have a longer time horizon of perhaps three to five years. Since economic cycles can be prolonged, this provides enough time for a full economic cycle to add any diversification benefit.

Benchmark Selection

Benchmark selection for an international bond portfolio has many ramifications and should be done carefully. As is the case when choosing an international equity benchmark index, the choice of a pure capitalization (market value) weighted index may create a benchmark that exposes the investor to a disproportionate share in the Japanese[2] market relative to the investor's liabilities or diversification preferences.[3] While international equity indexes chosen for benchmarks are most often quoted in the investor's local currency (i.e., unhedged), international bond benchmarks may be hedged, unhedged, or partially hedged depending on the investor's objectives. The choice of a hedged, unhedged, or partially hedged benchmark likely will alter the risk and return profile of the investment portfolio and should reflect the rationale for investing in international bonds.

2. The Japanese bond market historically has offered lower yields than most other bond markets.
3. While in the equity market growth in a company's market capitalization generally indicates financial strength, a company or country that issues a large amount of debt (especially relative to its equity in the case of a company or gross national product in the case of a country) may find itself in a more precarious financial position.

Available Benchmarks

Benchmarks can be selected from one or a combination of the many existing bond indexes:

- Global (all countries, including home country)
- International (ex-home country)
- Government-only
- Multisector or broad (including corporates and mortgages)
- Currency-hedged
- G7 only
- Maturity constrained, e.g., 1 to 3 years, 3 to 5 years, 7 to 10 years
- Emerging markets

Alternatively, a customized index or "normal" portfolio can be created.

The most frequently used fixed income benchmarks are the *Citigroup World Government Bond Index* (*WGBI*) and the *Lehman Global Aggregate*. As discussed earlier, the benchmark often provides both the return objective and the measure of portfolio risk.

Benchmark Currency Position

Currency management is a matter of much debate in the academic literature. Investing internationally naturally generates foreign currency exposures. These currency exposures can be managed either passively or actively, although most global bond managers use active management to some degree.

Many managers are attracted to active currency management because of the large gains that can be attained through correctly anticipating currency movements. Since currency returns are much more volatile than bond market returns, even modest positions in currencies can result in significant tracking error. Traditionally, the bond manager has handled both bond and currency exposures assuming that the same fundamental economic factors (identified later in this chapter) influence both bond yields and currency levels. However, many managers are hiring foreign exchange specialists because bonds and currencies can behave quite differently in reaction to the same stimulus. Both the risks and opportunities posed by currency movements suggest that some specialization in currency is warranted and that a joint optimization of the bond and currency decision provides better risk-adjusted returns.[4] Research also has shown that active management by currency specialists can consistently add to returns.

4. See Philippe Jorion, "Mean/Variance Analysis of Currency Overlays," *Financial Analysts Journal* (May–June 1994), pp. 48–56. Jorion argues that currency overlays, although they can add value, are inferior to an integrated approach to currency management.

The first task is to determine the neutral or strategic foreign currency exposure appropriate for the investment objectives. Most of the academic research on currency hedging for U.S. dollar–based investors suggests that a partially hedged benchmark offers superior risk-adjusted returns as compared with either a fully hedged or unhedged benchmark.[5] This research has led some to recommend a 50% hedged benchmark for either a passively managed currency strategy or as a good initial hedged position for an active currency manager. Once the benchmark has been selected, a suitable currency hedge position needs to be determined. For example, a U.S. dollar–based fixed income manager whose primary goal is risk reduction might adopt a hedged or mostly hedged benchmark that has historically shown greater diversification benefit from international bonds. Despite a higher correlation with the U.S. bond market than unhedged international bonds, hedged international bonds offer better risk reduction owing to a lower standard deviation of bond returns than a U.S.-only bond market portfolio.[6] In addition, this lesser volatility of hedged international bonds results in more predictable returns. Conversely, an investor who has a total-return objective and a greater risk tolerance would be more likely to adopt an unhedged or mostly unhedged benchmark and allow more latitude for active currency management.

From the perspective of a U.S. investor, Exhibit 49–1 shows that for the 18-year period 1985–2002 the currency component of investing in unhedged international bonds accounted for much of the total return volatility. The international bond index used is the Citigroup WGBI excluding the United States (denoted by "non-U.S. WGBI"). Investing in international bonds on a hedged basis reduced the return in most periods but also substantially reduced the return volatility. As can be seen in Exhibit 49–1, over the 18-year history of the WGBI, hedged international bonds returned less than unhedged international bonds and even lagged the U.S. component of the WGBI slightly. However, the volatility of the hedged non-U.S. WGBI was one-third that of the unhedged index and three-quarters that of the U.S. component.

To compare returns on a risk-adjusted basis, we can use the Sharpe ratio.[7] Despite the higher return of the unhedged non-U.S.- WGBI, its risk-adjusted return was lower than the hedged index and the U.S. bond component alone for the 1985 through 2002 period.

As noted earlier, using a 50% hedged portfolio offers a compromise in that its return is virtually midway between the return of the unhedged non-U.S. WGBI

5. See Gary L. Gastineau, "The Currency Hedging Decision: A Search for Synthesis in Asset Allocation," *Financial Analysts Journal* (May–June 1995), pp. 8–17 for a broad overview of the currency hedging debate. For a full discussion of the benefits of utilizing a partially hedged benchmark, see the currency discussion in Steve Gorman, *The International Equity Commitment* (Charlottesville, VA: AIMR, 1998).

6. Recall from modern portfolio theory the important role of correlation in determining the benefits from diversification.

7. The Sharpe ratio measures returns in excess of the risk-free rate per unit of standard deviation.

EXHIBIT 49–1

Hedged and Unhedged Returns: 1985–2002

	Non-U.S. WGBI	U.S.	Non-U.S. WGBI Hedged	50% Hedged
1985–2002				
Return	10.66%	9.17%	8.49%	9.69%
Volatility	10.4%	4.9%	3.4%	6.2%
Sharpe	0.47	0.71	0.82	0.64
1985–1990				
Return	18.23%	11.27%	8.01%	13.18%
Volatility	13.6%	6.0%	4.3%	8.4%
Sharpe	0.77	0.60	0.07	0.65
1991–1996				
Return	10.78%	8.23%	9.49%	10.23%
Volatility	8.6%	4.3%	3.2%	5.0%
Sharpe	0.69	0.78	1.44	1.09
1997–2002				
Return	3.46%	8.05%	7.97%	5.78%
Volatility	8.6%	4.3%	2.4%	4.8%
Sharpe	–0.14	0.80	1.38	0.24

Source: Exhibit 1 in Christopher B. Steward, J. Hank Lynch, and Frank J. Fabozzi, "International Bond Portfolio Management," Chapter 6 in Frank J. Fabozzi (ed.), *Fixed Income Readings for the Chartered Financial Analyst Program* (New Hope, PA: Frank J. Fabozzi Associates, 2004).

and the U.S. bond component with substantially lower volatility than the unhedged index, giving it a higher Sharpe ratio than the unhedged index. Of course, the relative performance of the hedged versus the unhedged index depends on the performance of the home currency (here the U.S. dollar), which can experience long cycles of strength or weakness.

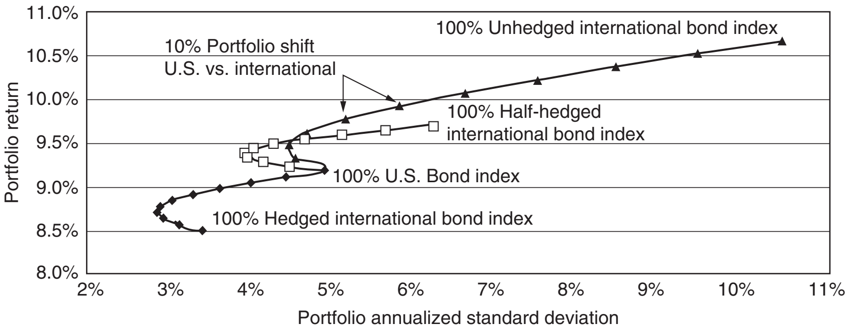
The advantage of using a partially hedged benchmark versus a fully hedged or fully unhedged benchmark is illustrated in a mean-variance framework in Exhibit 49–2. The 50% hedged portfolio offers better diversification with some small reduction in return when a modest allocation to international bonds is added to U.S. bond portfolios.

Risk Limits

Many investment guidelines will include explicit risk limits on bond and currency positions as well as duration and credit risk. Exposure limits can be expressed either as absolute percentages or as weights relative to a benchmark. Increasingly, tracking error limits also have been used to set risk limits in investment guidelines.

EXHIBIT 49–2

Risk-Return for Unhedged and Hedged International Bond Portfolios (U.S. Investor Perspective) Using 1985–2002 Historical Returns



Source: Exhibit 2 in Christopher B. Steward, J. Hank Lynch, and Frank J. Fabozzi, "International Bond Portfolio Management," Chapter 6 in Frank J. Fabozzi (ed.), *Fixed Income Readings for the Chartered Financial Analyst Program* (New Hope, PA: Frank J. Fabozzi Associates, 2004).

Bond markets are often divided into four trading blocs: dollar bloc (the United States, Canada, Australia, and New Zealand), European bloc, Japan, and emerging markets. The European bloc is subdivided into two groups: (1) Euro zone market bloc, which has a common currency (Germany, France, Holland, Belgium, Luxembourg, Austria, Italy, Spain, Finland, Portugal, and Greece), and (2) non-Euro zone market bloc (Norway, Denmark, and Sweden). The United Kingdom often trades more on its own, influenced by both the Euro zone and the United States, as well as its own economic fundamentals.

The trading-bloc construct is useful because each bloc has a benchmark market that greatly influences price movements in the other markets. Investors often are focused more on the spread level of, say, Denmark to Germany, than on the absolute level of yields in Denmark. [Since the beginning of the European Monetary Union (EMU) in 1999, the Euro zone bond markets have traded in a much tighter range.]

Limits on investment in countries outside the benchmark also should be specified at the outset. Despite the pitfalls of using duration to measure interest-rate risk across countries, risk limits on duration are nonetheless useful and should be established. The range of allowable exposures is often wider for bond exposures than for currency exposures.

Credit-risk limits, usually a minimum-weighted-average credit rating from the major credit rating agencies, and limits on the absolute amount of low- or non-investment-grade credits also should be included. Apart from default risk, the illiquidity of lower-rated securities may hamper a manager's ability to alter exposures as desired. In the past, owing to the lack of a liquid corporate bond market in many countries and the relative illiquidity of Eurobonds compared with domestic government bond markets, most credit risk in international bond portfolios was concentrated in U.S. and emerging market bonds. However, this difference in liquidity between U.S. corporate bonds and those in other countries has diminished significantly in recent years owing to strong growth in the European corporate bond market since EMU.

DEVELOPING A PORTFOLIO STRATEGY

Once the investment policy statement is established, the portfolio manager needs to develop a portfolio strategy appropriate to the investor's objectives and risk tolerances. Just as in many other areas of investment management, portfolio managers often subscribe to different management styles or investment disciplines.

The performance of most portfolio managers is judged against the benchmark return. There are a number of means by which portfolio managers can add to returns; however, the bulk of excess returns relative to the benchmark comes from broad bond market and currency allocation decisions. A disciplined investment approach based on fundamental economic factors or market indicators of value facilitates the market and currency selection process. Because of the historically high volatility of currency returns, the approach to currency management is a primary concern.

Styles of International Bond Portfolio Management

The challenges faced by international fixed income managers are different from those facing domestic fixed income managers. First, the international fixed income portfolio manager must operate in the U.S. bond market plus 10 to 20 other markets, each with their own market dynamics. Second, changes in interest rates generally affect different sectors of the U.S. bond market in much the same way (with the exception of mortgage-backed securities), although the magnitude of the changes may vary. Like the equity market, where it is not unusual to have some industries or market sectors move in opposite directions, international bond markets also may move in different directions depending on economic conditions and investor risk tolerances.

International bond managers also use one or more different management styles. These can be divided into four general categories: the experienced trader, the fundamentalist, the black box, and the chartist. We discuss each management style below.

The *experienced trader* uses her experience and intuition to identify market opportunities. The experienced trader tends to be an active trader, trying to anticipate the next market shift by international fixed income and hedge fund managers. The basis for these trades is derived from estimates of competitors' positions and risk tolerances bolstered by observation of market price movements and flow information. The experienced trader is often a contrarian, looking to profit from situations where many investors may be forced to stop themselves out of losing positions.

The *fundamental style* rests on a belief that bonds and currencies trade according to the economic cycle. Sector rotation within corporate bonds also will be affected by the economic cycle as different sectors perform relatively better at different points in the cycle. Some of these managers believe that the economic cycle is forecastable and rely mostly on economic analysis and forecasts in selecting bond markets and currencies. These managers tend to have less portfolio turnover because the economic fundamentals have little impact on short-term price movements. "Bottom-up" security selection in corporate bonds could also be characterized as a fundamentalist approach, even though it rests on issuer-specific fundamental analysis rather than on broad economic fundamentals.

The *black-box approach* is used by quantitative managers who believe that computer models can identify market relationships that people cannot. These models can rely exclusively on economic data, price data, or some combination of the two. Quantitative managers believe that using computer models can create a more disciplined investment approach that, because of other managers' emotional attachment to positions, their lack of trading disciplines, or their inability to process more than a few variables simultaneously, will provide superior investment results.

Some investors called chartists, technical analysts, or technicians may rely primarily on technical analysis to determine which assets to buy or sell.[8] Chartists will look at daily, weekly, and monthly charts to try to ascertain the strength of market trends or to identify potential turning points in markets. Trend-following approaches, such as moving averages, aim to allow the portfolio manager to exploit market momentum. Countertrend approaches, such as relative-strength indexes and oscillators, try to identify when recent price trends are likely to reverse.

Very few international bond portfolio managers rely on only one of these management styles but instead use some combination of each. Investment managers that rely on forecasts of the economic cycle to drive their investment process will from time to time take positions contrary to their medium-term strategy to take advantage of temporary under- or overvaluation of markets identified by technical analysis or estimates of market positions. Even "quant shops" that rely heavily on computer models for driving investment decisions will sometimes override the model's decisions and look to other management styles to add incremental returns. Regardless of the manager's investment style, investment decisions must be consistent with the investor's return objectives and risk tolerances and within the investment guidelines.

International bond portfolio managers would do well to maintain a disciplined approach to buy and sell decisions. This would require each allocation away from the benchmark to have a specified price target (or more often yield spread or exchange-rate level) and stated underlying rationale. Depending on the management style, the size of the position should reflect the strength of the

8. Technical analysis is covered in many equity management textbooks.

investor's conviction or model's signal. As long as the investment rationale that supported the initial decision remained unchanged, the position would be held or potentially increased if the market moves in the opposite direction. Each trade should be designed with consideration for the relevant bond yield or exchange rate's behavior through time. For example, an exchange rate that exhibits a tendency to trend will require a different buy and sell discipline than one that tends to consistently revert back to an average level.

Sources of Excess Return

The baseline for any international bond portfolio is the benchmark. However, in order to earn returns in excess of the benchmark, after management fees, the portfolio manager must find ways to augment returns. These excess returns can be generated through a combination of five broad strategies:

1. Currency selection
2. Duration management/yield-curve plays
3. Bond market selection
4. Sector/credit/security selection
5. Investing in markets outside the benchmark (if permitted)

Each of these strategies can add to returns; however, currency and bond market selections generally provide the lion's share of returns. We discuss each of these sources of excess return below.

Currency Selection

Most investment guidelines allow for some active management of currency exposures. The attraction of active currency management is strong because potential gains are so large. Historically, the spread between the top- and bottom-performing bond markets in local-currency terms has been 13%, on average. When currency movements are added to the local currency bond market returns, the average spread between the best- and worst-performing markets more than doubles to 28%. Thus, international bond portfolio managers may enhance returns significantly by overweighting the better-performing bond markets and currencies in the index.

Since the volatility of currency returns is generally higher than that of bond market returns, the incremental returns gained from currency exposures must be evaluated relative to the additional risk incurred. For an active currency management strategy to consistently provide superior risk-adjusted performance, a currency forecasting method is required that can predict future spot rates (i.e., future exchange rates) better than forward foreign exchange rates (i.e., rates that can be locked in today using the market for forward contracts). Forward foreign exchange rates are not forecasts of future spot foreign exchange rates but are determined by short-term interest-rate differentials between currencies.

Academic studies have shown that several strategies have been successful in generating consistent profits through active currency management. The fact that forward foreign exchange rates are poor predictors of future spot exchange rates is well established. Historically, discount currencies (i.e., those with higher interest rates than the investor's local currency) have depreciated less than the amount implied by the forward rates, providing superior returns from holding unhedged positions in currencies with higher short-term interest rates. Overweighting currencies with high real interest rates versus those with lower real interest rates also has been shown to provide incremental returns.[9]

In addition, some currency movements are not a random walk but exhibit serial correlation (i.e., currency movements have a tendency to trend).[10] In a market that tends to trend, simple technical trading rules may provide opportunities for incremental currency returns.[11] These findings in several academic studies demonstrate that excess currency returns can be generated consistently, providing a powerful incentive for active currency management.

Duration Management

Although closely aligned with the bond market selection decision, duration management also can enhance returns. Bullet versus barbell strategies in a curve-steepening or -flattening environment within a particular country's bond market can enhance yield and total return. In addition to these strategies that are also available to managers investing in their domestic bond market, the international fixed income portfolio manager has the option of shifting duration between markets while leaving the portfolio's overall duration unchanged.

Duration management has become easier in international markets in recent years. Many countries have concentrated their debt in fewer, more liquid bond issues. Official strip markets (which separate government bond cash flows into individual interest and principal payments) now exist in at least nine countries. Interest-rate futures, available in most markets, offer a liquid and low-cost vehicle for changing duration or market exposure quickly. The interest-rate swaps market, used extensively by large institutional investors, is generally very liquid across international bond markets. Following EMU, the swap curve, rather than

9. See Gastineau, "The Currency Hedging Decision," pp 13–14.

10. One suggestion as to why currency markets trend is that central banks attempt to smooth foreign exchange-rate movements through intervention. Thus, because central bank participation in the foreign exchange market is not motivated by profit, their actions keep the market from being truly efficient. See Robert D. Arnott and Tan K. Pham, "Tactical Currency Allocation," *Financial Analysts Journal* (May–June 1993), pp. 47–52.

11. See Richard M. Levich and Lee R. Thomas, "The Merits of Active Currency Risk Management: Evidence from International Bond Portfolios," *Financial Analysts Journal* (September–October 1993), pp. 63–70.

individual country yield curves, has been used increasingly as a reference or benchmark. Increasingly, countries have set up professional debt-management offices that are independent from both central banks and finance ministries. These debt-management offices have become significant users of derivatives themselves to minimize borrowing costs, alter the maturity structure or currency composition of outstanding debt, and promote liquidity in their domestic market.[12]

Bond Market Selection

Excess returns over the benchmark index from overweighting the best-performing bond markets can be extremely large. As we saw earlier, the annual local currency return differential between the best- and worst-performing developed bond markets has been 13% on average, providing significant opportunity for generating excess returns.

Sector/Credit/Security Selection

The corporate bond market experienced significant growth in many countries, especially in Europe following EMU. According to data collected by Merrill Lynch on the size and structure of the world bond market, government bonds account for 55% of the $30 trillion market for developed country bonds. Corporate bonds account for 25% of the bond market (or about 20% excluding the United States). Some global bond indexes include only government bonds, but others, like the Lehman Global Aggregate and the Citigroup Global Broad Investment Grade Indexes, include other instruments, including corporate bonds and mortgages.

Investing in Markets Outside the Index

If allowed by investment guidelines, allocating assets to markets outside the index can enhance returns significantly without dramatically altering the risk profile of the portfolio. Here are two examples: First, Finland was one of the best-performing bond markets during 1995, but because of its small size, it was not included in the Citigroup World Government Bond Index (WGBI) until June 1996. Second, investing in emerging markets debt as represented by the J.P. Morgan EMBI+ Index would have boosted returns substantially in 1999 and 2000 when it outperformed all developed bond markets in both local currency terms and on a U.S. dollar basis.[13]

The process for selecting an out-of-index market is similar to that followed by an active manager for a domestic bond portfolio when deciding whether or not

12. See "OECD Public Debt Markets: Trends and Recent Structural Changes" OECD 2002.
13. The J.P. Morgan EMBI+ Index is comprised of mostly U.S. dollar–denominated sovereign debt issued by emerging market countries. Therefore, credit risk and to a lesser extent interest-rate risk are the predominate risks associated with the index. For a U.S. investor, currency risk is virtually zero.

to construct a portfolio with allocations different from the benchmark index and whether or not to invest outside the index. The manager will assess the potential performance on a total-return basis of the markets outside the index relative to that of the markets to be underweighted in order to allocate funds to out-of-index markets. An international bond portfolio manager, however, also must take into account the effect of currency movements and hedging decision of an investment outside or within the index.

As we saw earlier, exposure to emerging markets can add to returns significantly. For example, a portfolio composed of 80% exposure to the Citigroup Non-U.S. Government Bond Index and 20% exposure to the J.P. Morgan EMBI+ Index from 1994 through 2002 would have added 120 basis points to the return of the international index and reduced the standard deviation of returns by 12%. A 20% allocation to emerging markets in an international bond portfolio that was half-hedged against foreign exchange-rate changes would have increased returns by 223 basis points while decreasing the standard deviation of returns by 37%.

A Fundamental-Based Approach to Investing

The portfolio strategy is often composed of a medium-term strategic allocation and a shorter-term tactical allocation. The *strategic allocation* is composed of positions held for one to three months or longer designed to take advantage of longer-term economic trends. A fundamental-based approach is used to develop the portfolio's strategic allocation. The investment style used in the fundamental-based approach is, of course, the fundamental style but also can be combined with a quantitative or black-box style to forecast relevant strategic factors. The *tactical allocation* generally relies on technical analysis or flow information to identify shifts in market prices that are likely to occur within a few days to several weeks. Tactical allocations are often contrarian in nature, driven by expectations of a reversal in a recent price trend.[14] Of course, the experienced trader, black-box, and chartist investment styles most often use technical analysis combinations in their tactical allocation decisions.

The strategic decision of which bond markets and currencies to overweight usually begins with an economic outlook and bond and currency forecasts in each of the markets considered for investment. The long-run economic cycle is closely correlated with changes in bond yields, and trends in both the economic cycle and bond yields tend to persist for a year or longer. The millions of dollars spent each year by money management firms, banks, and brokerage houses in forecasting economic trends is testimony to the potential returns that can be achieved by correctly forecasting economic growth or turning points in the economic cycle.

14. However, tactical allocations also can be momentum following, especially if a breakout of a technical range appears likely. Again, such technical strategies are discussed in investment management textbooks.

Forecasting interest rates, however, is extremely difficult. Academic literature generally holds that interest-rate forecasts are unable to generate consistent risk-adjusted excess returns. This is partly so because market prices can deviate substantially over the short term from the level consistent with the economic fundamentals. Economic fundamentals affect bond and currency prices over the medium to long term. Also, the volatile nature of certain economic data series may result in exaggerated market reactions to individual data releases that may be different from the actual trend in the economy. These deviations may persist for several months until either the initial figure is revised or several subsequent data releases reveal the error in the initial interpretation.

The creation of an independent economic outlook can be useful in several ways. First, it can help to identify when market interpretations of the economic data are too extreme or add value through correctly anticipating economic shifts not reflected in the market consensus. Second, since it is often not absolute changes in interest rates but changes in interest rates relative to other markets that determine the margin of performance in international fixed income investing, an independent economic outlook does not require accurate growth forecasts for each individual market but only economic growth differentials to be able to add value. Whether the portfolio will invest in U.S. bonds or not, the large influence of the U.S. dollar and the Treasury market on foreign markets underlines the importance of an independent outlook on the U.S. economy.

Thus the economic outlook forms the foundation for the *strategic* allocation to bonds and currencies. An economic outlook for each country should be constructed to assist in ranking the relative attractiveness of markets. However, even though economic fundamentals in a particular country may be extremely bond supportive, bond prices may be too high to make it an attractive investment. Likewise, bonds are sometimes excessively cheap in countries with poor economic fundamentals and hence may provide an attractive investment opportunity. Thus the economic outlook must be compared with either consensus economic forecasts or some market value measure to identify and rank attractive investment opportunities.

The strategic allocation decision regarding which markets to overweight or underweight relative to the benchmark is thus a complex interaction of expected returns derived from assessing economic trends and technical and value factors. Each set of variables is defined and explored below, beginning with the fundamental factors used to create the economic outlook.

The main fundamental economic factors are cyclic economic indicators, inflation, monetary policy, fiscal policy, debt, balance of payments, and politics. Each factor needs to be evaluated against market expectations to determine its likely impact on bond prices and currency rates. Each of these factors is covered in considerable detail in books on macroeconomics and international economics.

Identifying trends in economic fundamentals can help to identify attractive investment opportunities in markets, but some yardstick to measure relative value is needed. Determining relative value is highly subjective. Three relatively objective value measures—real yields, technical analysis, and market sentiment surveys—will be discussed below.

A *real yield* is the inflation-adjusted rate of return demanded by the market for holding long-term fixed income securities. Real yields can quickly be eroded by sustained inflation. Real yields are affected by a variety of factors, including supply and demand for capital as well as inflation expectations. Real yields are simply nominal bond yields minus expected inflation; however, expected inflation is often difficult to quantify. Some countries, including the United States, have inflation-indexed bonds that pay a real rate of interest above the inflation rate. These bonds not only provide investors with protection against a surge in inflation but also offer a means of gauging investor inflation expectations.[15]

Nominal bond yields deflated by current inflation, although not a precise measure of the market's real interest-rate premium, are easily measurable and still can provide some useful insight into bond valuation. Real yields can be compared across markets or against their long-run averages, such as 5 or 10 years, in each market. The usefulness of real yields as a measure of relative value has diminished as global inflation rates have converged to very low levels.

Technical analysis can be as simple as drawing a trend line on a chart or as complicated as calculating the target of the third impulse wave of an Elliott wave analysis. In addition to valuing bonds and currencies, technical analysis can be used to value everything from stocks to gold to pork bellies. What all technical analysis has in common is that it tries to predict future prices solely from examining past price movements. Most technical analysis models fall into one of two camps: trend following or countertrend. The former try to identify trends that should persist for some period of time, and the latter attempt to predict when a recent trend is likely to change.

Market sentiment can be used as a contraindicator of value in the following way. A heavy overweight of a particular country's bond market implies that fewer managers are likely to add to that market, and more managers, at least eventually, are likely to sell. Market sentiment can be estimated by investor sentiment surveys or by estimates of investment flows. Historic trends, as well as the overall levels, should be taken into account when assessing market sentiment. For example, an indication that managers are underweighting Japanese bonds might lead some to conclude that Japanese bonds are due for a rally even though international fixed income managers have consistently underweighted the Japanese market in part due to its low nominal yields. Sentiment surveys, however, may not capture all market participants such as retail investors, who can also move markets.

15. Nominal yield-to-maturity is composed of a real yield and an inflation expectations component (yield-to-maturity = real yield-to-maturity + expected inflation-to-maturity). The nominal government bond yield and the real yield offered by inflation-indexed debt of the same maturity can be used to calculate the expected inflation rate to the maturity, sometimes called the *break-even inflation rate*.

PORTFOLIO CONSTRUCTION

Translating the strategic outlook into a portfolio allocation requires a framework for assessing expected returns against incremental portfolio risk. The following discussion on sources of return illustrates how returns can be separated into three components: *excess returns on bonds, excess returns on currencies*, and the *short-term risk-free interest rate*. This component methodology can assist in identifying where market prices are most out of line with the economic outlook and whether bond market currency exposures should be hedged or left unhedged.

Components of Return

To explain the total return components of an international bond portfolio,[16] we will use the following notation. We will let "home currency" mean the currency of the manager. Thus, for a U.S. manager, it is U.S. dollars. For a Japanese portfolio manager it is yen. In the notation, the subscript H will denote home currency.

We will let "local currency" be the currency of the country where the manager has invested and use the subscript L to denote the local currency. Thus, to a U.S. portfolio manager, yen would be the local currency for bonds purchased in the Japanese bond market and denominated in yen, while for a Japanese portfolio manager, U.S. dollars would be the local currency for bonds purchased in the United States and denominated in U.S. dollars.

The expected total return of an unhedged international bond portfolio in terms of the home currency depends on three factors:

1. The weight of each country's bonds in the overall portfolio
2. The expected bond market return for each country in local currency
3. The expected exchange-rate percentage change between the home currency and the local currency

Mathematically, the expected total return of an *unhedged* bond portfolio in terms of the home currency can be expressed as follows[17]:

Total expected portfolio return in manager's home currency

$$= W_1 \times (r_1 + e_{H,1}) + W_2 \times (r_2 + e_{H,2}) + \cdots + W_N \times (r_N + e_{H,N}) \qquad (49\text{–}1)$$

16. The structure of this discussion is taken from Brian D. Singer and Denis S. Karnosky, *The General Framework for Global Investment Management and Performance Attribution* (Charlottesville, VA: The Research Foundation of the Institute of Chartered Financial Analysts, 1994). The notation used is consistent with that of the authors.

17. The relationship in Eq. (49–1) is approximate because bond market and currency returns of a foreign investment are more accurately expressed as the compounded gain of the two components: $(1 + r_i) \times (1 + e_{\$,i}) - 1$.

where

N = number of countries whose bonds are in the portfolio
W_i = weight of country i's bonds in the portfolio ($i = 1, 2, \ldots, N$)
r_i = expected bond return for country i in local currency ($i = 1, 2, \ldots N$)
$e_{H,i}$ = expected *percentage* change of the home currency with country i's local currency

We will refer to $e_{H,i}$ as the *currency return.*

The expected portfolio return as given by Eq. (49–1) is changed to the extent the manager alters currency exposures relative to the country distribution of the underlying bond exposures. A common instrument used to alter exposure to exchange rates is a currency forward contract. The relationship among the spot exchange rate, the interest rates in two countries, and the forward exchange rate on a currency forward contract is called *interest-rate parity*.[18] This extremely important relationship says that a manager, after hedging in the forward exchange-rate market, will realize the same domestic return whether investing domestically or in a foreign country. The arbitrage process that forces interest-rate parity is called *covered interest arbitrage.*

It can be demonstrated that the forward exchange rate between an investor's home currency, denoted H and the currency of country i, is equal to

$$F_{H,i} = S_{H,i}\left(\frac{1+c_H}{1+c_i}\right) \tag{49–2}$$

where

$F_{H,i}$ = forward exchange rate between investor's home currency and the currency of country i
$S_{H,i}$ = spot (or cash) exchange rate between investor's home currency and the currency of country i
c_H = short-term interest rate in the home country which matches the maturity of the forward contract
c_i = short-term interest rate in country i which matches the maturity of the forward contract

c_H and c_i are called the *cash rate*. The cash rate is generally the Eurodeposit rate (i.e., offshore deposit rate) for funds deposited in that currency which matches the maturity of the forward contract. Euro deposit rates are available for U.S. dollars and most other major currencies, including for euro-denominated deposits.

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18. For the derivation of the price of a currency forward contract, see Christopher B. Steward, J. Hank Lynch, and Frank J. Fabozzi, "International Bond Portfolio Management," Chapter 6 in Frank J. Fabozzi (ed.), *Fixed Income Readings for the Chartered Financial Analyst Program* (New Hope, PA: Frank J. Fabozzi Associates, 2004), pp. 170–173.

By rearranging the above terms in Eq. (49–2), the forward exchange rate discount or premium (or the percentage change of the forward rate from the spot exchange rate), denoted by $f_{H,i}$, *approximately* equals the differential between the short-term interest rates of the two countries. That is,[19]

$$f_{H,i} = \frac{F_{H,i} - S_{H,i}}{S_{H,i}} = c_H - c_i$$

That is, for the return on cash deposits to be equal in both currencies, the lower-interest-rate currency must appreciate to the forward foreign exchange rate.

The forward rate also can be expressed in "points" or the difference between the forward and spot rate $F_{H,i}$, $- S_{H,i}$. When interest rates are lower in the foreign country (i.e., the forward points are positive), the forward foreign exchange rate trades at a premium.

The Currency Hedge Decision

If a global bond portfolio is fully hedged, the portfolio return of Eq. (49–1) changes. Specifically, if the manager hedged the currency exposure in all countries using currency forward contracts, the total return for a fully hedged portfolio into the home currency can be expressed as follows:

Total expected portfolio return fully hedged into investor's home currency

$$= W_1 \times (r_1 + f_{H,1}) + W_2 \times (r_2 + f_{H,2}) + \cdots + W_N \times (r_N + f_{H,N}) \qquad (49\text{–}4)$$

where $f_{H,i}$ is the forward exchange-rate discount or premium between the home currency and country i's local currency. That is, instead of being exposed to some expected percentage change of the home currency to country i's currency, the manager will have locked in the percentage change of the forward exchange rate from the spot exchange rate (the forward discount/premium) at the time of the hedge.

Now, what will determine whether or not the manager will hedge the exposure to a given country's exchange rate using a currency forward contract? The decision is based on the expected return from holding the foreign currency relative to the forward premium or discount. That is, if the manager has a high level of conviction that the percentage return from exposure to a currency is greater than the forward discount or premium, then the manager will not use a forward contract to hedge the exposure to that currency. Conversely, if the manager has a high level

19. Equation (49–2) assumes that exchange rates are quoted in "direct terms," i.e., the value of the home currency for one unit of the local currency, though quote conventions vary by market. Over-the-counter forward contracts use market convention, most of which for the U.S. dollar are in indirect terms (local currency units per one dollar). Using indirect terms, the forward discount *or* premium in Eq. (49–3) becomes $f_{H,i} = c_i - c_H$. To avoid the complexities of compounding, the time period is assumed to be one year.

of conviction that the currency return will be less than the forward discount or premium, the manager will use a forward contract to hedge the exposure to a currency.

In the case where the manager believes that the percentage return from exposure to a currency will be greater than the forward discount or premium, the unhedged return for country i can be expressed as

$$\text{Unhedged expected return for country } i,\ R_{H,i} = r_i + e_{H,i} \qquad (49\text{–}5)$$

In the case where the manager believes the currency return will be less than the forward discount or premium, we can express the hedged return for a country in terms of the forward exchange rate between the home and local currencies using the interest rate parity relationship. As Eq. (49–3) showed, the forward premium or discount is effectively equal to the short-term interest rate differential; thus

$$f_{H,i} = c_H - c_i$$

By substituting this relationship into Eq. (49–4) for the forward hedge, the equation for an individual country's hedged return *HR* is

$$\text{Hedged expected return for country } i,\ HR_{H,i} = r_i + f_{H,i} \approx r_i + c_H - c_i \qquad (49\text{–}6)$$

There remain, however, two further hedging choices for the manager: *cross-hedging* and *proxy hedging*. We explain each of these below.

Cross-Hedging

Cross-hedging is a bit of a misnomer because it does not reduce foreign currency exposure but only replaces the currency exposure to country i's currency with currency exposure to country j's currency. For example, suppose a U.S. manager has an unwanted currency exposure in country i that arose from an attractive bond investment in country i. Rather than hedging with a forward contract between U.S. dollars and the currency of country i and eliminating the foreign currency exposure, the manager elects to swap exposure in country i's currency for exposure to country j's currency. This is accomplished by entering into a forward contract that delivers the currency of country j in exchange for the currency of country i where the manager has an unwanted currency exposure.

Why would a manager want to undertake a cross-hedge? A manager would do so if she expects her home currency to weaken, so she does not want to hedge the currency exposure to country i, but at the same time she expects that country j's currency will perform better than country i's currency.

When there is a cross-hedge, the hedged return for country i, $HR_{H,i}$, in Eq. (49–6) can be rewritten as follows:

$$\text{Cross-hedged expected return for country } i,\ CR_{H,i} = r_i + f_{j,i} + e_{H,j}$$

where $f_{j,i}$ is the forward discount or premium between country j and country i. This expression says that the cross-hedged return for country i depends on (1) the expected bond return for country i, (2) the currency return locked in by the cross-hedge between country j and country i, and (3) the currency return between the home currency and country j.

We can rewrite the preceding equation in terms of short-term interest-rates as given by interest-rate parity. That is, for $f_{j,i}$, we substitute $c_j - c_i$. Doing so and rearranging terms gives

$$\text{Cross-hedged expected return for country } i,\ CR_{H,i} \approx (r_i - c_i) + (c_j + e_{H,j}) \quad (49\text{–}7)$$

Equation (49–7) says that the cross-hedged expected return for country i depends on (1) the differential between country i's bond return and country i's short-term interest rate plus (2) the short-term interest rate in country j, and (3) the currency return between the home currency and currency j.

Proxy Hedging

Proxy hedging keeps the currency exposure in country i but creates a hedge by establishing a short position in country j's currency. Why would a manager want to undertake a proxy hedge? This strategy would normally be considered only where the currencies of country i and country j are highly correlated, and the hedge costs in country j are lower than in country i. A proxy hedge also can represent a bullish view on the home currency, with a more negative view on country j's currency than country i's currency.

When there is a proxy hedge, the hedged return for country i, $HR_{H,i}$, in Eq. (49–6) can be rewritten as follows:

$$\text{Proxy-hedged expected return for country } i,\ PR_{H,i} = r_i + e_{H,i} + f_{H,j} - e_{H,j}$$

where $f_{H,j}$ is the forward discount or premium between the home country and country j.

Notice that in this equation there is still the exposure to the exchange rate between the home currency and currency i. The proxy hedge comes into play by the shorting of the currency return between the home currency and currency j.

Based on interest-rate parity, we can replace $f_{H,j}$ with the difference in short-term interest rates, $c_H - c_j$, to get

$$\text{Proxy-hedged expected return for country } i,\ PR_{H,i} \approx r_i + e_{H,i} + c_H - c_j - e_{H,j}$$

This is equivalent to

$$\text{Proxy-hedged expected return for country } i,\ PR_{H,i} \approx (r_i - c_i) + (c_i + e_{H,i}) + [(c_H - c_j) - e_{H,j}] \quad (49\text{–}8)$$

Equation (49–8) states the expected return for country i using proxy hedging depends on (1) the differential between the bond return for country i and the short-term interest rate for country i; (2) the short-term interest rate for country i adjusted for the currency return for country i relative to the home currency; and

(3) the differential in the short-term interest rates between the home currency and country *j* adjusted for the short currency position in country *j*.

Recasting Relationships in Terms of Short-Term Interest Rates

When we substituted short-term interest-rate differentials for the forward premia or discounts earlier, it becomes apparent from Eqs. (49–6), (49–7), and (49–8) that the difference in return between hedging, cross-hedging, and proxy hedging is entirely due to differences in short-term interest rates and currency exposure. This is also true for the unhedged return for a country as given by Eq. (49–5). This can be seen by simply rewriting Eq. (49–5) as follows:

$$\text{Unhedged expected return for country } i,\ R_{H,i} = (r_i - c_i) + (c_i + e_{H,i})$$

The unhedged expected return is thus equal to (1) the differential between the bond return in country *i* and the short-term interest rate in country *i* and (2) the short-term interest rate in country *i* adjusted for the currency return.

These equations show how integral the short-term interest-rate differential is to the currency hedge decision. This means that (1) the short-term interest-rate differential should relate to the currency decision and (2) bond market returns should be calculated as an excess return, that is, less the local short-term interest rate. This can be made explicit by adding and subtracting the home currency short-term interest rate to the four return relationships—unhedged, hedged, cross-hedged, and proxy-hedged. By doing so, this allows the forward premium ($f_{H,i} = c_H - c_i$) to be inserted into the currency term, giving

$$\text{Unhedged expected return for country } i,\ R_{H,i} = c_H + (r_i - c_i) + (e_{H,i} - f_{H,i}) \quad (49\text{–}9)$$

$$\text{Hedged expected return for country } i,\ HR_{H,i} = c_H + (r_i - c_i) \quad (49\text{–}10)$$

$$\text{Cross-hedged expected return for country } i,\ CR_{H,i} = c_H + (r_i - c_i) + (e_{H,j} - f_{H,j}) \quad (49\text{–}11)$$

$$\text{Proxy-hedged expected return for country } i,\ PR_{H,i} = c_H + (r_i - c_i) + [(e_{H,i} - e_{H,j}) - f_{j,i}] \quad (49\text{–}12)$$

From Eqs. (49–9) through (49–12), we see the return for each strategy can be divided into three distinct return components:

Component 1. The short-term interest rate for the home currency (c_H)

Component 2. The excess bond return of country *i* over the short-term interest rate of country *i* ($r_i - c_i$)

Component 3. The excess currency return, either unhedged, cross-hedged, or proxy-hedged

The first two components, c_H and ($r_i - c_i$), are the same for each strategy. The excess currency return (the third component) becomes the currency return in excess of the forward premium (or discount) and becomes the basis for the decision of currency hedging. (We will illustrate this below.) The bond decision is purely a matter of selecting those markets which offer the best expected excess return ($r_i - c_i$) and the bond and currency allocation decisions are entirely independent. In a sense, the hedged expected return can be considered the base expected return because it is a component of the unhedged, cross-hedged, and proxy-hedged expected returns. Thus the excess currency returns in the third component are assessed to see if they can add any value over the baseline hedged expected return. This method of analyzing sources of return, in effect, treats bond and currency returns as if they were synthetic futures or forward positions.

It is important to note that only the hedged position eliminates all currency risk, and the only position that has a known return over the investment horizon. The cross-hedge substitutes one currency exposure for another but maintains foreign currency exposure. The proxy hedge leaves the portfolio exposed to "basis" risk if the proxy hedge currency appreciates relative to the investment currency.

Adjusting Bond Yields for Coupon Payment Frequency

In the United States and most other dollar bloc countries, coupon payments are made semiannually. There are other markets that follow this practice. Computing the yield for a semiannual-pay bond was explained previously using two steps. First, the semiannual interest rate that will make the present value of the semiannual cash flows equal to the price plus accrued interest is determined. Second, since the interest rate is semiannual, it is annualized by multiplying by 2. The resulting annualized yield is referred to as a *bond-equivalent yield.*

In European markets (except for the United Kingdom) and Japan, coupon payments are made annually rather than semiannually. Thus, the yield is simply the interest rate that makes the present value of the cash flows equal to the price plus accrued interest. No annualizing is necessary.

The yield quoted in terms of the home market's convention for payments is called the *conventional yield*. In countries where coupon payments are made annually, in Germany and Japan, for example, the conventional yield is simply the annual yield.

Despite the limitations of yield measures, managers compare yields across market sectors and between countries. Holding aside the problem of potential changes in exchange rates, yield comparisons begin by adjusting conventional yield (i.e., the yield as quoted in the home market) to be consistent with the way the yield is computed for another country. For example, a French government bond pays interest annually, while a U.S. government bond pays interest semiannually. If the U.S. government bond yield, is being compared to a French government bond yield, either (1) the U.S. government bond yield should be adjusted to the yield on an annual-pay basis or (2) the French government bond yield should be adjusted to a yield on a bond-equivalent yield basis.

The adjustment is done as follows: Given the yield on an annual-pay basis, its bond-equivalent yield (i.e., a yield computed for a semiannual-pay bond) is computed as follows:

$$\text{Bond-equivalent yield of an annual-pay bond} \\ = 2[(1 + \text{yield on annual-pay bond})^{0.5} - 1]$$

For example, suppose that the conventional yield on a French government bond is 4.55%. The bond-equivalent yield is then 4.50%, as shown below:

$$2[(1 + 0.0455)^{0.5} - 1] = 0.0450 = 4.50\%$$

Notice that the bond-equivalent yield of an annual-pay bond is less than that of the conventional yield.

To adjust the bond-equivalent yield of a semiannual-pay bond to that of an annual-pay basis so that it can be compared to the yield on an annual-pay bond, the following formula can be used:

$$\text{Yield on an annual-pay basis of a bond-equivalent yield} \\ = (1 + \text{yield on a bond-equivalent yield}/2)^2 - 1$$

For example, suppose that the conventional yield of a U.S. government bond is 4.20%. The yield on an annual-pay basis is

$$(1 + 0.0420/2)^2 - 1 = 0.0424 = 4.24\%$$

Notice that the yield on an annual-pay basis will be greater than the conventional yield.

Yield spreads are typically computed between the yield of a particular bond and that of a benchmark. The U.S. government bond market and the Euro swap market are the two most common benchmarks used.

Forward Rates and Break-Even Analysis

As explained earlier, there are various methods of evaluating relative value in international bond markets. Before these can be translated into a market allocation, a manager must compare their strategic outlook to that which is already priced into the market. This can be accomplished by either converting the economic outlook into point forecasts for bond and currency levels or looking at the forward rates implied by current market conditions and comparing them with the economic outlook.

Bond and currency break-even rates, the rate at which two investments produce identical total returns, are usually calculated versus a benchmark market return over a specific time horizon. A large yield spread between two markets implies a larger "cushion" (the required spread widening to equate total returns in both markets, or the break-even rate) over the investment time horizon.

Comparing of forward interest rates can be instrumental in identifying where differences between the strategic outlook and market prices may present investment opportunities. Forward interest rates use the shape of the yield curve to calculate implied forward bond rates and allow a quick comparison of what is required, in terms of yield shifts in each market, to provide a return equal to the short-term risk-free rate (a zero excess return). This would correspond to a bond excess return of zero in Eqs. (49–9) through (49–12), or $(r_i - c_i) = 0$. Forward interest rates represent a break-even rate not across markets but within markets. The strategic bond allocation then can be derived by increasing exposure to markets where the expected bond return over the short-term interest rate is most positive—that is, where the expected bond yield is furthest below the forward yield. Forward rate calculators are available on systems such as Bloomberg.

The forward foreign exchange rate represents a break-even rate between hedged and unhedged currency returns, as shown previously in the components of return analysis. In terms of Eqs. (49–9), (49–11), and (49–12), currency excess return is zero when the percentage change in the currency equals the forward premium or discount. Since forward foreign exchange rates are determined by short-term interest-rate differentials, they can be estimated from the interest rates on deposits, specifically, Eurodeposit rates, as in Eqs. (49–2) and (49–3), which can be obtained easily from market data services such as Bloomberg and Reuters.

Break-even analysis provides another tool for estimating relative value between markets. Because the prices of benchmark bonds are influenced by coupon effects and changes in the benchmark, many international fixed income traders and portfolio managers find it easier to keep pace with changes in yield relationships than price changes in each market. A constant spread between markets when yield levels are shifting, however, may result in a variation in returns as differing benchmark bond maturities and coupons result in a wide spread of interest rate sensitivity across markets. Thus market duration must be taken into account when determining break-even spread movements.

Since EMU, yield differentials within Europe have remained extremely tight. Holding Italian versus German bunds, for example, provides a yield advantage of only 22 basis points per year. Obviously, this small amount of additional yield can be easily offset by an adverse price movement between the two markets. In the mid-1990s, before EMU, Italian bonds would have yielded several hundred basis points more than German bonds because the additional currency risk involved in holding Italian bonds had a substantial impact on nominal yield spreads. Even a fairly wide yield cushion, however, also can evaporate quickly.

To illustrate this and show how break-even analysis is used, the yield spread between the 10-year U.S. and Japanese government bonds on December 3, 2002 was 322 basis points, providing Japanese investors who purchased the U.S. benchmark Treasury with additional yield income of 80 basis points per quarter. This additional yield advantage, however, can be eliminated by the spread widening substantially less than the 80 basis points. The widening can occur in one of the following two ways:

- Yields in Japan can decrease, resulting in price appreciation of the Japanese government bond
- Yields in the United States can increase, resulting in a price decline of the U.S. Treasury bond

Of course, a combination of the two also can occur. To quantify the amount of spread widening that would erase the yield advantage from investing in a higher yielding market, we need to conduct a break-even analysis.

It is important to note this break-even analysis is not a total-return analysis; it applies only to bond returns in local currency and ignores currency movements. This break-even analysis is effective in comparing bond markets that share a common currency, as within the Euro zone; however, currency must be taken into account when applying break-even analysis to markets with different currencies. The additional yield advantage in the preceding example is erased if the U.S. dollar depreciates by more than 0.80% during the quarter. Below we illustrate how a hedged break-even analysis can be calculated using hedged returns or simply the forward foreign exchange premium or discount between the two currencies.

The duration of the Japanese bond at the time of this analysis was 9.4. This means that for a 100 basis point change in yield, the approximate percentage price change for the Japanese bond would be 9.4%. For a 50 basis point change in yield, the percentage price change for the Japanese bond would change by approximately 4.7%. We can generalize this as follows:

$$\text{Change in price} = 9.4 \times \text{change in yield}$$

If we let W denote the spread widening, we can rewrite the preceding equation as

$$\text{Change in price} = 9.4 \times W$$

We want to determine the amount of yield movement in Japan that would exactly offset the yield advantage of 0.80% from investing in U.S. bonds. Thus we need to calculate what decline in Japanese bond yields would generate exactly 0.80% in price appreciation to make the Japanese investor indifferent between the two investments (ignoring any potential currency movements). Thus the equation becomes

$$0.80\% = 9.4 \times W$$

Solving for W,

$$W = 0.80\%/9.4 = 0.085\% = 8.5 \text{ basis points}$$

Therefore, a spread widening of 8.5 basis points due to a decline in the yield in Japan would negate the additional yield from buying the U.S. Treasury issue. In other words, a change in yields of only 8.5 basis points is needed in this case to delete the three-month yield advantage of 80 basis points.

We refer to this yield spread change as the *break-even spread movement*. Note that the break-even spread movement must (1) be related to an investment horizon and (2) use the higher of the two countries' modified durations. Using the highest modified duration provides the minimum spread movement that would offset the additional yield from investing in a higher-yielding market. Thus, in our example, the three-month break-even spread movement due to Japanese yields is 8.5 basis points, meaning that it is the spread movement due to a drop in Japanese rates by 8.5 basis points that would eliminate the three-month additional yield from investing in U.S. Treasury bonds. The break-even spread movement using the 8.1 duration in the U.S. would have been 9.9 basis points (0.8/8.1 = 9.9); a difference of only 1.4 basis points.

The break-even spread movement just described completely ignores the effect of currency movements on returns. It also ignores the implied appreciation or depreciation of the currency reflected in the forward premium or discount. If we subscribe to the methodology discussed earlier in the chapter of attributing cash returns to the currency decision and measuring bond market returns as the local return minus the cash rate, the results of the break-even spread movement analysis on a hedged basis may be quite different. We can easily calculate the hedged break-even spread movement by adding in the forward foreign exchange discount or premium. At the time of this break-even analysis, three-month interest rates were 0.0675% in Japan and 1.425% in the United States. With this information, we can obtain the embedded forward rate using Eq. (49–3); that is,

$$f_{¥,\$} = c_{¥} - c_{\$} = (0.0675\% - 1.425\%)/4 = -0.34\%$$

The expected hedged return over the three-month period, assuming no change in rates, is the sum of the nominal spread differential (0.80%) and the forward premium (–0.34%), or 0.46%. Thus the break-even spread movement on a hedged basis is a mere five basis points (0.46% = 9.4 × W) instead of the 8.5 basis points of potential widening calculated on a local currency basis. Consequently, a Japanese investor would have to expect either that spreads would not widen by more than five basis points or believe that the dollar would depreciate versus the yen by less than the embedded forward rate to make the trade attractive. Because currency hedge costs (i.e., the forward premium or discount) are determined by short-term interest rates, the break-even spread movement on a hedged basis always will be smaller when hedging a currency with higher short-term interest rates.

Alternatively, we could use Eq. (49–10) to calculate the expected hedged return to a yen-based investor over a three-month period and compare it to the return on a Japanese 10-year bond over the same period. In order to do so, it is first necessary to adjust the U.S. government bond yield (which is quoted on a bond-equivalent yield basis) to an annual-pay yield basis because the Japanese yield is based on an annual basis. The conventional yield of 4.20% for the U.S. government bond was 4.24% on an annual-pay basis. Assuming no change in rates, the expected hedged return is

$$[(r_{\$} - c_{\$}) + c_{¥}]/4 = [(4.24\% - 1.43\%) + 0.07\%]/4 = (2.88\%)/4 = 0.72\%$$

and the expected Japanese bond return is (1.02%/4, or 0.26%). Thus the expected return on a hedged basis is 0.44%, which is close to the 0.46% in the first answer that we calculated.

Security Selection

Once the bond market allocation decisions have been made and the optimal duration and yield-curve profile selected for each market, the overall portfolio structure needs to be constructed through the purchase or sale of individual securities. Many international bond investors prefer to trade only benchmark issues because they are more liquid than other similar-maturity bonds. This can sometimes lead to a "hump" in the yield curve as investors prefer a certain issue or maturity sector. The same phenomenon can result from a squeeze of certain issues in the repo market or short-term demand imbalances for bonds deliverable into short bond futures positions.

Taxation issues also need to be taken into account when selecting individual bonds for purchase. For example, several markets have tax systems that encourage investors to hold lower-coupon bonds; hence certain bonds will tend to trade rich or cheap to the curve depending on their coupon. In markets that impose withholding taxes on coupon payments, international fixed income portfolio managers often minimize their tax liability by replacing a bond that is near its coupon date with another bond of similar maturity. Market anomalies also can arise from differing tax treatment within markets. For example, Italian Eurobonds issued before 1988 are exempt of withholding tax for Italian investors; hence they tend to trade at a lower yield than similar maturity bonds issued after 1988.

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CHAPTER
FIFTY

TRANSITION MANAGEMENT

DANIEL GALLEGOS

Transition management is the process of facilitating the movement of an investment portfolio from one strategy or manager to another. This operation can consist of a complete portfolio restructuring, a straight liquidation, and/or a hedged transaction. A transition team's primary goal is to facilitate the transition in a controlled manner that will achieve the client's objectives. These objectives will vary but most likely will consist of retaining the portfolio's current market value while mitigating unwanted risks associated with the transition. A transition management team is comprised of a number of experts who facilitate the transition. Areas of expertise include trading, investment administration, trade clearing, operations, legal, risk management, and accounting. In this chapter an overview of the transition management process and a description of the various components will be discussed.

OVERVIEW OF FIXED INCOME TRANSITION MANAGEMENT

The fixed income transition management process is made up of three distinct phases: planning, implementation, and reporting. Because fixed income securities are traded in the over-the-counter market, a great amount of detail and strategic planning is necessary to ensure a risk-controlled implementation. The planning phase encompasses the initial screening of the client's objectives, as well as a detailed analysis of the composition of both the legacy and target portfolios. It is in this phase that the timing and cost expectations are set. The implementation phase includes the development of a detailed transition strategy, opening of accounts, preparation for the settlement of various currencies, audit tracking, and hedge preparation. Once the restructuring is completed and the assets have been delivered, the reporting phase is begun. The reporting phase is composed of a performance analysis, trade recap, proceeds reconciliation, and development of the client's final report.

The Transition Manager's Legal Capacity, Transference Methods, and Trading Programs

During the transition process, the transition manager may or may not be named a fiduciary. This distinction is important because assignment as a fiduciary can alter some aspects of the service a transition manager can provide. A fiduciary transition manager most likely would not be able to provide principal bids on client portfolios. It may be inappropriate for a fiduciary to interject his capital to facilitate a transition; a conflict of interest may arise in such a case. Typically, a transition manager acting as fiduciary will trade as agent.

Transference Methods and Types of Trading

As noted earlier, the transition manager can trade as an agent or a principal. A transition manager acting as an agent solicits bids or offerings from a number of investors to obtain the best possible price. This process is accomplished by segregating securities into various "buckets" and creating transaction lists. The transaction lists are then submitted to the market using a competitive bid/offer process. This process helps alleviate the execution price risk arising from the lack of price transparency in the fixed income markets. However, it can take several days to complete a fixed income transition using this process—thereby exposing the client to unwanted market risks if unhedged.

In cases where a client is particularly concerned about market risk, a principal bid may be preferred. Principal bids are bids provided by a dealer for an entire portfolio at a single price. This method decreases the time it takes to transition the assets; however this can bear a large upfront cost. The upfront cost is applied by the bidder to compensate for the risks associated with holding the portfolio's securities within their own inventory. Prices on principal bids usually range from 30 basis points and greater.

In-kind selections are one way that assets are transferred out of the legacy portfolio. The target manager always should be given the option to peruse the legacy portfolio. This allows the target manager to select securities to take in-kind, providing the client with the benefit of not having to pay the bid-ask spread associated with buying and selling the same security. Securities deemed fit for the new manager's strategy are retained and are then transferred to the new portfolio. The value at which they are transferred is usually determined by using the custodian price as of the close of business the day prior to the transfer date. The cost basis for individual securities also may be transferred if the client desires—availability of this option can vary depending on the client's tax situation.

Crossing bonds is another way of transferring assets out of the legacy portfolio; however, these assets are not transferred into the new portfolio but rather into other portfolios managed by the target manager. A Department of Labor (DOL) exemption must be used in order to cross bonds; it should not be assumed that all managers have this capability. This transference method does have drawbacks. The DOL exemption allows the fair value of the bonds in question to be established by requiring the transition manager to solicit indicative price levels on both the bid and ask sides for a particular security. A midlevel is derived by using three different bid-side quotes and three different ask-side quotes. The drawback in establishing fair value in this manner lies in the lack of required specialization from the investment houses providing these indications. Price-discrepancy problems and possible differences between the newly established price and the bond's fair market value price can result. For bonds that are liquid and whose price transparency is not an issue, the client may realize a benefit of one-half the bid-ask spread of the bonds being transferred.

The most common trading type is an open-market trade via a competitive bidding process. Normally, the portfolio is broken down into various lists ranging from 10 to 15 securities. A common strategy to facilitate operations is to submit trade lists based on bonds that have similar characteristics. To effectively organize these lists, securities should first be separated by market sectors such as corporate, mortgage, and government. These groups would then be further organized by credit rating, term-to-maturity, and security type. This is done because most investment houses have traders who specialize in sectors that are defined in this manner. Open market trading in a competitive process can be more time-consuming than in a principal trade. However, the probability of receiving fair market value for a portfolio increases with this process. To ensure that maximum value is realized, a strategic selection of bidders should be made based on their specialization in specific market sectors and security types. Just as important is the anonymity of the lists prior to their trade dates. Lists should be shown to investors expected to participate in the competition on trade date, but not before. For the purchasing of securities, there can be some distinct differences. The purchasing of assets differs in that the target manager may set the maximum price level he/she will accept as a purchase price. If an offering price of a target asset is less attractive than the target manager anticipated, an alternate security may be selected by the target manager. Locating a target asset may involve an iterative process and, as a result, require the involvement of the target manager. In either scenario, the target manager may provide a proxy security or, alternatively, ask for the delivery of cash.

Although the restructuring of portfolios may bring about performance concerns owing to sector misweights, in some cases target managers are provided a grace period with regard to measurement of their performance. This allowance is provided to compensate for the time it takes to restructure a fixed income portfolio as a result of market inefficiencies.

Transition Costs

Transition costs can be either explicit or implicit. *Explicit costs* are costs that can be quantified using a known multiplier such as a basis point fee or a commission charge. Transition management fees for fixed income transitions normally are explicit fees that are based on the market value of the assets being transitioned. Other explicit fees that occur during a fixed income transition are futures commissions, option commissions, and international taxes.

The amount of the transition fee usually is determined by the complexity and time allocated to efficiently perform the transition. The fee usually is determined after the pretrade analysis has been completed, and the client's objectives are fully understood. In the case of a principal bid, an upfront fee will be embedded in the bid. This may or may not be considered an explicit cost. The fee for a principal bid is likely to change based on the holdings of the portfolio being transitioned and the accuracy of the portfolio pricing. Because bonds are traded in the OTC market, prices received by third-party vendors are indications.

Implicit costs for fixed income transitions are the amount of price degradation realized when the execution price is compared with that of the perceived fair value of the security. This implicit cost can arise as a result of stale pricing, unattractive position sizes, and economic, global, or sector events. Opportunity costs are another transition cost that should be considered carefully.

Liquidity Sources

A number of different media are used to transmit trade orders. A few common ones are Bloomberg, e-mail, and electronic trading platforms. However, on the other end are primary dealers or regional brokers. To enhance the liquidity of the transition process, it is recommended that a combination of the two be present in the bid process.

Primary dealers usually provide the greatest amount of liquidity for larger position sizes. Experience suggests that they are less averse than regional brokers to adding large liquid investment-grade positions to their existing portfolios. As a result, fair-value prices for these types of securities often are realized in an efficient manner. Odd-lot and non-investment-grade securities sometimes realize better execution results at the regional broker level. Regional sales forces do not normally position large quantities of bonds in their in-house portfolios; therefore, they are more willing to work individual orders with customers, which can help realize fair value for the smaller, more obscure positions.

Some of the more efficient domestic electronic platforms that exist today are in the government, agency, TBA, and investment-grade corporate bond markets. The greatest price transparency is in the government market, followed by the TBA and agency markets. The U.S. corporate bond market has made great strides over the past couple of years to improve its price-transparency constraints. This improvement can be attributed largely to the NASD's Trade Reporting and Compliance Engine (TRACE) program, which disseminates corporate trade data via the Bond Trade Dissemination Service (BTDS) data feed. The initial purpose of the TRACE program was to alleviate the lack of price transparency in the non-investment-grade corporate bond market. Recently, the NASDAQ expanded the universe of its trade recap system to include investment-grade corporate securities.

PROCESSES OF A TRANSITION

In this section the processes of a transition are described.

Planning

The planning phase of a transition is composed of creation of the transition proposal, review of legal and custodial documentation, and transition strategy discussions between the client and transition team.

The proposal or pretrade analysis is usually the first time the transition team has looked at the strategy in question. It is not unusual for more than one portfolio to be included in this analysis. A client's restructuring an entire pension strategy, which can consist of numerous rebalances and strategy changes thereby increasing the complexity of the transition. It is also likely that a client may not have chosen a new target manager and that the transition manager may be given the task of temporary portfolio manager. As a temporary portfolio manager, the transition management team may be asked to maintain the strategy's market exposure through the use of futures and/or forward currency overlay strategies.

Transition Proposal

Once the operational strategy has been defined, the next step is to look at the current assets and create a pretrade proposal. The goal of the pretrade proposal is to evaluate the costs associated with the transition, and to estimate the time it will take to complete.

The fixed income markets have numerous price-transparency issues, especially with those more esoteric securities such as high-yield bonds, private-placement issues, and certain types of collateralized mortgage obligations. If the legacy strategy has been terminated for performance reasons, it is possible that there are numerous undesirable securities in the legacy portfolio. This can decrease the number of assets selected to be taken in kind by the new manager. In such cases, the liquidity review takes on added importance during the pretrade analysis. It is in this phase that the client's expectations have to be managed. Depending on the type of strategy the proceeds and assets are moving into—commingled or standalone—the funding timeline of the target portfolio can become sensitive. It is likely that a commingled fund strategy will have open funding dates periodically throughout a month. The findings from the pretrade analysis should help structure an optimal trading strategy to meet the funding requirements. Those securities which pose high liquidity concerns should be flagged so that the distribution of proceeds can be determined accurately. The timing of the distribution of proceeds of illiquid securities can be the number one reason that these deadlines are missed.

Good initial indicators of a bond's liquidity are the number of pricing sources providing market levels, issue size, the number of involved parties in the underwriting, complexity of the issue structure, and availability of a prospectus or private-placement memorandum. All these characteristics should be reviewed prior to submitting the pretrade analysis. Factors to include during the liquidity review are:

- *The number of pricing sources.* The more pricing sources that are available for a particular security usually means the bond is more liquid than those who have few or no price providers. This can be attributed to widely traded and widely held issues.

- *Issue size.* The larger the issues size of a security, the greater is the likelihood that more investors hold the bond in their portfolio. This increases the number of interested parties that already may know the credit characteristics behind your issue, which may help provide fair-value liquidity.
- *Involved parties in underwriting.* Many times the banks who brought a deal to market will continue to provide liquidity for their deals. The logic is that if there is no market for the deals they bring to market, doing business with them in the primary market becomes less attractive for the investor.
- *Complexity of issue structure.* Many investment funds are precluded from buying certain type of esoteric structures, which decreases their liquidity.

Legal and Custodial Documentation

Legal documentation procedures will vary depending on the client. For repeat clients, the process can be made easy by having established documentation in place for future transitions. It is advisable that every client should be set up in a manner where all documentation does not have to be repeated, but rather an agreement is established that will decrease the administrative burden going forward. During these discussions, all key contact information should be stored, such as e-mails, faxes, and alternate contacts. The client's attorneys should review authorization letters; this can be a time-consuming process as detailed terms are ironed out, discussed, and finalized. Trading in any of the client's accounts should not take place prior to the receipt of an authorization to trade. One also needs to know the type of plan—ERISA or non-ERISA—and/or whether the client is domestic or nondomestic. This can change the type of documentation needed and may change the types of services the transition manager may offer.

Implementation

Implementation is a tremendously complex phase of the fixed income transition. It is in this phase that the transition management team has been officially hired, and specific expectations have been set. Numerous simultaneous operations occur at this point.

A transition management team performs many roles; some common roles are those of a project manager, investment administrator, and portfolio manager. One of the roles during the trading phase encompasses the responsibility of finalizing of documentation, such as the authorization to trade and the direction letter. These documents should be signed and agreed on by both company's legal departments prior to the start of trading. The coordination of time lines and contact information for the new target managers should be generated and disseminated to the appropriate parties. The project manager may also maintain communication channels between the client and the portfolio manager; this ensures that details of the transition progress throughout this phase are communicated. The expectations of the target managers in relation to the assets to be delivered and timing of the proceeds to be received also should be communicated.

The investment administrator might coordinate the discussions with the custodial group. They may verify the receipt of the certified lists, as well as verify the starting cash positions. Investment administrators also may be involved in the coordination of showing target managers the securities that are available for in-kind transfers. If the investment administrator assumes this responsibility, it is recommended that she become the sole point of contact between target managers and the transition management group. This should ensure there is no miscommunication with regard to the assets selected.

The portfolio manager is responsible for creating the transition restructuring strategy. This encompasses the liquidity analysis, hedging strategy implementation/creation, portfolio restructuring planning, and execution implementation. In this phase, the portfolio manager also should establish the time line for distribution of proceeds. Included on this time line are the expected proceed adjustments due to mortgage factor changes or other cash-flow updates/corrections that may create distribution delays.

Restructuring of Assets

The crux of the implementation phase is the restructuring of assets. A trading strategy is designed to maximize the value realized for the individual securities while following a well-controlled process and minimizing any undesired operations or market risk. The restructuring of assets may be composed of in-kind selections, internal crossing, and open-market trading. Prior to the start of restructuring, a detailed plan must be devised.

Establishing Price Levels and Determining Liquidity

If the constituents from the pretrade analysis have not changed, then that analysis may act as a good outline for the restructuring strategy. However, this is seldom the case, and in many instances, those clients who have requested a pretrade analysis had not requested the termination of trading of their accounts at that time. The same methodology for determining liquidity in the pretrade analysis should be used. Some of the core components in establishing a restructuring strategy include establishing pricing levels, identifying securities with high price volatility, and identifying possible liquidity concerns.

When establishing pricing levels, it is important to use a consistent pricing source. This will facilitate performance reporting during the posttrade phase and over time allow the transition manager to identify sector shortfalls in terms of accurate pricing. Most pricing services provide prices as of a business day's close. At that close, credit spread levels should be established using the closing prices of the securities and the closing prices of an appropriate benchmark. This enables the bond trader to better determine an acceptable range at which to execute; this becomes increasingly helpful during times of a volatile market. Because spread duration has a smaller impact on the daily price movement of a security, under most conditions it should be safe to establish an execution criterion based on the initial trade date pricing levels.

The U.S. domestic government markets have high price transparency, and those securities can be priced reliably at the time of execution using live trade screens. Some U.S. agency securities also benefit from these platforms, as do TBA mortgages. Although the U.S. government bond market generally experiences few discrepancies related to price transparency, there are some government securities whose prices can vary greatly from dealer to dealer, such as inflation index securities (TIPS).

Price transparency for some issues is a problem in the corporate bond market. One way of establishing price levels for investment-grade corporate debt is through the use of the TRACE program. TRACE usually provides a good measure of where a bond is currently trading. The TRACE program requires all corporate bond trades that fall within its universe to be reported within a short time frame of their execution. This has enabled technology to capture the execution levels throughout the day for various fixed income securities and, as a result, has increased the amount of price transparency for those sectors.

Generic mortgage products such as 15- and 30-year pass-through securities experience little price discrepancies in the current coupon mortgages. These securities normally are priced off of a relevant TBA issue that acts as a benchmark. Normally, there is a premium in price associated with seasoned pass-throughs securities and specified pools in comparison with their respective TBA. Those pools with coupons that are not within a close range of the market's current coupon also may experience price discrepancies and may not be traded widely. When this is the case, liquidity and pricing can become a problem. Not only is establishing a pricing level a concern when a transition manager formulates a restructuring strategy, but price volatility owing to economic events is of great concern as well.

One way of mitigating those risks associated with corporate bond issues that have a high probability of experiencing a significant credit event in the near future is to screen the issues for negative credit watch ratings. By identifying the volatile issues or market sectors, the price degradation associated with holding these issues during their fall can be decreased. The major rating agencies routinely publish their credit watch reports and detail securities that have been placed on their negative credit watch owing to suspect economic performance or other findings. If these securities are not selected to be taken in-kind, it is recommended that they be liquidated as soon as possible. Liquidity not only becomes a concern with esoteric structures, the size of an issue also can cause liquidity problems as well. Fixed income markets are comprised primarily of institutional investors, and for this reason, a premium is received for position sizes deemed attractive to an institutional investor. These are normally termed *round-lot positions* and will vary depending on the security type and issue. A round lot's size usually begins between $1 million and $5 million.

Most developed foreign markets do not pose liquidity concerns when trading their investment-grade debt securities. Foreign investment-grade securities usually have multiple dealers making markets in individual issues, thus assuring sufficient liquidity. However, foreign non-investment-grade debt markets tend to have less transparency than in U.S. domestic non-investment-grade markets; significant due diligence is required prior to trading these assets.

In the United States, the most widely traded high-yield corporate bonds appear on the TRACE database and generally should not pose liquidity concerns. However, the majority of U.S. domestic high-yield corporate bonds are not reported to the TRACE program and can pose both liquidity and price transparency concerns. It is recommended that a competitive bid strategy be used like that in other security types. When liquidating high-yield securities it is not uncommon for some securities not to receive bids. To facilitate the liquidity issues associated with these types of securities, once the competitive bid process has been tried and is unsuccessful, it is best to derive a target price level and assign one or more brokers to work the orders through their networks.

Timeline for the Restructure and Proceeds Distributions of Assets Sold
A key objective for the transition manager is to be able to restructure a portfolio efficiently while meeting the client's timing deadlines. A common analysis is to study the liquidity characteristics of those securities being bought or sold. However, one area commonly overlooked are trading characteristics with selling various types of mortgage products.

Throughout the month, mortgage factors change, and the factor posting date can vary depending on whether one is selling or buying an agency mortgage or a private-label product. In order to prepare for the cash-flow timing mismatches, an intense screening of the mortgage securities in the transition should be done. Mortgage securities in the portfolio should be identified; then there must be a determination as to whether they are going to be traded on good factors or not. If the factors are expected to change after the settlement date, no adjustment to the proceeds will have to occur. Factor adjustments can cause net proceeds at the end of the transition to vary slightly, and the availability of those proceeds can cause problems if not carefully accounted for. The process of correcting a trade after it has been booked is commonly referred to as the *cancel and correct process*. When dealing with mortgage-related products, it is always best to screen all the holdings and make a conservative estimate of the proceeds to be delivered in a second distribution. This estimate can be derived using historical factor change data.

Liquidation strategies also will vary depending on whether it is a buy/sell event and/or a hedge is in place. If the transition is a buy/sell event, then exposures to duration buckets and sectors should be identified and factored into the strategy. The balancing of a buy/sell program while rebalancing a hedge is more operationally intensive than a straight liquidation, and this should be considered when providing initial transition timelines.

Reporting Phase

The reporting phase encompasses the creation of the posttrade report, the cash reconciliation of distribution proceeds, and the audit and transfer of remaining assets. The posttrade report is a summary of the transition. The posttrade report does not have to be a lengthy document; however, it is not unlikely that senior management of the client firm will be using this as a tool to disseminate information. The posttrade report should be written in a manner that summarizes the transition's operations and effectiveness and also should include execution details for readers who want to study the transition's performance. The posttrade report usually consists of the following components: transition synopsis, execution performance summary, portfolio composition analysis, and execution detail.

Transition synopsis is a text document that should describe from a high level what transpired during the transition and should highlight key points, such as market value of assets transitioned, performance versus benchmark, and any other pertinent information. Also discussed should be any unusual economic events that may have affected the transition. Fees may or may not be stated here.

The execution performance summary can be either a text document or a spreadsheet. However, the crux of this report is how the portfolio performed during the transition. Details should include dates at which proceeds were raised and how close execution levels were in comparison with expected price levels. This section also should highlight costs such as taxes or commissions paid.

The composition analysis allows the client to view the portfolio by market sector, security type, and credit rating. Details such as duration, number of securities, and liquidation timing also should be displayed.

The execution detail section is a list of assets and their execution prices. This is usually in spreadsheet format and includes details such as accrued interest, trade date, settle date, and net proceeds.

Another crucial component of the reporting phase is the reconciliation of the ending cash and asset balances. The ending cash balance reconciliation entails the accounting of the original cash, the impact of profits or losses that occurred during the transition, and the settlement proceeds of trades. This part of the transition is of great importance because the transition cannot be considered complete until the proceeds have been distributed. The reconciliation function is usually completed independently by both the investment coordinator and the portfolio manager. The goal is to ensure that the ending cash balance available stated by the custodian agrees with the reconciliation done by the transition manager. Once the final cash numbers have been agreed on, final cash distributions can be made, and if applicable, the remaining assets in the transition account can be transferred to the target manager.

If assets do remain in the transition account, to either satisfy a purchase program or because of illiquidity, a final position audit should be performed by the portfolio manager of the transition management group. Those assets which were purchased to satisfy the wish list of a target manager should be certified by the portfolio manager of the transition management group and an explanation must be provided for any assets that were not purchased. For those assets which remain in the account owing to illiquidity, an explanation should be provided to both the target manager and the client that describes their status.

RISK MANAGEMENT AND TRANSITION MANAGEMENT

In many respects, transition management from the perspective of both the provider and client is synonymous with risk management. The service provider measures the success of a transition by the efficiency in which the service was completed. Minimizing unwanted costs and maintaining the objective strategy in a risk-controlled manner are the primary focuses for the provider. For the client, the process of transition management is for the transition manager to provide the service in a manner that will maintain the client's goals in an efficient and controlled fashion. To do this, the provider must implement and follow strict risk-management guidelines. The primary risks associated with an investment portfolio's transition are execution risks, operations risks, and market-exposure risks. The following is a description of each.

Execution Risks

Some of the risks associated with execution can stem from the following: information leakage, lack of bidding participants, inappropriate broker networks, inaccurate fair-value indications, and unforeseen economic events.

Negative impact can occur because of information leakage in a number of ways. Two of the more common are revealing the list without using proper discretion and revealing who the client is. The constituents of the portfolio should remain as anonymous as possible for as long as possible. Overexposure could be perceived as a sign of distress and ultimately result in a lower price. The same is true on the reverse side: If the client is a buyer and sellers know this, the price may become artificially inflated. Anonymity of the client should be preserved at all costs.

Lack of bidding participants and inappropriate broker networks are two risks that are closely related. Prior to selling any security, descriptive information, such as security type and market sector, should be understood. The more knowledge the portfolio manager has about the individual security, the greater is the likelihood the right broker network will be used. It has been my experience that the risk of receiving no bids on individual bonds increases as the number of brokers receiving the bid lists decreases. Establishing a network of brokers who specialize in various sectors can increase the chances of improved execution levels.

Establishing a fair-value price level in the debt markets has become one of the pinnacle topics in bond trading today. Because of the lack of transparency in bond pricing, numerous resources have and are being developed to address this issue. It is not unlikely that some pricing sources will be more accurate in particular sectors when compared with others; however, knowing where specific pricing source providers have shortfalls will aid tremendously in establishing execution levels for various sectors.

Unforeseen economic events are unavoidable. However, the screening of rating agency credit watch reports is an efficient tool to help mitigate the risks associated with suspect credits.

Operations Risk

Operations risks lie in every facet of the transition, and accordingly, every department must have procedures to mitigate them. Commonly overlooked and undervalued are those risks associated with trade settlement and investment administration. A successful transition is measured not only by the proceeds raised or the accuracy of a restructuring but also by how seamless the transition process is to the client.

Another important consideration is, What if there are technological malfunctions? Can the process still be completed? Contingency planning is critical to successful transition management because of the size and complexity of portfolios commonly associated with transitions.

Market-Exposure Risks

The lack of appropriate market exposure is one of the largest risks a client may face during a transition. During a straight liquidation, a client may have specific funding dates on which it can enter a new strategy. Therefore, timing of proceeds distributions should be planned accurately and or a hedge strategy should be considered.

Some popular hedging instruments include currency forwards and futures. Forwards can be used to maintain currency exposure to various markets that differ from the current base currency of the portfolio. Futures can be used to synthetically create market exposure to specific indexes and/or specific assets types. An important consideration when using futures is the availability of cash for the use of collateral. When collateral is pledged in a form other than cash, a haircut is taken by the futures broker. Consequently the market value of the security will need to exceed the initial cash margin requirement. Another consideration during an ongoing hedge is that funds will have to be available to pay marks to market as needed. Prior to trading both currencies and/or futures with counterparties, certain credit requirements must be met, and futures and currency accounts must be opened.

MEASURING TRANSITION PERFORMANCE

Currently, the transition industry is in the midst of formulating a performance measure that compares the difference between the return on the actual portfolio and the return on the target portfolio. It is hoped that this measure might quantify both the explicit and implicit costs associated with the transition via a single number.

There are some specific hurdles that hinder the ability to measure the success of a fixed income transition. First, fixed income securities are traded in the OTC market, where liquidity and price transparency are much lower than in exchange-traded markets. Another hurdle is that most fixed income transitions are one-sided, and restructuring of the target portfolio usually is a multiday trading event and may or may not be done by the transition manager.

The lack of price transparency presents a performance hurdle that a number of entities are attempting to address. Custodians usually provide portfolio values to the plan sponsors. To do this, the custodian usually subscribes to a pricing service. The price providers may differ depending on the custodian. Although there are numerous price providers, the pricing levels are likely to vary from one to another. The majority of fixed income securities are priced daily, but there are some securities that may not trade every day and as a result may have less accurate prices in comparison with more liquid issues. Depending on the security type, issue size, and a number of other factors, the deviation in price from one provider to another can be quite significant. It is not unusual for an esoteric security to have price differences between providers of 10 points or more. Because of the lack of transparency, the prices provided are considered fair-value indications, and the actual execution level of the bond in question my vary depending on the individual investor's (purchaser's) perception of the bond's fair value.

Measuring the completion of a fixed income transition presents another performance-measurement hurdle. Most fixed income portfolios are created using proprietary fair-value models. Because the desire to hold different weights of various securities depends greatly on the portfolio manager's proprietary models, the purchase decision for a particular bond can be complex. The attractiveness of each issue can change given a small change in price, and not all issues are readily available for sale. Because of this, portfolio managers have various proxy securities that help them to derive their strategies. This lack of transparency and liquidity makes the buy side of a fixed income transition, an intimate transaction and guidance from the target portfolio manager is recommended. The restructuring can take place over a couple of days or up to a month, depending on the size and strategy of the new investments. This hurdle obviously makes it difficult to measure the effectiveness of the transition or the market value of the target portfolio.

Execution Measurement

Given that the ability to accurately determine implicit costs associated with fixed income securities remains ambiguous, one way to address this problem is to evaluate the execution levels realized for a given fixed income transaction versus the daily price indications. The result then can be carried forward to derive the execution performance for the entire portfolio.

The process for calculating this execution price impact is as follows. Prior to trading any fixed income security, a fair-value indication is derived by using the bid-side pricing from the custodial pricing service. The prices provided are usually as of the previous night's close; a credit spread to an appropriate benchmark needs to be established as of that time. Establishing a credit spread for each security provides an objective initial price level; this will facilitate the measurement of performance. It is this pricing level (credit spread) that now becomes the benchmark for the security to be evaluated against, and the impact is the difference between the indication and the execution level.

It is likely that a small percentage of the bonds will have pricing levels significantly different from their true market fair value. Such occurrences need to be addressed on a case-by-case basis. At this point, the execution performance can be reported using a number of different metrics: credit spread, in basis points, dollar price spread, or market value.

POINTS TO CONSIDER

Transition management is complex and can expose a plan to significant risks and costs. A transition manager should be selected with care. Some key considerations when reviewing fixed income transition managers are

- Will there be a dedicated portfolio manager?
- What is the company's track record of trading in various market sectors?
- Does the company have the ability and experience using various hedging instruments to maintain market exposure?
- Does the company have experience working with nonaffiliated legacy and destination managers?
- Does the company have experience working with nonaffiliated custodial groups?

PART
SEVEN

DERIVATIVES AND THEIR APPLICATIONS

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CHAPTER
FIFTY-ONE

INTRODUCTION TO INTEREST-RATE FUTURES AND OPTIONS CONTRACTS

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With the advent of options, futures, and forwards on interest-rate instruments, proactive fixed income risk management, in its broadest sense, assumes a new dimension. Investment managers and traders can achieve new degrees of freedom. It is now possible to alter the interest-rate sensitivity of a fixed income portfolio economically and quickly. *Derivative contracts,* known as such because they derive their value from an underlying instrument, offer investment managers and traders risk and return patterns that were previously either unavailable or too costly.

The purpose of this chapter is twofold. First, we explain the basic characteristics of options, futures, and forward contracts. Second, we review the most actively traded and most representative over-the-counter (OTC) and listed contracts. We omit from our discussion the use of futures for hedging; this topic will be explained in more detail in Chapter 57.

BASIC CHARACTERISTICS OF DERIVATIVE CONTRACTS

Futures Contracts

A *futures contract* is an agreement between a buyer (seller) and an established futures exchange or its clearinghouse in which the buyer (seller) agrees to take (make) delivery of a specific amount of a valued item such as a commodity, stock, or bond at a specified price at a designated time. For some futures contracts, settlement at expiration is in cash rather than actual delivery.

When an investor takes a position in the market by buying a futures contract, the investor is said to *be long the futures* or have a *long position in the futures.* If, instead, the investor's opening position is the sale of a futures contract, the investor is said to *be short the futures* or have a *short position in the futures.*

Futures contracts based on a financial instrument or a financial index are known as *financial futures.* Financial futures can be classified as interest-rate futures, stock index futures, or currency futures. This chapter focuses on interest-rate futures and includes a description of the most important interest-rate futures contracts currently traded.

To illustrate how financial futures work, suppose that *X* buys a futures contract and *Y* sells a futures contract on a 6% five-year Treasury note for settlement one year from now. Suppose also that the price at which *X* and *Y* agree to transact one year from now is $100. This is the futures price. This means that one year from now *Y* must deliver a 6% five-year Treasury note and will receive $100. *X* will take delivery of a 6% five-year Treasury note and will pay $100.

The profit or loss realized by the buyer or seller of a futures contract depends on the price and interest rate on the delivery date. For example, if the market price of a 6% five-year Treasury note at the settlement date is $110, because rates have declined, the buyer profits, paying $100 for a security that is worth $110. In contrast, the seller loses, because an instrument worth $110 must be delivered in exchange for $100. If interest rates rise on 6% five-year Treasury notes so that the market price is $90, the seller of the futures contract profits and the buyer loses.

When the investor first takes a position in a futures contract, he must deposit a minimum dollar amount per contract as specified by the exchange. As the price of the futures contract fluctuates, the value of the investor's equity in the position changes. At the close of each trading day, any market gain results in an increase in the investor's equity, whereas any market loss results in a decrease. This process is referred to as *marking to market.* Should an investor's equity position fall below an amount determined by the exchange, he must provide additional margin. On the other hand, if an investor's equity increases, he may withdraw funds. Consequently, a futures position may require substantial cash flows before the delivery date. Margin is described in more detail later in this chapter.

Forward Contracts

A *forward contract* is much like a futures contract. A forward contract is an agreement for the future delivery of some amount of a valued item at a specified price at a designated time. Futures contracts are standardized agreements that define the delivery date (or month) and quality and quantity of the deliverable. Futures contracts are traded on organized exchanges. A forward contract is, in contrast, usually nonstandardized and is traded over the counter by direct contact between buyer and seller.

Although both futures and forward contracts set forth terms of delivery, futures contracts are not intended to be settled by delivery. In fact, generally only a small percentage of outstanding futures contracts are delivered or go to final settlement. However, forward contracts *are* intended to be held to final settlement. Many of the most popular forward contracts, however, settle in cash rather than actual delivery.

Forward contracts may or may not be marked to market. Consequently, there is no interim cash flow on forwards that are not marked to market.

Finally, both parties in a forward contract are exposed to credit risk because either party may default on its obligation. In contrast, credit risk for futures contracts is minimal because the clearing corporation associated with the exchange guarantees the other side of each transaction.

Options

An *option* is a contract in which the seller of the option grants the buyer of the option the right to purchase from, or sell to, the contract seller a designated instrument at a specified price within a specified period of time. The seller (or *writer*) grants this right to the buyer in exchange for a certain sum of money, called the *option price* or *option premium.*

The price at which the instrument may be bought or sold is called the *exercise* or *strike price.* The date after which an option is void is called the *expiration date.* An *American option* may be exercised any time up to and including the expiration date. A *European option* may be exercised only on the expiration date.

When an option writer grants the buyer the right to purchase the designated instrument, it is called a *call option.* When the option buyer has the right to sell the designated instrument to the writer, the option is called a *put option.* The buyer of an option is said to be *long the option;* the writer is said to be *short the option.*

Consider, for example, an option on a 6% five-year Treasury note with one year to expiration and an exercise price of $100. Suppose that the option price is $2 and the current price of the Treasury note is $100 with a yield of 6%. If the option is a call option, then the buyer of the option has the right to purchase a 6% five-year Treasury note for $100 within one year. The writer of the option must sell the Treasury note for $100 to the buyer if he or she exercises the option. Suppose that the interest rate on the Treasury note declines and its price rises to $110. By exercising the call option, the buyer realizes a profit, paying $100 for a Treasury note that is worth $110. After considering the cost of buying the option, $2, the net profit is $8. The writer of the option loses $8. If, instead, the market interest rate rises and the price of the Treasury note falls below $100, the call option buyer will not exercise the option, losing the option price of $2. The writer will realize a profit of $2. Thus the buyer of a call option benefits from a decline in interest rates (a rise in the price of the underlying fixed income instrument) and the writer loses.

If the option is a put rather than a call and the interest rate on Treasury notes declines and the price rises above $100, the option buyer will not exercise the option. The buyer will lose the entire option price. If, on the other hand, the interest rate on Treasury notes rises and the note's price falls below \$100, the option buyer will profit by exercising the put option. In the case of a put option, the option buyer benefits from a rise in interest rates (a decline in the price of the underlying fixed income instrument) and the option seller loses.

The maximum amount that an option buyer can lose is the option price. The maximum profit that the option writer (seller) can realize is the option price. The option buyer has substantial potential upside return, whereas the option writer has substantial downside risk. The risk/reward relationships for option positions are investigated in Chapter 54.

Options can be written on cash instruments or futures. The latter are called *futures options* and are traded only on exchanges. Options on cash instruments are also traded on exchanges but have been traded much more successfully over the counter. These *OTC,* or *dealer, options* are tailor-made options on specific Treasury issues, mortgage securities, or interest-rate indexes. Option contracts are reviewed later in this chapter.

Differences between Option and Futures (or Forward) Contracts

Unlike a futures or forward contract, an option gives the buyer the *right* but not the *obligation* to perform. The option seller has the obligation to perform. In the case of a futures or forward contact, both the buyer and seller are obligated to perform. In addition, the buyer of a futures or forward contract does not pay the seller to accept the obligation, whereas in the case of an option, the buyer pays the seller an option premium.

Consequently, the risk/reward characteristics of the two contracts also differ. In a futures or forward contract, the long position realizes a dollar-for-dollar gain when the price of the futures or forward increases and suffers a dollar-for-dollar loss when the price of the futures or forward decreases. The opposite holds for a short position. Options do not provide such a symmetric risk/reward relationship. The most a long position may lose is the option premium, yet the long retains all the upside potential. However, the gain is always reduced by the price of the option. The maximum profit the short position may realize is the option price, but the short position has substantial downside risk.

REPRESENTATIVE EXCHANGE-TRADED INTEREST-RATE FUTURES CONTRACTS

Interest-rate futures contracts can be classified by the maturity of their underlying security. Short-term interest-rate futures contracts have an underlying security that matures in less than one year or a short-term reference interest rate. The maturity of the underlying security of long-term futures exceed one year. Below we describe the specifications of the long-term futures contracts (Treasury bond futures, Treasury notes futures, agency note futures, and municipal bond futures) and short-term futures contracts (Treasury bill futures, Eurodollar CD futures, interest-rate swap futures, and federal funds futures).

The Treasury Bond Futures Contract

The Treasury bond (T-bond) futures contract is the most successful interest-rate (or commodity) futures contract. Prices and yields on the T-bond futures contract are quoted in terms of a (fictitious) 20-year 6% Treasury bond, but the exchange where the contract is traded, the Chicago Board Options Exchange (CBOT), allows many different bonds to be delivered in satisfaction of a short position in the contract. Specifically, any noncallable Treasury bond with at least 15 years to maturity from the first day of the delivery month qualifies for delivery. Consequently, there are usually at least 15 outstanding bonds that constitute good delivery.

The T-bond futures contract calls for the short (i.e., the seller) to deliver $100,000 face value of any one of the qualifying Treasury bonds. However, because the coupons and maturities vary widely, the price that the buyer pays the seller depends on which bond the seller chooses to deliver. The rule used by the CBOT is one that adjusts the futures price by a conversion factor that reflects the price the bond would sell for at the beginning of the delivery month if it were yielding 6%. Using such a rule, the conversion factor for a given bond and a given delivery month is constant through time and is not affected by changes in the price of the bond or the price of the futures contract.

The seller has the right to choose which qualifying bond to deliver and when during the delivery month delivery will take place. When the bond is delivered, the buyer is obligated to pay the seller the futures price times the appropriate conversion factor, plus accrued interest on the delivered bond.

Paradoxically, the success of the CBOT Treasury bond contract can in part be attributed to the fact that the delivery mechanism is not as simple as it may first appear. There are several options implicit in a position in bond futures. First, the seller chooses which bond to deliver. Thus, the seller has an option to swap between bonds. If the seller is holding bond A for delivery, but bond B becomes cheaper to deliver, she can swap bond B for bond A and make a more profitable delivery. Second, within some guidelines set by the CBOT, the seller decides when during the delivery month delivery will take place. She thus has a timing option that can be used to her advantage. Finally, the short retains the possibility of making the wildcard play. This potentially profitable situation arises from the fact that the seller can give notice of intent to deliver for several hours after the exchange has closed and the futures settlement price has been fixed. In a falling market, the seller can use the wildcard option to profit from the fixed delivery price.

The seller's options tend to make a contract a bit more difficult to understand, but at the same time they make the contract more attractive to speculators, arbitrageurs, dealers, and anyone else who understands the contract better than other market participants. Thus, in the case of the Treasury bond futures contract, complexity has helped provide liquidity.

Because of the importance of this contract, it is discussed in more detail in Chapter 53.

Treasury Note Futures

There are three Treasury note futures contracts: 10-year, 5-year, and 2-year. All three contracts are modeled after the Treasury bond futures contract and are traded on the CBOT. The underlying instrument for the 10-year Treasury note futures contract is $100,000 par value of a hypothetical 10-year 6% Treasury note. There are several acceptable Treasury issues that may be delivered by the short. An issue is acceptable if the maturity is not less than 6.5 years and not greater than 10 years from the first day of the delivery month. The delivery options granted to the short position are the same as for the Treasury bond futures contract.

For the 5-year Treasury note futures contract, the underlying is $100,000 par value of a U.S. Treasury note that satisfies the following conditions: (1) an original maturity of not more than five years and three months, (2) a remaining maturity not more than five years and three months, and (3) a remaining maturity of not less than four years and two months.

The underlying for the 2-year Treasury note futures contract is $200,000 par value of a U.S. Treasury note with a remaining maturity of not more than two years and not less than one year and nine months. Moreover, the original maturity of the note delivered to satisfy the two-year futures cannot be more than five years and three months.

Agency Note Futures

The Chicago Mercantile Exchange (CME) began trading in 2000 futures contracts in which the underlying instrument is a Freddie Mac and Fannie Mae agency debenture security. These contracts are modeled after the Treasury bond futures contract in that the underlying bond is hypothetical with a notional coupon. The underlying instrument for the CME 10-year Agency note futures contract is a Freddie Mac Reference Note or a Fannie Mae Benchmark Note having a par value of $100,000 and a notional coupon of 6.5%.

As with the Treasury futures contracts, there are several issues which can be delivered to settle the contract. For an issue to be deliverable, the CME requires that the original maturity is 10 years and which does not mature for a period of at least 6.5 years from the date of delivery. The contract delivery months are March, June, September, and December. Like Treasury futures, there is a conversion factor associated with each issue in the deliverable basket. The CME 5-year Agency note futures contract is structured similarly.

The CBOT introduced a 5-year and 10-year Agency note futures contract at about the same time but these contracts were delisted on February 13, 2004.

10-Year Municipal Note Index Futures

The CBOT's 10-year municipal note index futures contract is based on the notional price of a synthetic 10-year, 5% coupon municipal note with a par value of $100,000. The notional price is based upon an index constructed by FT Interactive Data Corporation which includes up to 250 Aaa-rated, widely-held bond issues designed to be representative of the high-grade sector of the municipal bond market. Index revisions occur on the first business day of February, May, August, and November. Contract expiration months are March, June, September, and December and the contracts are settled in cash. The final settlement value is determined using a discount rate equal to the average yield-to-worst of the component bonds in the index on the last day of trading.

The Treasury Bill Futures Contract

The IMM's futures contract on Treasury bills was the first contract on a short-term debt instrument, and has been the model for most subsequent contracts on short-term debt. The contract is based on three-month Treasury bills with a face value of $1 million.

The contract is quoted and traded in terms of a futures "price," but the futures price is, in fact, just a different way of quoting the futures interest rate. Specifically, the futures price is the annualized futures rate subtracted from 100. For example, a futures price of 97.50 means that Treasury bills are trading in the futures market at a rate of 2.50%. The actual price that the buyer pays the seller is calculated using the usual formula for Treasury bills:

$$\text{Invoice price} = \$1{,}000{,}000 \times \left[1 - \text{rate} \times \left(\frac{\text{days to maturity}}{360}\right)\right]$$

where the rate is expressed in decimal form. As this formula shows, each basis point change in the interest rate (or each 0.01 change in the futures price) leads to a $25 change in the invoice price for a 90-day bill. Consequently, the value of a 0.01 change in the futures contract is always $25.

The Treasury bill futures contract is considerably simpler than the T-bond and T-note futures contracts. First, because all Treasury bills of the same maturity are economically equivalent, there is effectively only one deliverable issue, namely, Treasury bills with three months to maturity. The fact that the three-month bills may be either new three-month bills or older bills that currently have three months of remaining life makes little difference because the new and old issues will trade the same in the cash market. Thus, all the subtleties surrounding conversion factors and most deliverable issues are absent from the Treasury bill futures market. Furthermore, there is little uncertainty or choice involved in the delivery date, because delivery must take place during a very narrow time frame, usually a three-day period. The rules of the exchange make clear well in advance the exact dates on which delivery will take place. Finally, because there are no conversion factors, there is no wildcard play in the Treasury bill futures market.

Although the Treasury bill futures contract is simple and thus may not provide as many speculative and arbitrage opportunities as the more complex long- and intermediate-term futures contracts, it does provide a straightforward means of hedging or speculating on the short end of the yield curve. Because the Treasury bill rate is a benchmark off which other short-term rates may be priced, the bill contract fills a well-defined need of many market participants.

The Eurodollar Futures Contract

Eurodollar CDs are U.S. dollar-denominated CDs issued primarily in London by U.S., Canadian, European, and Japanese banks. These CDs earn a fixed rate of interest related to dollar LIBOR. The term LIBOR comes from the London Interbank Offered Rate and is the interest rate at which one London bank offers funds to another London bank of acceptable credit quality in the form of a cash deposit. The rate is "fixed" by the British Bankers Association every business morning by the average of the rates supplied by member banks.

The 3-month (90 days) Eurodollar CD is the underlying instrument for the Eurodollar futures contract. The contracts are traded on the International Monetary Market of the Chicago Mercantile Exchange and the London International Financial Futures Exchange (LIFFE). As with Treasury bill futures contract, this contract has a $1 million face value and is traded on an index price basis. The index price basis in which the contract is quoted is equal to 100 minus the annualized futures LIBOR. For example, a Eurodollar CD futures price of 97.50 means a futures 3-month LIBOR of 2.50%.

The minimum price fluctuation or tick for this contract is 0.005 or 1/2 basis point. Accordingly, the tick value for this contract is $12.50 as determined by the following expression:

$$\text{Tick value} = \$1{,}000{,}000 \times (0.005 \times 90/360) = \$12.50$$

The Eurodollar futures contract is a cash settlement contract.

Swap Futures Contracts

Interest-rate swaps are discussed in Chapter 55. The CBOT introduced a swap futures contract in 2001. The underlying instrument is the notional price of the fixed-rate side of a 10-year interest-rate swap that has a notional principal equal to $100,000 and that exchanges semiannual interest payments at a fixed annual rate of 6% for floating interest-rate payments based on three-month LIBOR.

This swap futures contract is cash-settled, with a settlement price determined by the International Swap and Derivatives Association (ISDA) benchmark 10-year swap rate on the last day of trading before the contract expires.

This benchmark rate is published with a one-day lag in the Federal Reserve Board's statistical release H.15. Contracts have settlement months of March, June, September, and December, just like the other CBOT interest-rate futures contracts that we have discussed.

The London International Financial Futures Exchange (LIFFE) introduced the first swap futures contract called Swapnote, which is referenced to the euro interest-rate swap curve. Swapnotes are available in 2-, 5-, and 10-year maturities. The CME also lists a swap futures contract with maturities of 2, 5, and 10 years that is similar to those listed on the CBOT.

Fed Funds Futures Contracts

The 30-day federal funds futures contract is designed for financial institutions and businesses who want to control their exposure to movements in the federal funds rate. The federal funds futures contract began trading on the CBOT in October 1988. These contracts have a notional amount of $5 million, and the contract can be written for the current month up to 24 months in the future. Underlying this contract is the simple average overnight federal funds rate (i.e., the effective rate) for the delivery month. As such, this contract is settled in cash on the last business day of the month. Just as the other short-term interest-rate futures contracts discussed earlier, prices are quoted on the basis of 100 minus the overnight federal funds rate for the delivery month. These contracts are marked to market using the effective daily federal funds rate as reported by the Federal Reserve Bank of New York.

Mechanics of Futures Trading

Types of Orders

When a trader wants to buy or sell a futures contract, the price and conditions under which the order is to be executed must be communicated to a futures broker. The simplest type of order, yet potentially the most perilous from the trader's perspective, is the *market order.* When a market order is placed, it is executed at the best price available as soon as the order reaches the trading pit, the area on the floor of a futures exchange where all transactions for a specific contract are made. The danger of market orders is that an adverse move may take place between the time the trader places the order and the time the order reaches the trading pit.

To avoid the dangers associated with market orders, the trader can place a *limit order* (or *resting order*) that designates a price limit for the execution of the transaction. A *buy limit order* indicates that the futures contract may be purchased only at the designated price or lower. A *sell limit order* indicates that the futures contract may be sold only at the designated price or higher.

The danger of a limit order is that there is no guarantee that it will be executed at all. The designated price may simply not be obtainable. Even if the contract trades at the specified price, the order may not be filled because the market does not trade long enough at the specified price (or better) to fill all outstanding orders. Nevertheless, a limit order may be less risky than a market order. The trader has more control with a limit order, because the price designated in the limit order can be revised based on prevailing market prices as long as the order has not already been filled.

The limit order is a conditional order: It is executed only if the limit price or a better price can be obtained. Another type of conditional order is the *stop order.* A stop order specifies that the order is not to be executed until the market reaches a designated price, at which time it becomes a market order. A *buy stop order* specifies that the order is not to be executed until the market rises to a designated price (i.e., trades at or above, or is bid at or above, the designated price). A *sell stop order* specifies that the order is not to be executed until the market price falls below a designated price (i.e., trades at or below, or is offered at or below, the designated price). A stop order is useful when a futures trader already has a position on but cannot watch the market constantly. Traders can preserve profits or minimize losses on open positions by allowing market movements to trigger a closing trade. In a sell (buy) stop order, the designated price is less (greater) than the current market price of the futures contract. In a sell (buy) limit order the designated price is greater (less) than the current market price of the futures contract.

There are two dangers associated with stop orders. Because futures markets sometimes exhibit abrupt price changes, the direction of the change in the futures price may be very temporary, resulting in the premature closing of a position. Also, once the designated price is reached, the stop order becomes a market order and is subject to the uncertainty of the execution price noted earlier for market orders.

A *stop-limit order,* a hybrid of a stop order and a limit order, is a stop order that designates a price limit. Thus, in contrast to the stop order, which becomes a market order if the stop is reached, the stop-limit order becomes a limit order if the stop is reached. The order can be used to cushion the market impact of a stop order. The trader may limit the possible execution price after the activation of a stop. As with a limit order, the limit price might never be reached after the order is activated, and therefore the order might not be executed. This, of course, defeats one purpose of the stop order—to protect a profit or limit a loss.

A trader also may enter a *market-if-touched order.* A market-if-touched is like a stop order in that it becomes a market order if a designated price is reached. However, a market-if-touched order to buy would become a market order if the market *falls* to a given price, whereas a stop order to buy becomes a market order if the market *rises* to a given price. Similarly, a market-if-touched order to sell becomes a market order if the market rises to a specified price, whereas the stop order to sell becomes a market order if the market falls to a given price. One may think of the stop order as an order designed to exit an existing position at an acceptable price (without specifying the exact price), and the market-if-touched order as an order designed to enter a position at an acceptable price (also without specifying the exact price).

Orders may be placed to buy or sell at the open or the close of trading for the day. An *opening order* indicates that a trade is to be executed only in the opening range for the day, and a *closing order* indicates that the trade is to be executed only within the closing range for the day.

Futures brokers may be allowed to try to get the best possible price for their clients. The *discretionary order* gives the broker a specified price range in which to fill the order. For example, a discretionary order might be a limit order that gives the broker a one-tick (i.e., one basis point or 1/32) discretion to try to do better than the limit price. Thus, even if the limit price is reached and the order could be filled at that limit, the broker can wait for a better price. However, if it turns out that the market goes in the wrong direction, the broker must fill the order but at no worse than one tick from the limit price. A *not held order* gives the broker virtually full discretion over the order. The not held order may be placed as any of the orders mentioned so far (market, stop, limit, etc.), but if the broker believes that filling the orders is not advisable, he or she need not fill them.

A client may enter orders that contain order cancellation provisions. A *fill-or-kill* order must be executed as soon as it reaches the trading floor, or it is canceled immediately. A *one-cancels-other order* is a pair of orders that are worked simultaneously, but as soon as one order is filled, the other is canceled automatically.

Orders may designate the time period for which the order is effective—a day, week, or month, or perhaps by a given time within the day. An *open order,* or *good-til-canceled order* is good until the order is specifically canceled. If the time period is not specified, it is usually assumed to be good only until the end of the day. For some orders, like the market order, a specific time period is not relevant, because they are executed immediately.

On execution of an order, the futures broker is required to provide confirmation of the trade. The confirmation indicates all the essential information about the trade. When the order involves the liquidation of a position, the confirmation shows the profit or loss on the position and the commission costs.

Taking and Liquidating a Position

Once an account has been opened with a broker, the futures trader may take a position in the market. If the trader buys a futures contract, she is said to have a long position. If the trader's opening position is the sale of the futures contract, she is said to have a short position.

The futures trader has two ways to liquidate a position. To liquidate a position before the delivery date, she must take an offsetting position in the same contract. For a long position, this means selling an identical number of contracts; for a short position, this means buying an identical number of contracts.

The alternative is to wait until the delivery date. At that time, the investor liquidates a long position by accepting the delivery of the underlying instrument at the agreed-on price or liquidates a short position by delivering the instrument at the agreed-on price. For interest-rate futures contracts that do not call for actual delivery (e.g., Eurodollar futures), settlement is in cash at the settlement price on the delivery date.

The Role of the Clearing Corporation

When an investor takes a position in the futures market, there is always another party taking the opposite position and agreeing to satisfy the terms set forth in the contract. Because of the *clearing corporation* associated with each exchange, the investor need not worry about the financial strength and integrity of the party taking the opposite side of the contract. After an order is executed, the relationship between the two parties is severed. The clearing corporation interposes itself as the buyer for every sale and the seller for every purchase. Thus the investor is free to liquidate a position without involving the other party to the original transaction and without worry that the other party may default. However, the investor *is* exposed to default on the part of the futures broker through which the trade is placed. Thus, each institution should make sure that the futures broker (and specifically the *subsidiary* that trades futures) has adequate capital to ensure that there is little danger of default.

Margin Requirements

When first taking a position in a futures contract, an investor must deposit a minimum dollar amount per contract as specified by the exchange. (A broker may ask for more than the exchange minimum, but may not require less than the exchange minimum.) This amount is called the *initial margin,* and constitutes a good faith deposit. The initial margin may be in the form of Treasury bills. As the price of the futures contract fluctuates, the value of equity in the position changes. At the close of each trading day, the position is marked to market, so that any gain or loss from the position is reflected in the equity of the account. The price used to mark the position to market is the settlement price for the day.

Maintenance margin is the minimum level to which an equity position may fall as a result of an unfavorable price movement before additional margin is required. The additional margin deposited, also called *variation margin,* is simply the amount that will bring the equity in the account back to its initial margin level. Unlike original margin, variation margin must be in cash. If there is excess margin in the account, that amount may be withdrawn.[1]

If a variation margin is required, the party is contacted by the brokerage firm and informed of the additional amount that must be deposited. A margin notice is sent as well. Even if futures prices subsequently move in favor of the

1. Although there are initial and maintenance margin requirements for buying stocks and bonds on margin, the concept of margin differs for futures. When securities are bought on margin, the difference between the price of the security and the initial margin is borrowed from the broker. The security purchased serves as collateral for the loan and interest is paid by the investor. For futures contracts, the initial margin, in effect, serves as good-faith money, indicating that the investor will satisfy the obligation of the contract. No money is borrowed by the purchaser. Similarly, the seller of futures borrows neither money nor securities.

institution such that the equity increases above the maintenance margin, the variation margin must still be supplied. Failure to meet a request for variation margin within a reasonable time will result in the closing out of a position.

Margin requirements vary by futures contract and by the type of transaction; that is, whether the position is an outright long or short or a spread (a long together with a short), and whether the trade is put on as a speculative position or as a hedge. Margins are higher for speculative positions than for hedging positions and higher for outright positions than for spreads. Margin requirements also vary between futures brokers. Exchanges and brokerage firms change their margin requirements as contracts are deemed to be more or less risky, or as it is felt that certain types of positions (usually speculative positions) should be discouraged.

REPRESENTATIVE EXCHANGE-TRADED FUTURES OPTIONS CONTRACTS

Although futures contracts are relatively straightforward financial instruments, options on futures (or *futures options,* as they are commonly called) deserve extra explanation. Options on futures are very similar to other options contracts. Like options on cash (or spot) fixed income securities, both put and call options are traded on fixed income futures. The buyer of a call has the right to buy the underlying futures contract at a specific price. The buyer of a put has the right to sell the underlying futures contract at a specific price. If the buyer chooses to exercise the option, the option seller is obligated to sell the futures in the case of the call, or buy the futures in the case of the put.

An option on the futures contract differs from more traditional options in only one essential way: The underlying instrument is not a spot security, but a futures contract on a security. Thus, for instance, if a call option buyer exercises her option, she acquires a long position in futures instead of a long position in a cash security. The seller of the call will be assigned the corresponding short position in the same futures contract. For put options the situation is reversed. A put option buyer exercising the option acquires a short position in futures, and the seller of the put is assigned a long position in the same futures contract. The resulting long and short futures positions are like any other futures positions and are subject to daily marking to market.

An investor acquiring a position in futures does so at the current futures price. However, if the strike price on the option does not equal the futures price at the time of exercise, the option seller must compensate the option buyer for the discrepancy. Thus, when a call option is exercised, the seller of the call must pay the buyer of the call the current futures price minus the strike price. On the other hand, the seller of the put must pay the buyer of the put the strike price minus the current futures price. (These transactions are actually accomplished by establishing the futures positions at the strike price, then immediately marking to market.) Note that, unlike options on spot securities, the amount of money that changes hands at exercise is only the difference between the strike price and the current futures price, not the whole strike price. Of course, an option need not be exercised for the owner to take her gains; she can simply sell the option instead of exercising it.

We now turn to the options contracts themselves. We describe two of the most important contracts, the CBOT's option on the long-term bond futures contract and the IMM's option on the Eurodollar contract. There are also options on the 5- and 10-year note futures contracts, but because they are both very similar in structure to options on Treasury bond futures, they are not included in this section.

Options on Treasury Bond Futures

Options on CBOT Treasury bond futures are in many respects simpler than the underlying futures contracts. Usually, conversion factors, most deliverables, wildcard plays, and other subtleties of the Treasury bond futures contract need not concern the buyer or seller of options on Treasury bond futures. Although these factors affect the fair price of the futures contract, their impact is already reflected in the futures price. Consequently, they need not be reconsidered when buying or selling an option on the futures.

The option on the Treasury bond futures contract is in many respects an option on an index; the "index" is the futures price itself, that is, the price of the fictitious 20-year 6% Treasury bond. As for the futures contract, the nominal size of the contract is $100,000. Thus, for example, with futures prices at 95, a call option struck at 94 has an intrinsic value of $1,000 and a put struck at 100 has an intrinsic value of $5,000.

In an attempt to compete with the OTC option market, in 1994 the CBOT introduced the *flexible Treasury futures options.* These futures options allow counterparties to customize options within certain limits. Specifically, the strike price, expiration date, and type of exercise (American or European) can be customized subject to CBOT constraints. One key constraint is that the expiration date of a flexible contract cannot exceed that of the longest standard option traded on the CBOT. Unlike an OTC option, where the option buyer is exposed to counterparty risk, a flexible Treasury futures option is guaranteed by the clearinghouse. The minimum size requirement for the launching of a flexible futures option is 100 contracts.

The premiums for options on Treasury bond futures are quoted in terms of points and 64ths of a point. Thus an option premium of 1-10 implies a price of $1^{10}/_{64}\%$ of face value, or $1,156.25 (from $100,000 × 1.15625%). Minimum price fluctuations are also $^{1}/_{64}$ of 1%.

Although an option on the Treasury bond futures contract is hardly identical to an option on a Treasury bond, it serves much the same purpose. Because spot and futures prices for Treasury bonds are highly correlated, hedgers and speculators frequently find that options on bond futures provide the essential characteristics needed in an options contract on a long-term fixed income instrument.

Options on Eurodollar Futures

Options on Eurodollar futures fill a unique place among exchange-traded hedging products. These options are currently the only liquid listed option contracts based on a short-term interest rate.

Options on Eurodollar futures (traded on the IMM) are based on the quoted Eurodollar futures price (i.e., 100 minus the annualized yield). Like the underlying futures, the size of the contract is $1 million and each 0.01 change in price carries a value of $25. Likewise, the option premium is quoted in terms of basis points. Thus, for example, an option premium quoted as 20 (or 0.20) implies an option price of $500; a premium of 125 or (1.25) implies an option price of $3,125.

Like other debt options, buyers of puts on Eurodollar futures profit as rates move up and buyers of calls profit as rates move down. Consequently, institutions with liabilities or assets that float off short-term rates can use Eurodollar futures options to hedge their exposure to fluctuations in short-term rates. Consider institutions that have liabilities that float off short-term rates. These include banks and thrifts that issue CDs and/or take deposits based on money market rates. Also included are industrial and financial corporations that issue commercial paper, floating-rate notes, or preferred stock that floats off money market rates. Likewise, those who make payments on adjustable-rate mortgages face similar risks.[2] In each instance, as short-term rates increase, the liability becomes more onerous for the borrower. Consequently, the issuers of these liabilities may need a means of capping their interest-rate expense. Although options on Eurodollar futures do not extend as far into the future as many issuers would like, they are effective tools for hedging many short-term rates over the near term. Consequently, an institution with floating-rate liabilities can buy an interest-rate *cap* by buying puts on Eurodollar futures. As rates move up, profits on the put position will tend to offset some or all of the incremental interest expense.

On the other side of the coin, and facing opposite risks, are the purchasers of floating-rate instruments—that is, investors who buy money market deposits, floating-rate notes, floating-rate preferred stock, and adjustable-rate mortgages. Investors who roll over CDs or commercial paper face the same problem. As rates fall, these investors receive less interest income. Consequently, they may feel a need to buy interest-rate *floors,* which are basically call options. As rates fall, calls on debt securities increase in value and will offset the lower interest income received by the investor.

In conclusion, options on Eurodollar futures can be used to limit the risk associated with fluctuations in short-term rates. This is accomplished by buying puts if the exposure is to rising rates, or by buying calls if the exposure is to falling rates.

2. To the extent that the interest-rate payment on an adjustable-rate mortgage has an upper and lower bound, the risk to issuers and investors is limited by the nature of the instrument.

Mechanics of Trading Futures Options

To take a position in futures options, one works with a futures broker. The types of orders that are used to buy or sell futures options are generally the same as the orders discussed for futures contracts. The clearinghouse associated with the exchange where the futures option is traded once again stands between the buyer and the seller. Furthermore, the commission costs and related issues that we discussed for futures also generally apply to futures options.

There are no margin requirements for the buyer of futures options, but the option price must be paid in full when the option is purchased. Because the option price is the maximum amount that the buyer can lose regardless of how adverse the price movement of the underlying futures contract, there is no need for margin.

Because the seller has agreed to accept all of the risk (and no reward other than the option premium) of the position in the underlying instrument, the seller generally is required to deposit not only the margin required for the underlying futures contract but also with certain exceptions, the option price as well. Furthermore, subsequent price changes adversely affecting the seller's position will lead to additional margin requirements.

OTC CONTRACTS

There is a substantial over-the-counter (OTC) market for fixed income options and forwards. (Forward contracts are the OTC equivalent of futures contracts.) For example, in the OTC market, one can easily buy or sell options on LIBOR, commercial paper, T-bill, and prime rates. One can buy and sell options on virtually any Treasury issue. One can buy and sell options on any number of mortgage securities. One can buy and sell options with expirations ranging from as short as one day to as long as 10 years. In the OTC market, one can easily take forward positions in three- and six-month LIBOR going out to about 2 years.

In the options market in particular, a natural division has evolved between the OTC market and the listed market. Given the relatively small number of futures contracts, the exchanges' need for standardization, and the synergy created by the futures options contract trading side by side with the underlying futures contract, the exchanges have been most successful with options on futures contracts. Because off-exchange options on futures are prohibited, futures options cannot be traded over the counter. On the other hand, because the OTC market is very good at creating flexible structures and handling a diversity of terms, the OTC market has been more successful than the exchanges in trading options on cash securities and on cash market interest rates.

In the following sections, we discuss the structure of the OTC fixed income derivative markets and their advantages and disadvantages relative to the exchange-traded markets. We also discuss the most important contracts traded in the OTC market. These are options on mortgage securities, options on cash Treasuries, caps and floors on LIBOR, and forward rate agreements on LIBOR.

The Structure of the OTC Market

As in other OTC markets, there is no central marketplace for OTC fixed income options and forward contracts. A transaction takes place whenever a buyer and seller agree to a price. Unlike an exchange transaction, the terms, size, and price of the contract generally remain undisclosed to other market participants. Accordingly, the OTC market is much less visible than the exchange markets and it is more difficult to ascertain the current market price for a given option or forward contract. Two groups, however, help to alleviate this problem. First, there are the OTC market makers. Market makers in OTC fixed income options and forwards are typically large investment banks and commercial banks. A market maker, by definition, stands ready to buy or sell a given option or forward contract to accommodate a client's needs. To be effective, the market maker must be willing and able to handle large orders and must keep the bid-ask spreads reasonably narrow.

The other group that helps bring order to the OTC market is the brokers. The sole job of the brokers is to bring together buyers and sellers; it is not the brokers' job to take positions in option and forward contracts. The buyers and sellers that the brokers bring together can be market makers or the end users of the contracts. To do their job, the brokers must distribute information about the prices where they see trades taking place and the prices at which they believe further trades can be completed. This information is distributed to potential buyers and sellers over the phone and over publicly available media such as Telerate pages.

Because there is no central market for OTC fixed income options and forwards, there can be no clearinghouse. Consequently, those who position OTC contracts may have to give considerable weight to the creditworthiness of their counterparty. For example, entities that sell options or position forward rate agreements (FRAs) can have potential liabilities equal to several times their net worth. Furthermore, there is no guarantee that these counterparties have effective hedges against their positions or, in fact, that they are hedging at all. Furthermore, financial problems on the part of the counterparty can jeopardize the ability or willingness of the counterparty to make good on the terms of a contract even if it is hedged. Consequently, unlike the exchange-traded markets, where one neither knows nor cares who is on the other side of a trade, in the OTC market it is usually very important to know who is on the other side. Creditworthiness can be one of the most important considerations in the trade.

The potential credit problems associated with OTC trades are mitigated in a number of ways. First, some institutions will not buy options from or take either side of an FRA contract with any party other than a major entity with a sound credit rating. Second, some institutions require their counterparty to post collateral immediately after the transaction is completed. This collateral serves much the same purpose as initial margin in the futures and futures options market. Finally, some institutions reserve the right to call for additional collateral from their counterparties if the market moves against the counterparty. This is analogous to variation margin in the exchange-traded markets. Although these provisions may not be as good as a central clearinghouse, they are apparently good enough for a very large number of institutions and good enough for a very large market to develop.

Liquidity, in terms of being able to easily close out an existing position, can be a constraint in the OTC market. OTC options and forwards generally are not assignable transactions. Thus, for example, if one sells an option, the contingent liability associated with that option cannot be transferred to a third party without the express permission of the option buyer. If an option seller wants to cover a short option position, often the best strategy is to buy a similar option from a third party to offset the risks of the original option. However, if the credit of the offsetting party is in question, or the offsetting option is not identical, risks will remain for the option seller. The option buyer can face similar problems if closing out the option before expiration. Credit considerations and the fact that the option buyer may not be able to sell an identical option to offset the first option make it more difficult to effectively close out the long option position. Because FRAs involve contingent liabilities for both sides of the transaction, similar problems exist for both buyers and sellers of FRAs.

Some of the problems associated with the OTC market arise from the fact that the contracts are not standardized. However, nonstandardization leads to many benefits as well. As indicated earlier, OTC contracts can be specified in virtually any terms that are acceptable to both buyer and seller. A potential buyer or seller thus can approach a market maker with whatever structure is needed and in many (but certainly not all) cases obtain the desired structure at a reasonable price. Compared to the very rigid structure of the exchange-traded markets, this is a remarkable advantage.

The OTC Contracts

Options on Mortgages

The OTC market for options on fixed income instruments began in the mid-1970s with *standby* commitments. Standbys were essentially put options on mortgages that allowed the holder (usually a mortgage banker) to sell mortgages at a given price during a given period of time. Although standbys were popularized by the Federal National Mortgage Association, other institutions soon got into the business of selling options. Thrift institutions, in particular, soon became sellers of puts, as well as calls, on mortgages. The thrift would typically sell out-of-the-money puts (struck at a yield that seemed attractive relative to current yields) and out-of-the-money calls (often struck at the thrift's cost of the underlying securities). Until the early 1980s, there were no real market makers in the OTC mortgage options market. Thus a trade typically did not occur until an end user who wanted to buy an option could be paired with an end user who wanted to sell the very same option. The intermediary who stood in between these two parties was usually not willing to position one side without the other.

Today, the market for options on mortgages includes many more participants, although the original standby commitments no longer exist. Investment banks and commercial banks now play a major role in the mortgage options market. Many of the large investment and commercial banks are now willing to position mortgage options without having the other side of the trade. This makes the market much more liquid and flexible than it would be otherwise. The end users of options on mortgages have not changed greatly, but the number of users has increased greatly. Mortgage bankers continue to buy puts on mortgages. Thrifts continue to sell both puts and calls. As some thrifts now play the role of mortgage banker, they too have become buyers of puts on mortgages. Money managers have also become a part of the market, usually as sellers of call options against mortgages in their portfolios.

The market for mortgage options today is composed almost entirely of options on the standard agency pass-through mortgage securities. Options on CMO tranches, IOs, POs, and the like are not a significant part of the OTC mortgage options market. The majority of the options traded are on 30-year mortgages, but options on 15-year products are also readily available. In terms of expiration, trading in mortgage options tends to be concentrated in the shorter expirations, with most of the options expiring within 60 days, and the vast majority expiring within one year. In terms of strike price, most of the trading is in at the money and out of the money options.

Given the willingness of OTC market makers to position options, a client can easily trade options on $25 million of underlying securities with little or no prior notice. Some firms will position $100 million or more of mortgage options on the wire. Thus, the OTC options market can be as liquid as the exchange-traded options markets.

Options on Treasury Securities

Although not as old as the OTC options market for mortgages, the OTC options market for Treasury securities is now just as large and liquid. As in the mortgage options market, investment banks and commercial banks play major roles as market makers, frequently standing ready to buy or sell options on $100 million (or more) of Treasury securities. Most of the action is in options expiring within 60 days, written at the money or out of the money. Options on Treasuries are concentrated in the on-the-run issues, with most of the remaining business being done in the off-the-run issues.

Except for the mortgage bankers, who have considerably less interest in options on Treasuries, the end users of options on Treasuries mirror the market for options on mortgages. Thrifts tend to be writers of out-of-the-money puts and calls, and money managers and mutual funds tend to be covered call writers.

Caps and Floors on LIBOR

The primary OTC options covering the short end of the yield curve are the caps and floors on three- and six-month LIBOR. A cap on LIBOR is, in essence, a series of puts on LIBOR-based debt, whereas a floor on LIBOR is, in essence, a series of calls on LIBOR-based debt.

The buyer of a cap or floor holds most of the rights in the contract, as with other options. The seller of a cap or floor will of course receive an options premium from the buyer but is then obligated to perform on the contract.

To see how these contracts work, consider a five-year, \$100 million cap on three-month LIBOR struck at 4%. Such a contract will specify reset dates occurring every three months for a total of 20 resets. The first reset will usually occur immediately or within a couple of weeks of the trade date, and the last reset will usually be about three months before the stated maturity of the contract. To determine what the payoff to the cap buyer will be, on every reset date one compares the three-month LIBOR (taken from a predetermined source) with the 4% strike rate. If the three-month LIBOR is at or below 4%, nothing is owed to the cap buyer. However, if the three-month LIBOR is above 4%, the cap seller must pay the cap buyer the monetary value of the amount by which three-month LIBOR exceeds 4%. In this case, for a 90-day interest accrual period, the value of each basis point is \$2,500 (from 0.0001 × \$100,000,000 × 90/360). Thus, for example, if three-month LIBOR on a particular reset date is 4.50%, the cap seller owes the cap buyer \$125,000 for that reset. If, on the next reset date, three-month LIBOR is 6%, the cap seller owes the cap buyer \$500,000 for that reset. If, on the next reset date, three-month LIBOR is 3.50%, the cap seller owes nothing to the cap buyer for that reset. In most cases, the cap seller pays the cap buyer the amount of money owed for a particular reset at the end of the interest accrual period-in this case, three months after the reset date.

The mechanics of floors are similar, except that the payoff comes when rates fall below a given level, instead of when they rise above a given level. For example, if one buys a \$25 million seven-year 3% floor on six-month LIBOR, there are a total of 14 reset dates. On each of these reset dates, one compares six-month LIBOR to 3%. If six-month LIBOR is above 3%, nothing is owed to the buyer of the floor for that reset. However, if six-month LIBOR is below 3%, for a 180-day interest accrual period the floor seller owes the floor buyer \$1,250 for every basis point by which six-month LIBOR is below 3% (from 0.0001 × \$25,000,000 × 180/360).

Like other OTC options markets, the cap and floor market is composed of market makers, end users, and brokers. The market makers are once again the large investment banks and commercial banks. However, there are fewer market makers and generally wider spreads in the cap and floor market than there are in the options market for mortgages or Treasury securities. Nonetheless, there is an active market out to 10 years, particularly for out-of-the-money caps and, to a lesser degree, out-of-the-money floors.

The end-user buyers of caps and floors are primarily institutions with risks that they need to cover. For example, institutions that fund short and lend long will tend to have losses as short-term rates rise. Similarly, businesses that fund by rolling over short-term obligations such as commercial paper or by bank borrowings tied to LIBOR or the prime rate will tend to have losses as short-term rates rise. These institutions, which include many thrifts, banks, and finance companies, as well as industrial and construction companies, can protect themselves against rising short-term rates by buying caps. End-user buyers of floors tend to be firms that face losses if rates fall. Such a case might occur, for example, if an institution borrows at a floating rate with a built-in floor. Such an institution may be structured so that floating rates, per se, pose no problem; the problem arises when the floating rate at which they borrow is no longer really floating because the floor has been hit. This institution may buy a floor so that it will receive monetary compensation from the floor seller whenever the floating rate falls below the floor rate, thus covering the risks of lower rates.

The sellers of caps and floors, other than the market makers, are quite varied. In some cases, sellers sell caps or floors outright to bring in premium income. Others sell caps and/or floors to smooth out the cash flows on other fixed income instruments, such as certain derivative mortgage products. In other cases, sellers only implicitly sell the caps or floors. The following example illustrates both kinds of sellers.

When the cap market was developing, it quickly became obvious that there were many natural buyers of caps, but few natural sellers of caps. One successful effort to create sellers of caps occurred when investment bankers, who had many potential buyers of caps, realized that caps could be created as a derivative of the floating-rate note (FRN) market. Issuers of FRNs routinely issue notes reset off LIBOR. Furthermore, there were known buyers of *capped* FRNs; but of course, capped FRNs must have a higher coupon than uncapped FRNs to compensate the FRN buyer for the cap risk. If an issuer sells capped floating-rate notes, the issuer, in effect, buys a cap on LIBOR from the buyer of the FRN. This cap can then be sold to the investment banker, who in turn sells it to capbuying clients. The deals that took place took exactly this form. The investment bankers underwrote capped FRNs for certain FRN issuers who agreed to make caplike payments to their investment banker. The banker then sold caps to another client but did not incur any market risks because the two sets of potential payments offset one another. Using part of the proceeds of the sale of the cap, the investment bank agreed to make payments to the issuer to bring the cost of the floating-rate debt down to a level below that of uncapped floating-rate notes. Thus the investment bankers, the issuers of the FRNs, the buyers of the FRNs, and the ultimate cap-buying clients all walked away with a satisfactory transaction.

Such a transaction illustrates how creative financing can be used to create a seller of an instrument when no obvious seller exists. In this example, the issuers of the FRNs are willing to sell caps, given the fact that they, in turn, find someone willing to sell the caps to them. The ultimate seller of caps is the buyer of the capped FRNs. The buyers of the FRNs are, however, only implicit sellers of caps in the sense that they never explicitly have a position in caps on their books.

This example, which is just one of dozens, shows how market makers explicitly and implicitly induce end users of financial products to buy or sell the instruments that allow the market makers to cover their positions in the OTC market. This is not to say that the market makers are taking advantage of the other parties to their trades. As is often the case, all parties to a transaction can come out ahead.

Forward Rate Agreements (FRAs)

The FRA market represents the OTC equivalent of the exchange-traded futures contracts on short-term rates. FRAs are a natural outgrowth of the interbank market for short-term funds. However, unlike the interbank market, virtually any creditworthy entity can buy or sell FRAs.

The liquid and easily accessible sector of the FRA market is for three- and six-month LIBOR. Rates are quoted widely for settlement starting one month forward, and settling once every month thereafter out to about six months forward. Thus, for example, on any given day forward rates are available for both three- and six-month LIBOR one month forward, covering, respectively, the interest period starting in one month and ending in four months, and the interest period starting in one month and ending in seven months. These contracts are referred to as 1×4 and 1×7 contracts. On the same day, there will be FRAs on three- and six-month LIBOR for settlement two months forward. These are the 2×5 and 2×8 contracts. Similarly, settlements occur three months, four months, five months, and six months forward for both three- and six-month LIBOR. These contracts are also denoted by the beginning and end of the interest period they cover.

On each subsequent day, contracts with the same type of structures, that is, contracts with one month, two months, and so on, to settlement date, are offered again. Thus, although on any given day a relatively limited number of structures are widely quoted, new contracts with new settlement dates are offered at the beginning of each day. This is quite different from the futures market, where the same contracts with the same delivery dates trade day after day.

As for other OTC debt instruments, there are market makers and brokers who make the market work. However, unlike the other OTC derivative instruments, in the FRA market the commercial banks are clearly the dominant force among the market makers. This dominance is due to the ability of the banks to blend their FRA transactions into their interbank transactions and overall funding operations. Consequently, many banks are willing to quote on a much wider variety of structures than the standard structures explained above. One can choose maturities other than three- and six-month LIBOR, and one can choose many settlement dates other than at an even number of months in the future.

In most cases, FRAs are written so that no money changes hands until the settlement date. To determine the cash flows on the settlement date, LIBOR taken from some predetermined source is compared to the LIBOR rate specified in the FRA contract. The actual dollar amount that changes hands is the dollar value of the difference between the two rates, *present valued* for a period equal to the maturity of the underlying LIBOR, either three or six months. The rationale behind present valuing is that if an FRA is used to hedge the rate on a deposit (or other short-term instrument), the loss (gain) due to a change in interest rates will be paid (saved) at the maturity of the deposit, not at the issue date. Thus, because cash payments on the FRA are made on the settlement date (which presumably is the same as the issue date of the deposit) the present value of the interest expense (or saving) on the deposit will equal the amount of money actually received or paid on the FRA.

Finally, one peculiarity of the FRA market deserves note. If one *buys* an FRA, one profits from an *increase* in rates, and if one *sells* an FRA, one profits from a *decline* in rates.

SUMMARY

In this chapter we have examined several of the most important and representative exchange-traded and OTC interest-rate futures and options contracts. In the next chapter we discuss the pricing of futures contracts and the applications of futures to portfolio management.

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CHAPTER
FIFTY-TWO

PRICING FUTURES AND PORTFOLIO APPLICATIONS

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One of the primary concerns most traders and investors have when taking a position in futures contracts is whether the futures price at which they transact will be a fair price. Buyers are concerned that the price may be too high and that they will be picked off by more experienced futures traders waiting to profit from the mistakes of the uninitiated. Sellers worry that the price is artificially low and that savvy traders may have manipulated the markets so that they can buy at bargain-basement prices. Furthermore, prospective participants frequently find no rational explanation for the sometimes violent ups and downs that occur in the futures markets. Theories about efficient markets give little comfort to anyone who knows of or has experienced the sudden losses that can occur in the highly leveraged futures markets.

Fortunately, the futures markets are not as irrational as they may at first seem; if they were, they would not be so successful. The interest-rate futures markets are not perfectly efficient markets, but they probably come about as close as any market. Furthermore, there are very clear reasons why futures prices are what they are, and there are methods by which traders, investors, and borrowers will quickly eliminate any discrepancy between futures prices and their fair levels.

In this chapter we will explain how the fair or theoretical value of an option is determined. We then explain several portfolio applications of interest-rate futures.

PRICING OF FUTURES CONTRACTS

There are several different ways to price futures contracts. Fortunately, all lead to the same fair price for a given contract. Each approach relies on the *law of one price*. This law states that a given financial asset (or liability) must have the same price regardless of the means by which one goes about creating that asset (or liability). In this section we will demonstrate one way in which futures contracts can be combined with cash market instruments to create cash flows that are identical to other cash securities.[1] The law of one price implies that the synthetically created cash securities must have the same price as the actual cash securities. Similarly, cash instruments can be combined to create cash flows that are identical to futures contracts. By the law of one price, the futures contract must have the same price as the synthetic futures created from cash instruments.

Illustration of the Basic Principles

To understand how futures contracts should be priced, consider the following example. Suppose that a 20-year 100 par value bond with a coupon rate of 12% is selling at par. Also suppose that this bond is the deliverable for a futures contract that settles in three months. If the current three-month interest rate at which funds can be loaned or borrowed is 8% per year, what should be the price of this futures contract?

Suppose the price of the futures contract is 107. Consider the following strategy:

Sell the futures contract at 107.

Purchase the bond for 100.

Borrow 100 for three months at 8% per year.

The borrowed funds are used to purchase the bond, resulting in no initial cash outlay for this strategy. Three months from now, the bond must be delivered to settle the futures contract and the loan must be repaid. These trades will produce the following cash flows:

From settlement of the futures contract	
Flat price of bond	107
Accrued interest (12% for three months)	+3
Total proceeds	110

1. For other ways to price futures contracts, see Chapter 5 in Mark Pitts and Frank J. Fabozzi, *Interest Rate Futures and Options* (Chicago: Probus Publishing, 1990).

From the loan	
Repayment of principal of loan	100
Interest on loan (8% for three months)	+2
Total outlay	102
Profit	8

This strategy will guarantee a profit of 8. Moreover, the profit is generated with no initial outlay because the funds used to purchase the bond are borrowed. The profit will be realized *regardless of the futures price at the settlement date.* Obviously, in a well-functioning market, arbitrageurs would buy the bond and sell the futures, forcing the futures price down and bidding up the bond price so as to eliminate this profit. This strategy of purchasing a bond with borrowed funds and simultaneously selling a futures contract to generate an arbitrage profit is called a *cash and carry trade.*

In contrast, suppose that the futures price is 92 instead of 107. Consider the following strategy:

Buy the futures contract at 92.

Sell (short) the bond for 100.

Invest (lend) 100 for three months at 8% per year.

Once again, there is no initial cash outlay. Three months from now a bond will be purchased to settle the long position in the futures contract. That bond will then be used to cover the short position (i.e., to cover the short sale in the cash market). The outcome in three months would be as follows:

From settlement of the futures contract	
Flat price of bond	92
Accrued interest (12% for three months)	+3
Total outlay	95
From the loan	
Principal received from maturing investment	100
Interest earned from the three-month investment (8% for three months)	+2
Total proceeds	102
Profit	7

The 7 profit is a pure arbitrage profit. It requires no initial cash outlay and will be realized regardless of the futures price at the settlement date. Because this strategy involves initially selling the underlying bond, it is called a *reverse cash and carry trade*.

There is a futures price that will eliminate the arbitrage profit, however. There will be no arbitrage if the futures price is 99. Let's look at what would happen if the two previous strategies were followed and the futures price were 99. First, consider following cash and carry trade:

Sell the futures contract at 99.

Purchase the bond for 100.

Borrow 100 for three months at 8% per year.

In three months, the outcome would be as follows:

From settlement of the futures contract	
Flat price of bond	99
Accrued interest (12% for three months)	+3
Total proceeds	102
From the loan	
Repayment of principal of the loan	100
Interest on the loan (8% for three months)	+2
Total outlay	102
Profit	0

There is no arbitrage profit.

Next, consider the following reverse cash and carry trade:

Buy the futures contract at 99.

Sell (short) the bond for 100.

Invest (lend) 100 for three months at 8% per year.

The outcome in three months would be as follows:

From settlement of the futures contract	
Flat price of bond	99
Accrued interest (12% for three months)	+3
Total outlay	102
From the loan	
Principal received from maturing investment	100
Interest earned from the three-month investment (8% for three months)	+2
Total proceeds	102
Profit	0

Thus neither strategy results in a profit. The futures price of 99 is the equilibrium price because any higher or lower futures price will permit arbitrage profits.

Theoretical Futures Price Based on Arbitrage Model

Considering the arbitrage arguments just presented, the equilibrium futures price can be determined on the basis of the following information:

- The price of the bond in the cash market.
- The coupon rate on the bond. In our example, the coupon rate was 12% per annum.
- The interest rate for borrowing and lending until the settlement date. The borrowing and lending rate is referred to as *the financing rate.* In our example, the financing rate was 8% per annum.

We will let

r = financing rate

c = current yield, or coupon rate divided by the cash market price

P = cash market price

F = futures price

t = time, in years, to the futures delivery date

and then consider the following cash and carry trade that is initiated on a coupon date:

Sell the futures contract at F.

Purchase the bond for P.

Borrow P until the settlement date at r.

The outcome at the settlement date is as follows:

From settlement of the futures contract	
Flat price of bond	F
Accrued interest	$+ctP$
Total proceeds	$F + ctP$
From the loan	
Repayment of principal of the loan	P
Interst on loan	$+ rtP$
Total outlay	$P + rtP$

The profit will equal

$$\text{Profit} = \text{total proceeds} - \text{total outlay}$$

$$\text{Profit} = F + ctP - (P + rtP)$$

In equilibrium, the theoretical futures price occurs where the profit from this strategy is zero. Thus, to have equilibrium, the following must hold:

$$0 = F + ctP - (P + rtP)$$

Solving for the theoretical futures price, we have

$$F = P + Pt(r - c) = P[1 + t(r - c)] \qquad (52\text{–}1)$$

Alternatively, consider the following reverse cash and carry trade:

Buy the futures contract at F.

Sell (short) the bond for P.

Invest (lend) P at r until the settlement date.

The outcome at the settlement date would be as follows:

From settlement of the futures contract	
Flat price of bond	F
Accrued interest	$+ ctP$
Total outlay	$F + ctP$
From the loan	
Proceeds received from maturing of investment	P
Interest earned	$+ rtP$
Total proceeds	$P + rtP$

The profit will equal

$$\text{Profit} = \text{total proceeds} - \text{total outlay}$$
$$\text{Profit} = P + rtP - (F + ctP)$$

Setting the profit equal to zero so that there will be no arbitrage profit and solving for the futures price, we obtain the same equation for the futures price as Eq. (52–1).

Let's apply Eq. (52–1) to our previous example in which

$$r = 0.08$$
$$c = 0.12$$
$$P = 100$$
$$t = 0.25$$

Then the theoretical futures price is

$$F = 100 + 100 \times 0.25(0.08 - 0.12)$$
$$= 100 - 1 = 99$$

This agrees with the equilibrium futures price we derived earlier.

The theoretical futures price may be at a premium to the cash market price (higher than the cash market price) or at a discount from the cash market price (lower than the cash market price), depending on the value of $(r - c)$. The term $r - c$ is called the *net financing cost* because it adjusts the financing rate for the coupon interest earned. The net financing cost is more commonly called the *cost of carry,* or simply *carry. Positive carry* means that the current yield earned is greater than the financing cost; *negative carry* means that the financing cost exceeds the current yield. The relationships can be expressed as follows:

Carry	Futures Price
Positive ($c > r$)	Will sell at a discount to the cash price ($F < P$)
Negative ($c < r$)	Will sell at a premium to the cash price ($F > P$)
Zero ($r = c$)	Will be equal to the cash price ($F = P$)

In the case of interest-rate futures, carry (the relationship between the short-term financing rate and the current yield on the bond) depends on the shape of the yield curve. When the yield curve is upward-sloping, the short-term financing rate will generally be less than the current yield on the bond, resulting in positive carry. The futures price will then sell at a discount to the cash price for the bond. The opposite will hold true when the yield curve is inverted.

A Closer Look at the Theoretical Futures Price

To derive the theoretical futures price using the arbitrage argument, we made several assumptions. We will now discuss the implications of these assumptions.

Interim Cash Flows. No interim cash flows owing to variation margin or coupon interest payments were assumed in the model. However, we know that interim cash flows can occur for both of these reasons. Because we assumed no variation margin, the price derived is technically the theoretical price for a forward contract (which is not marked to market at the end of each trading day). If interest rates rise, the short position in futures will receive margin as the futures price decreases; the margin can then be reinvested at a higher interest rate. In contrast, if interest rates fall, there will be variation margin that must be financed by the short position; however, because interest rates have declined, the financing can be done at a lower cost. Thus, whichever way rates move, those who are short futures gain relative to those who are short forward contracts that are not marked to market. Conversely, those who are long futures lose relative to those who are long forward contracts that are not marked to market. These facts account for the difference between futures and forward prices.

Incorporating interim coupon payments into the pricing model is not difficult. However, the value of the coupon payments at the settlement date will depend on the interest rate at which they can be reinvested. The shorter the maturity of the futures contract and the lower the coupon rate, the less important the reinvestment income is in determining the theoretical futures price.

The Short-Term Interest Rate (Financing Rate). In deriving the theoretical futures price, it is assumed that the borrowing and lending rates are equal. Typically, however, the borrowing rate is greater than the lending rate.

We will let

$$r_B = \text{borrowing rate}$$
$$r_L = \text{lending rate}$$

Consider the following strategy:

Sell the futures contract at F.

Purchase the bond for P.

Borrow P until the settlement date at r_B.

The futures price that would produce no arbitrage profit is

$$F = P + P\,(r_B - c) \tag{52–2}$$

Now consider the following strategy:

Buy the futures contract at F.

Sell (short) the bond for P.

Invest (lend) P at r_L until the settlement date.

The futures price that would produce no profit is

$$F = P + P(r_L - c) \tag{52–3}$$

Equations (52–2) and (52–3) together provide boundaries for the theoretical futures price. Equation (52–2) provides the upper boundary, and Eq. (52–3) the lower boundary. For example, assume that the borrowing rate is 8% per year, or 2% for three months, and the lending rate is 6% per year, or 1.5% for three months. Then, using Eq. (52–2) and the previous example, the upper boundary is

$$\begin{aligned} F(\text{upper boundary}) &= \$100 + \$100(0.02 - 0.03) \\ &= \$99 \end{aligned}$$

The lower boundary using Eq. (52–3) is

$$\begin{aligned} F(\text{lower boundary}) &= 100 + \$100(0.015 - 0.03) \\ &= \$98.50 \end{aligned}$$

In calculating these boundaries, we assumed no transaction costs were involved in taking the position. In actuality, the transaction costs of entering into and closing the cash position as well as the round-trip transaction costs for the futures contract, must be considered and do affect the boundaries for the futures contract.

Deliverable Bond and Settlement Date Unknown. In our example we assumed that only one bond is deliverable and that the settlement date occurs three months from now. As explained earlier in this chapter, futures contracts on Treasury bonds and Treasury notes are designed to allow the short position the choice of delivering one of a number of deliverable issues. Also, the delivery date is not known.

Because there may be more than one deliverable, market participants track the price of each deliverable bond and determine which is the cheapest to deliver. The futures price will then trade in relation to the bond that is cheapest to deliver. The cheapest to deliver is the bond or note that will result in the smallest loss or the greatest gain if delivered by the short futures position.[2]

In addition to the reasons we have already discussed, there are several reasons why the actual futures price will diverge from the theoretical futures price based on the arbitrage model. First, there is the risk that although an issue may be the cheapest to deliver at the time a position in the futures contract is taken, it may not be the cheapest to deliver after that time. Thus, there will be a divergence between the theoretical futures price and the actual futures price. A second reason for this divergence is the other delivery options granted the short position. Finally, there are biases in the CBOT conversion factors.

Deliverable Is a Basket of Securities. The municipal index futures contract is a cash settlement contract based on a basket of securities. The difficulty in arbitraging this futures contract is that it is too expensive to buy or sell every bond included in the index. Instead, a portfolio containing a smaller number of bonds may be constructed to track the index. The arbitrage, however, is no longer risk-free, because there is the risk that the portfolio will not track the index exactly. This is referred to as *tracking-error risk.* Another problem in constructing the portfolio so that the arbitrage can be performed is that the composition of the index is revised periodically. Therefore, anyone using this arbitrage trade must constantly monitor the index and periodically rebalance the constructed portfolio.

APPLICATIONS TO PORTFOLIO MANAGEMENT

This section describes various ways in which a money manager can use interest-rate futures contracts.

Changing the Duration of the Portfolio

Money managers who have strong expectations about the direction of interest rates will adjust the duration of their portfolio to capitalize on their expectations. Specifically, if they expect interest rates to increase, they will shorten the duration of the portfolio; if they expect interest rates to decrease, they will lengthen the duration

2. An alternative procedure is to compute the implied (break-even) repo rate. This rate is the yield that would produce no profit or loss if the bond were purchased and a futures contract were sold against the bond. The cheapest-to-deliver bond is the one with the highest implied repo rate. For a further discussion, see Chapter 53.

of the portfolio. Also, anyone using structured portfolio strategies must periodically adjust the portfolio duration to match the duration of some benchmark.

Although money managers can alter the duration of their portfolios with cash market instruments, a quick and less expensive means for doing so (especially on a temporary basis) is to use futures contracts. By buying futures contracts on Treasury bonds or notes, they can increase the duration of the portfolio. Conversely, they can shorten the duration of the portfolio by selling futures contracts on Treasury bonds or notes.

Asset Allocation

A pension sponsor may wish to alter the composition of the pension fund's assets between stocks and bonds. An efficient means of changing asset allocation is to use financial futures contracts: interest-rate futures and stock index futures.

Creating Synthetic Securities for Yield Enhancement

A cash market security can be synthetically created by using a position in the futures contract together with the deliverable instrument. The yield on the synthetic security should be the same as the yield on the cash market security. If there is a difference between the two yields, it can be exploited so as to enhance the yield on the portfolio.

To see how, consider an investor who owns a 20-year Treasury bond and sells Treasury futures that call for the delivery of that particular bond three months from now. The maturity of the Treasury bond is 20 years, but the investor has effectively shortened the maturity of the bond to three months.

Consequently, the long position in the 20-year bond and the short futures position are equivalent to a long position in a three-month riskless security. The position is riskless because the investor is locking in the price that he or she will receive three months from now—the futures price. By being long the bond and short the futures, the investor has synthetically created a three-month Treasury bill. The return the investor should expect to earn from this synthetic position should be the yield on a three-month Treasury bill. If the yield on the synthetic three-month Treasury bill is greater than the yield on the cash market Treasury bill, the investor can realize an enhanced yield by creating the synthetic short-term security. The fundamental relationship for creating synthetic securities is as follows:

$$\text{RSP} = \text{CBP} - \text{BFP} \qquad (52\text{–}4)$$

where

CBP = cash bond position
BFP = bond futures position
RSP = riskless short-term security position

A negative sign before a position means a short position. In terms of our previous example, CBP is the long cash bond position, the negative sign before

BFP refers to the short futures position, and RSP is the riskless synthetic three-month security or Treasury bill.

Equation (52–4) states that an investor who is long the cash market security and short the futures contract should expect to earn the rate of return on a risk-free security with the same maturity as the futures delivery date. Solving Eq. (52–4) for the long bond position, we have

$$\text{CBP} = \text{RSP} + \text{BFP} \tag{52–5}$$

Equation (52–5) states that a cash bond position equals a short-term riskless security position plus a long bond futures position. Thus a cash market bond can be synthetically created by buying a futures contract and investing in a Treasury bill.

Solving Eq. (52–5) for the bond futures position, we have

$$\text{BFP} = \text{CBP} - \text{RSP} \tag{52–6}$$

Equation (52–6) tells us that a long position in the futures contract can be synthetically created by taking a long position in the cash market bond and shorting the short-term riskless security. Shorting the short-term riskless security is equivalent to borrowing money. Notice that it was Eq. (52–6) that we used in deriving the theoretical futures price when the futures was overpriced. Recall that when the futures price was 107, the strategy to obtain an arbitrage profit was to sell the futures contract and create a synthetic long futures position by buying the bond with borrowed funds. This is precisely what Eq. (52–6) states. In this case, instead of creating a synthetic cash market instrument as we did with Eqs. (52–4) and (52–5), we have created a synthetic futures contract. The fact that the synthetic long futures position was cheaper than the actual long futures position provided an arbitrage opportunity.

If we reverse the sign of both sides of Eq. (52–6), we can see how a short futures position can be synthetically created.

In an efficient market, the opportunities for yield enhancement should not exist very long. Even in the absence of yield enhancement, however, synthetic securities can be used by money managers to hedge a portfolio position that they find difficult to hedge in the cash market either because of lack of liquidity or because of other constraints.

Hedging

Hedging[3] with futures involves taking a futures position as a temporary substitute for transactions to be made in the cash market at a later date. If cash and futures prices move together, any loss realized by the hedger from one position (whether cash or futures) will be offset by a profit on the other position. When the net profit or loss from the positions are exactly as anticipated, the hedge is referred to as a *perfect hedge.*

3. Hedging is discussed in more detail in Chapter 57.

In practice, hedging is not that simple. The amount of net profit will not necessarily be as anticipated. The outcome of a hedge will depend on the relationship between the cash price and the futures price when a hedge is placed and when it is lifted. The difference between the cash price and the futures price is called the basis. The risk that the basis will change in an unpredictable way is called *basis risk*.

In most hedging applications, the bond to be hedged is not identical to the bond underlying the futures contract. This kind of hedging is referred to as *cross-hedging*. There may be substantial basis risk in cross-hedging. An unhedged position is exposed to price risk, the risk that the cash market price will move adversely. A hedged position substitutes basis risk for price risk.

A short (or sell) hedge is used to protect against a decline in the cash price of a fixed income security. To execute a short hedge, futures contracts are sold. By establishing a short hedge, the hedger has fixed the future cash price and transferred the price risk of ownership to the buyer of the futures contract. As an example of why a short hedge would be executed, suppose that a pension fund manager knows that bonds must be liquidated in 40 days to make a $5 million payment to the beneficiaries of the pension fund. If interest rates rise during the 40-day period, more bonds will have to be liquidated to realize $5 million. To guard against this possibility, the manager would sell bonds in the futures market to lock in a selling price.

A long (or buy) hedge is undertaken to protect against an increase in the cash price of a fixed income security. In a long hedge, the hedger buys a futures contract to lock in a purchase price. A pension fund manager may use a long hedge when substantial cash contributions are expected and the manager is concerned that interest rates will fall. Also, a money manager who knows that bonds are maturing in the near future and expects that interest rates will fall can employ a long hedge to lock in a rate.

PORTABLE ALPHA

There are two basic approaches to investment management: passive and active. The objective of passive management is to match the performance of a benchmark that represents a defined asset class while the objective of active management is to select individual assets that are likely to perform better than the average. The returns to an active strategy will consist of returns based on market exposure and returns based on selection skill. The returns resulting from superior selection skills are referred to as *alpha*. Pure alpha strategies are those with no market risk and thus returns do not depend on market direction. An example is a long/short strategy that is market neutral.

In a period when equity markets have increased volatility and lower prospects for increasing returns, institutional investors look to reallocate funds to asset classes with lower volatility such as fixed income securities. Moreover, institutional investors confront an environment of funding shortfalls and moderate returns, which necessitates the development of alternative and more efficient sources of returns. *Portable alpha strategies* can be employed to maintain exposure to a lower volatility asset class while producing returns that approach equities. The portable alpha strategy can either be used as a core investment in an asset class or as an overlay strategy.

Portable alpha strategies refer to an investment methodology or process that blends traditional asset class exposure with alternative investment strategies in order to add returns without assuming additional risk. The concept is "portable" in the sense that the integration of alternative with traditional does not impact management style or acceptable risk parameters adversely, which means it is easily transferred into an existing asset class or benchmark through the application of an overlay program to achieve the targeted asset exposure. Thus, the alpha is created independently of the core portfolio and transferred with the use of derivatives in order to maintain the characteristics of the core portfolio.

The significance of portable alpha strategies is that the asset allocation decision can be separated from the search for alpha within the asset class. Thus, portable alpha is a return enhancement strategy and not an asset substitution strategy. The advantage of the portable alpha approach is its flexibility in terms of adding returns without additional risk.[4] Many portable alpha strategies involve long and short positions. Exchange traded futures contracts can be integral to a portable alpha strategy either as a means to overlay an existing core portfolio or as a means to synthetically maintain the core exposure to the fixed income asset class.[5]

The basis of "portable" alpha is that it explicitly changes the investment management process by separating the management of market returns and pure alpha returns.[6] Pure alpha strategies are factor or market neutral and have no correlation with market direction. The objective of portable alpha strategies is to improve the efficiency of finding positive incremental returns. For equity strategies it involves stock selection and for fixed income it might involve bond selection or the exploitation of yield curve inefficiencies. In any case, derivatives including futures and swaps are vital to achieve the strategic asset allocation exposures. This paradigm shift that explicitly separates market returns and alpha has implications for manager selection and risk management.

Since alpha is the total return less market returns, the production of alpha does not depend on market direction and therefore positive alpha is possible in all market environments. The portable alpha strategy can be implemented as an overlay on an existing asset class or as a separate investment that uses swaps and futures to maintain the overall strategic asset allocation mix. Theoretically, portable

4. Furthermore, the implementation of portable alpha strategies significantly expands the universe of managers beyond the limitations imposed by style or orientation.

5. For an example of a portable alpha overlay strategy see, Edgar E. Peters and Perr J. Vieth, "Portable Alpha Overlay Via PanAgora's Fixed Income Active Core Strategy," PanAgora Asset Management, undated.

6. See Adele Kohler, "Implementation Guide for Portable Alpha and Efficient Beta Exposure," State Street Global Advisors, undated.

alpha strategies can be produced from any strategy assuming it contains alpha and there is sufficient liquidity to implement the strategy. Thus, there are three basic ways to develop a portable alpha generating strategy.

1. Identify an alpha generating long portfolios, use futures to eliminate market risk and overlay the strategy on the existing asset class.
2. Identify pure alpha generating investments from the hedge fund or fund of fund communities, sell off a portion of the asset class, and replace with futures and alpha generating investments.
3. Replace entire asset class with pure alpha generating strategies and use derivatives to maintain targeted market exposure.

Portable alpha represents a change in the investment process and a different way to think about risk and return. Futures contracts are an integral part of the implementation of many portable alpha investment programs.

SUMMARY

In this chapter we have explored the cash and futures arbitrage and equilibrium futures pricing. The theoretical futures price is determined by the net financing cost, or carry. Carry is the difference between the financing cost and the cash yield on the underlying cash instrument. The basic futures pricing model presented in this chapter must be modified to account for nuances of specific futures contracts. In the next chapter, the basic pricing model is extended to the Treasury bond futures contract.

Some of the important uses of futures contracts by portfolio managers—altering a portfolio's duration, the potential to create synthetic securities with enhanced returns, and hedging—are discussed. Probably the most common application is hedging a portfolio. The details of how to do this with interest-rate futures (and futures options) are explained in Chapter 57.

CHAPTER
FIFTY-THREE

TREASURY BOND FUTURES MECHANICS AND BASIS VALUATION

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Since its inception in 1977, the bond futures contract has been the grandfather of the family of financial futures contracts. It is the primary vehicle for hedging an investor's Treasury cash positions and is easily the most liquid Treasury futures contract. It has become so successful, in fact, that it is often the driving force of the Treasury market.

An investor owning or long a bond futures contract can expect the delivery of one of a group of bonds within a certain time. Conversely, an investor who is short that contract is expected to make that delivery. However, the belief that the bond futures contract is simply a substitute for the current cash long bond is potentially a very costly one. The bond future may have the trading characteristics of many different bonds. Depending on the current yield environment, shape of the yield curve, and other factors, some bonds will obviously have a much greater impact on the pricing and consequent movement of the futures contract. One should never assume that only one bond controls its price.

The futures contract is like a large station wagon carrying a group of bonds. The bonds that are most important sit in the front and have the most impact on its direction and speed, but during some instances, the forgotten bonds in the back can grab control of the steering wheel. The true essence of basis pricing is determining how likely certain bonds are to gain control and how long they will drive. Frequently, the car that seemed to be driving straight on the expected route can lurch right through a trader's profit and loss (P&L) and sometimes right over the trader. Thus it is of paramount importance to comprehend fully the different dimensions of the contract and its deliverability options.

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MECHANICS OF THE FUTURES CONTRACT

Conversion Factor

The Chicago Board of Trade (CBOT) initially was a place where participants in the agricultural market (e.g., farmers) went to protect themselves against inclement weather and other factors that could cause wide price and delivery swings. Thus the CBOT made a number of bonds deliverable because it was well-steeped in agricultural futures and wanted to ensure ease in delivering bonds if there was a large open interest at settlement. The conversion factor helps in that regard. In fact, if only one bond were eligible for delivery, the open interest or total number of positions in the bond future would be lower. Because most traders never involve themselves in the delivery process, there obviously can be positions before the last day of trading of that futures contract that are much larger than the deliverable bond.[1] However, such positions would still curtail activity in bond futures because there would be no more delivery games, which would be the antithesis of what the board desires—the largest volume of trading and positioning possible. Undoubtedly, it is cynical to claim that this was the board's main reason for allowing a group of bonds to be delivered, because most of the ideas that have come out of basis trading originated far after the contract's introduction. It was most likely an effort to stop a squeeze on any one deliverable bond.

For this reason, the CBOT established a delivery factor algorithm to approximately equalize the cost of delivering a host of eligible bonds. Certainly, the factor does not make all bonds equally profitable to deliver. In fact, it is one of the main reasons why they are not. Without a factor system, the contract would simply be a futures contract on the lowest coupon bond with the longest maturity, because this would obviously have the lowest dollar price and, thus, be the cheapest security to deliver.

The factor rate the CBOT uses is 6%. That is, when calculating conversion factors (CF), these bonds are all priced to yield 6%. The resulting price is then divided by 100 and rounded off to the nearest ten-thousandth (four decimal places). A 25-year bond with a 7% coupon to yield 6% should be priced at $112.86. The conversion factor is simply 1.1286 (price/100). Keep in mind that the CF is roughly the price of the security to yield 6%.

This, however, is not precisely correct. To calculate the CF exactly, one must take the first day of the delivery month of the futures contract as the settlement date and the first day of the last delivery month as its maturity (the contract month that is closest to the maturity without being longer than the maturity). In other words, whatever the length of the bond, one simply would round down to the nearest quarter. For example, if the bond were maturing on 5/31/25, the maturity date used to calculate the CF would be 3/01/25. Even though June 1 is an eligible

1. The amount outstanding of each issue in the basket of deliverable bonds varies from $3.01 billion of both the 8¾% 5/20 to $18 billion of the 6¼% of the 8/23. The open interest on bond futures is typically between 500,000 and 600,000, whereas the number delivered is much smaller. For the December 1999 contract, only 26,000 contracts were delivered.

date and only one day from the actual maturity, it falls *after* the bond matures. One must remember to always go back to the last contract month passed. Thus, for both maturity and settlement, there can only be four days used: March 1, June 1, September 1, and December 1, for these are the four contract months for bonds on the CBOT. The CF for the 6 1/8% of 11/15/27 for the December 2001 contract is determined as follows:

Settlement date	12/01/01
Maturity date	9/01/27
Priced to yield	6% (as always)
To price	$101.63
CF	1.0163

Invoice Price

The futures contract trades in increments of $100,000 per contract. Thus, for every contract a trader is long and involved in delivery, he will receive $100,000 par amount of an eligible bond. The one defining characteristic of an eligible bond is that it must be 15 years or longer to maturity or to call. The trader long the futures and short the cash bond must pay, upon being delivered the bond, the following invoice price per contract:

$$\text{Invoice price} = \text{futures settlement price} \times \text{conversion factor} \times \$1{,}000 + \text{accrued interest}$$

Accrued interest is simply the amount of interest earned on a bond from the last coupon payment to the settlement date. The futures settlement price is the official closing price determined by the CBOT at the end of each trading day. If one makes delivery after the contract has stopped trading, the settlement price is the price at which the contract stopped trading.

To illustrate the calculation of the invoice price, consider the 7 1/8% of 2/15/23 for delivery into the September 2001 contract if delivery is made on September 30, 2001 and the futures settlement price (price at which the contract ceases to trade) is 90 8/32.

$$\text{CF} = 1.1347$$

$$\text{Futures settlement price} = 90.25$$

Accrued interest per contract[2] = $890.63

2. Accrued interest is calculated by simply dividing the coupon rate by 2 and multiplying that quotient by the number of days elapsed since the last coupon payment divided by the total number of days in that six-month period. In this case, the total number of days between the coupon payment on August 15 and the settlement date of September 30 is 46 days. Therefore, the accrued interest is simply (7.125/2) × (46/184).

Then

$$\begin{aligned}\text{Invoice price} &= 90.25 \times 1.1347 \times \$1{,}000 + \$890.63\\ &= \$92{,}275\end{aligned}$$

Implied Repo Rate

Simply looking at the bond with the highest conversion factor will not identify which bond is cheapest to deliver (CTD). It is necessary to take into account that if a bond has a conversion factor greater than one, it is a premium bond and must be purchased at a premium.

The best instrument with which to gauge cheapness should incorporate the *relative* cost of delivering, and this is precisely what the implied repo rate indicates. The implied repo rate is the return received by going long the basis. This involves buying the cash bond, financing it at the current borrowing or repo rate to term, and then delivering those bonds to satisfy the short futures obligation. Therefore, the bond with the highest implied repo rate is the one that is cheapest to deliver; the higher the implied repo rate, the cheaper the bond is to deliver.

The implied repo rate is simply

$$\frac{\text{Cash in} - \text{cash out}}{\text{Cash out}} \times \frac{60}{n}$$

where n is the number of days involved in the trade. We must annualize the return by multiplying the cash-flow quotient by $360/n$ because other money market rates are also quoted using this convention.

For the exact return, the formula is as follows:

$$\frac{[(\text{FP} \times \text{CF}) + \text{Ae} + \text{IC} - (\text{price of bond} + \text{Ab})] \times 360}{d_1 \times (\text{price of bond} + \text{Ab}) - (\text{IC} \times d_2)}$$

where

FP = futures price
Ab = accrued interest of bond at beginning or inception of trade
Ae = accrued interest of bond at end of trade (delivery to cover short)
IC = interim coupon (any coupon that falls between settlement date and delivery date)
d_1 = number of days between settlement and actual delivery
d_2 = number of days between interim coupon and bond delivery

For example, the implied repo rate of the $8\frac{1}{2}$% of 2/15/20 with settlement on 7/14/01, delivery on 9/30/01, a futures price of 91, and a bond price of

116.50 is calculated as follows:

$$\text{FP} = 91$$
$$\text{CF} = 1.2748$$
$$\text{Ae} = \frac{8.5}{2} \times \frac{46}{184} = 1.0625$$
$$\text{IC} = \frac{8.5}{2} = 4.25$$
$$\text{Bond price} = 119.6875$$
$$\text{Ab} = \frac{8.5}{2} \times \frac{149}{181} = 3.499$$
$$d_1 = 9/30/94 - 7/14/94 = 78 \text{ days}$$
$$d_2 = 9/30/94 - 8/15/94 = 46 \text{ days}$$

Thus the implied repo rate is

$$\frac{[(91 \times 1.2748) + 1.0625 + 4.25 - (116.50 + 3.499)] \times 360}{78 \times (116.50 + 3.499) - (4.25 \times 46)} = 0.0518, \text{ or } 5.18\%$$

The Delivery Procedure

The vast majority of people who trade bond futures never involve themselves in the process of delivery because of its complexities. Instead, they either liquidate the futures position completely with an offsetting transaction or roll forward into the next contract, which is more liquid. If an investor is long a future after it has ceased trading, she can expect to be delivered a Treasury bond, and if an investor is short a future after it has stopped trading, she will be required to deliver a Treasury bond to fulfill the obligation required of her position. The short would adhere to the following three-day procedure.

1. *Position day.* The day in which the CBOT is given notice by the futures short that he plans to make delivery of a certain amount of bonds in two business days. This intention can be made any time before 8 P.M. central standard time (CST). The first eligible intention day is the second-to-last business day of the month before the delivery month. If the investor has not informed the board of intention to deliver by the second-to-last day of the delivery month, then the board automatically assumes that he will be delivering at the end of the month.
2. *Notice day.* The day in which the CBOT is given notice about which particular issue he intends to deliver and then matches the short with the futures long who has had the longest outstanding position. The board then informs the long that she will be delivered to the next day. Notice must occur before 2 P.M. CST unless it is the last notice day of

the month, in which case notice must be made before 3 P.M. The party long the futures is notified by 4 P.M. which bond she will be receiving.

3. *Delivery day.* The short must have in his account by 10 A.M. CST the bonds he has specified he would deliver and actually must deliver them by 1 P.M. CST to the long party the board has assigned to him. The long pays the short the invoice price for that particular bond only after being delivered the bonds.

The short may not promise to deliver a certain bond and then deliver another one; there is a one point per contract penalty for not delivering the bonds specified on notice day. The advantage gained by switching bonds will seldom ever offset the one point penalty.

THE BASIS

As mentioned earlier, the best measure of what is cheapest to deliver is the implied repo rate. However, this is not the way most people determine which issue is the cheapest or whether the futures contract is over- or undervalued. That is done through following the basis because, computationally, the implied repo rate is considerably more difficult and because the basis is derived from price, which is what traders deal in when they trade cash bonds and futures.

The basis is simply the difference between the cash bond price and the converted futures price. The converted futures price is the product of the futures price and the conversion factor. To place the figure in 32ds, multiply the basis by 32.

$$\text{Basis} = (\text{bond price} - \text{futures price} \times \text{conversion factor}) \times 32$$

A long basis trade involves the purchase of a deliverable cash bond and sale of a factor-weighted amount of futures contracts. Going short the basis means selling a deliverable cash bond and buying a factor-weighted number of futures contracts.

It should be recognized that the basis on the cheapest-to-deliver (CTD) bond must converge to zero by the end of the delivery month. Riskless money could be made if this were not the case. For example, if the basis were still worth something on the last day of the month, a trader could do the following: (1) sell the basis and then effectively "buy" the bond on delivery and (2) sell the futures position to fulfill his short basis obligation. The trader is synthetically selling the cash bond at a level higher than it is delivered to him. This difference is the positive value of the basis on that last day.

Many people believe that the basis can never be negative. This is simply not true. The *net* basis can never be negative because an option can never have a negative value because it only provides one with the *opportunity* to transact at a certain price, not an obligation. The gross basis may be negative before the delivery month if there is an inverted curve and if the value of the delivery options granted to the short is low. (This is a rare occurrence.) However, during the delivery month, the basis cannot be negative at any time because one could simply buy the basis (buy bonds, sell futures) and subsequently unwind it by selling cash bonds at the higher current market price while being able to buy futures at the same level.

The most famous blunder in basis trading occurred at the end of 1987. In the middle of December, a primary dealer who was long 5,500 December bond futures contracts was delivered \$550 million par amount of the 10 3/8% 11/15/12 to satisfy the short's obligation. Even though this issue was the cheapest, the basis on the bond was trading in the marketplace at around \$10,000 per \$1 million. Of course, the dealer congratulated itself on its serendipity. The firm had fallen quite unexpectedly into a cash pool of about \$5.5 million. This present was known on Wall Street as the Christmas gift; the deliverer should not have handed those bonds over until the last day because it could have at least made positive carry by holding them, and conversely, the Wall Street firm could now forgo the cost of being short the cash bonds. That bond was trading in the cash market at approximately \$109.30; however, the firm received bonds at an effective cost of \$108.30, which is 87 25/32 (contract price) multiplied by a conversion factor of 1.2336. As soon as the firm was delivered these bonds, it turned around and sold them back out to complete every trader's fantasy—a huge profit with no risk.

The early delivery in this case was not only excruciatingly painful for the deliverer but also uncommon. However, even discounting this example as a fluke, one might still wonder why anyone would be content in buying the basis and earning a lower return or implied repo rate than could be obtained from simply investing money at current short-term interest rates.[3] The discrepancy exists because the basis long has several deliverability options that could increase his or her return, sometimes dramatically. These options, combined with carry, comprise the value of the basis. Both will be discussed in the next two sections.

CARRY

Carry is a Wall Street term used to describe the amount of money made or lost by holding, or carrying, a bond. The ownership of the bond provides interest income, which is offset by the financing charge one must pay to borrow the money to purchase the bond. Obviously, with an upward-sloping yield curve, there is positive carry when one is long a bond, whereas an inverted curve burdens the long with negative carry (i.e., a daily loss).

For basis trades, most people calculate carry until the last possible delivery date, which is usually the best time for delivery with a normal yield curve. An inverted curve is more complex, as one has to determine whether the negative

3. If we were to look at an implied repo table, we would see that all eligible bonds have a lower return or implied repo rate than the present money market rates.

carry (money lost by financing a bond purchase, or the bond yield minus the financing or repo rate) is greater than the value of the options.

An ideal example is Paul Volcker's monetarist experiment between 1979 and 1981, when the curve twisted and often was inverted. Initially, traders automatically delivered their bonds on the first eligible delivery date to avoid the negative carry. As time passed, the deliveries began to take place later in the month. This occurred because some traders began to realize that it was advantageous to deliver later in the month, retain the options, and suffer through the negative carry. Early delivery in this scenario should be based solely on whether the exercising of the option is more valuable than the money forgone in financing. Thus it is crucial to value those options accurately.

However, one should be cautious in dismissing the importance of carry. The simplicity of its calculation can and often does belie its ability to damage a trader's P&L. There is no question that with a certain term repo rate (financing rate to a certain date—in this case, that date is usually the end of the delivery month), figuring the amount of carry for that period is quite easy. However, as any repo desk will attest, those financing rates do not stay very constant and can often swing dramatically.

For example, assume that a bond is currently yielding 8% and the repo rate to the end of the delivery month is 3%. If there are 30 days left, the amount of money made per million by carrying the bond is $4,075.[4] However, if a dealer or a big hedge fund decided to squeeze[5] or tighten an issue in the financing market or if there are simply too many shorts in that issue and the rate drops to 2%, then the carry increases quickly to $4,908 per million. On the surface, this does not appear to be a substantial amount, but for a basis position of $500 million, quite an ordinary position for some basis traders, this translates into a difference of $416,500—quite a large payout.

This variability can be avoided by simply locking up, or lending (borrowing), money at the current term rate. In this case, the trader who is short the bonds and

4. A relatively precise and fairly common estimation of carry is as follows:

$$(\text{Coupon rate}/365) - (\text{repo rate}/360 \times \text{price}/100)$$

In this case, because the yield is also 8%, the price is 100. Thus the calculation is $(0.08/365) - (0.03/360) \times 100/100 = 0.0001358$. Per million, the carry is $135.84. For 30 days, this totals $4,075.

5. A squeeze in the repo market occurs when there are too many traders short a particular issue and not enough lenders of that security. The most famous example of this was the squeeze of the April and May 1993 two-year notes. Many traders were short the issue during the when-issued period in hopes of purchasing them cheaper during the auction. Unfortunately for them, most were unable to buy them from the Treasury in the auction. Consequently, desperate shorts who needed to make delivery or fail, and effectively lend money at 0% in the finance market, often were willing to lend money at exactly that level. Large regional banks are frequently mentioned as creating a tight repo rate in an issue when they buy a large amount of an issue and keep it in their portfolio instead of lending it out. The Fed has now established a policy that if an issue becomes remarkably or "unnaturally" tight, they will reopen that issue to mitigate the shortage.

has cash available to borrowers could lend money at the fixed rate of 3% for the duration of her expected holding, which appears to be 30 days. Unfortunately, this act of prudence is often overlooked for several reasons. In some cases, the trader may not know how long she will keep the trade alive, or she may predict that the term rate will rise in the future. However, the reason also could be appetite for risk, ignorance, or sloth. Regardless of the motive, this oversight can prove to be very volatile. However, these concerns do not affect the true value of the basis because one can always be assured of a certain financing rate. The key to rewards lies in valuing the deliverability options.

OPTIONS

The true essence of determining basis richness or cheapness is in the valuation of the net or option-adjusted basis, which is the gross basis minus carry. This value is comprised of the value of the different deliverability options. The mathematics of calculating those different options is highly complex, not only because of the inherent difficulty associated with valuing any derivative with multiple pricing constraints, but also because many of these constraints, and hence the effect on the option prices, are interdependent. Even if a trader were to correctly value each delivery option, he may not obtain the value of the net basis simply by summing them because some options are mutually exclusive. For example, if the trader exercises the wildcard, he cannot exercise the switching option.

For the sake of clarity, each option will be explained independently. It is beyond the scope of this chapter to derive precise values for each option. Although the following explanations omit the exact mathematical derivations, they should prove helpful in understanding the skeleton of basis valuation. The five different deliverability options are the yield-shift option, yield-spread option, new-auction option, wildcard option, and switching option.

Yield-Shift Option

Because the conversion factor is the price of the bond at 6% divided by 100, there is a general bias toward delivering bonds with higher durations when yields are above 6% and with lower durations when yields are below 6%.

The logic behind this idea is rather simple. Consider that the converted cash price equals the bond price divided by the CF. Assuming that there is no severe penalty for high-coupon bonds (i.e., they do not trade substantially cheaper), all bonds would be almost equally deliverable if yields are at 6%. However, if rates are below 6% and an investor uses a 6% factor to discount, then he is underestimating the value of the subsequent coupon and principal receipts. Likewise, if the trader uses 6% as the discount rate when rates are above 6%, he is overvaluing those future payments. Now, the low-coupon, long-maturity bonds have a higher CF than they should, and this makes them more attractive to deliver.

For a different perspective, suppose that yields are rising above 6% and are now pushing up against 8%. Obviously, the higher duration bonds drop more in price than the shorter durations when yields rise. Because the CF is constant, the fiat price (price/CF) is lower. The price of the higher-duration issue goes down more than the lower-duration bond, and this leads to a lower converted price. If yields are moving down through 6% and to almost 5%, for example, then the higher-duration bond will rise in price faster. This is not what traders want if they are short because this will increase the converted price. The low-duration bond is preferable because its price rises more slowly in both relative and absolute terms.

It has been proven that when yields are above 6%, it is generally cheaper to deliver bonds with higher durations, and when they are below 6%, it is generally cheaper to deliver bonds with lower durations.

The 6% mark is the general cutoff, but it is not the precise point at which all the break-even prices of the eligible bonds are equal. This is so because the CF truncates the actual maturity of the bond: It is rounded down to the last contract month, and the first deliverable date is used as the settlement date. Also, there is a slight difference because it is assumed that all callable bonds will be called at the first call date, which is obviously not necessarily true. After the bond auction in November 1984, the Treasury discontinued the issuance of callable bonds, which effectively added five years to the maturity of post-1984 bonds in determining the factors.

To see how the cutoff ultimately affects deliverability, consider that if carry is ignored, then the converted cash (CC) price of any given Treasury issue is the price of the bond divided by its conversion factor. That is,

$$CC = \frac{\text{bond price}}{CF}$$

Remember that the basis at the end of the delivery month has to be zero. Obviously, the bond price must equal, by that last day, the futures settlement price multiplied by the CF. Thus, if one can sell a bond at the market price and buy futures at a price less than the CC, then a profit will be locked in. Also, by definition, the most deliverable bond is the one with the lowest CC price. Exhibit 53–1 shows the group of bonds that we will consider to be the entire eligible basket for delivery.

EXHIBIT 53–1

Deliverability Analysis of Yields below 6%

Issue	Price	Yield	CF	CC
8 7/8% 8/17	144.843	5.00%	1.3062	110.89
8 1/8% 8/19	138.33	5.02%	1.2405	111.51
6 1/2% 11/26	120.303	5.10%	1.0659	112.87
6 1/8% 11/27	114.304	5.15%	1.0167	112.43

EXHIBIT 53–2

Deliverability Analysis of Yields above 6%

Issue	Price	Yield	CF	CC
8 7/8% 8/17	118.75	7.00%	1.3062	90.91
8 1/8% 8/19	111.641	7.02%	1.2405	90.00
6 1/2% 11/26	92.283	7.15%	1.0659	86.58
6 1/8% 11/27	87.153	7.20%	1.0167	85.72

The bonds are all yielding less than 6%, and thus the market favors those issues with lower durations; clearly, the $8^7/_8$ and $8^1/_8$ have the lowest durations of the four. This can be verified by observing the CCs. The lowest CC, 110.89, belongs to the $8^7/_8$ and the highest CC belongs to the $6^1/_8$, which has the highest duration. However, as Exhibit 53–2 shows, if bond yields rise above 6%, the basket instantly inverts as the higher-duration bonds put a sparkle in the deliverer's eye. The $6^1/_2$ and the $6^1/_8$ are now several points more deliverable than the 11/26 and 27 bonds. In general, one can assume that when yields rise, higher-duration issues (low-coupon, long-maturity) become more deliverable, and when yields decline, lower-duration issues (high-coupon, short-maturity) become more deliverable.

It is easier to observe this characteristic simply by looking at a graph of converted cash prices versus different bond yields. As shown in Exhibit 53–3, as bond yields rise through 6%, the higher duration 6 has a lower converted or break-even futures price than the lower duration $8^7/_8$ and the $8^1/_8$, and is thus cheaper to deliver. The converse is also true—the further bond yields fall below 6%, the cheaper the $8^7/_8$ and the $8^1/_8$ is to deliver.

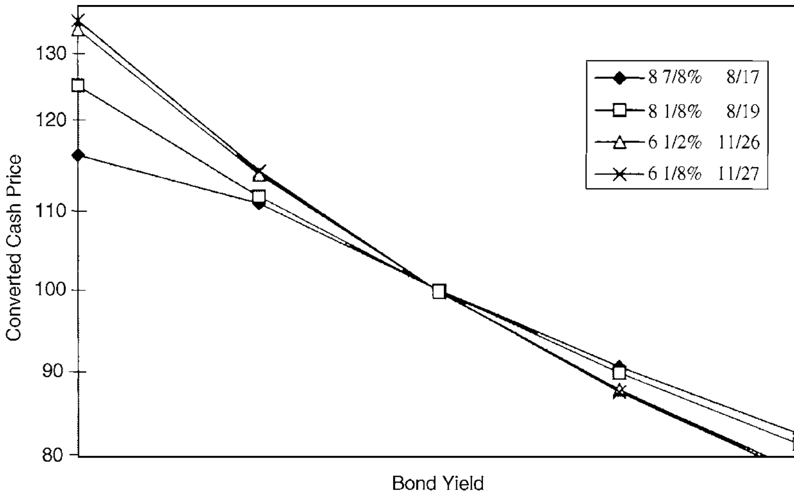
The value of the yield shift option is clearly correlated with the proximity of current rates to the switchover point (the yield level at which it becomes more profitable to deliver opposite duration bonds).[6] If rates are relatively stable and long bond yields are hovering around 8%, the probability of rates breaking through the switchover point is very low, and thus the value of the yield change option is also very low. Conversely, if bond yields are fluctuating wildly around the 6% level, the option can be quite valuable.

One probably would imagine that if yields at the beginning of a delivery month were 8%, for example, and gradually declined 5 basis points every trading day for the next couple of weeks, the value of the option would increase as it slowly approached 6%. This is not necessarily true because, like an ordinary option, the value of the yield-change option suffers from time decay or theta. This is simply the daily decline in an option's value due strictly to the passage of time.

6. This point is generally around 6%, but as discussed before, this is not the precise level. In this case, it appears to be closer to 5.98 percent.

EXHIBIT 53–3

Attractiveness of Market Basket Owing to Yield Change



The theta as we approach the expiration date of the option (which is, in this case, the eighth-to-the-last business day of the delivery month) does not increase linearly but rather almost exponentially. Therefore, if the aforementioned scenario occurred, the March yield-shift option would approach being worthless, whereas the June yield-shift option would increase in value. This is not only because the June contract still has months before expiration but also because the rate of time decay is different for the two contract months.

Yield-Spread Option

The basket of bonds is affected not only by the general yield movements but also by the yield spread between the different bonds in the basket. Clearly, bonds that are more expensive in the cash bond market relative to their neighbors are usually more expensive to deliver. Several factors can affect these yield spreads, including the stripping of a bond, tightening in the repo markets, or simply buying or selling of a certain issue by a fund.

This also explains why the cheapest to deliver (CTD) is not always the bond that is delivered. The CTD is only the cheapest up to a certain point. If everyone who intended to deliver bought the CTD and its price rose, it probably would not remain the cheapest. Exhibit 53–4 shows this clearly.

At the time of this writing, for the September 1994 contract, the $11^1/_4$ was the CTD, followed by the $10^5/_8$ and the $11^3/_4$. Notice how close the implied repo rates of these three issues are. This implies that even a small change in price between the issues can easily change the profitability landscape. If the price of

EXHIBIT 53–4

Yield-Spread Effects on Implied Repo Rates for the September 1994 Contract

Issue	Price	Yield	CF†	Implied Repo Rate
11 1/4 % 2/15/10–15	155.52	6.45%	1.3230	2.79%
10 5/8 8/15/10–15	148.44	6.47	1.2634	2.75
11 3/4 11/15/09–14	156.30	6.21	1.3242	2.74
11 1/4* 2/15/10–15	155.64	6.44	1.3230	2.72*

*Former CTD, now most expensive to deliver.

†Note that the CF was one priced to yield 8% and was changed to yield 6% beginning with the March 2000 bond future. The analysis, however, is exactly the same.

the $11^1/_4$ increases by only 0.008% or $^4/_{32}$, while the other two bonds stay unchanged, the implied repo rate of the $11^1/_4$ decreases to 2.72%, which makes the issue the most expensive out of this basket.

Clearly, if the CTD can change with seemingly minor moves, upon large shifts in the yield curve, the basis can move dramatically. Inherent in every basis trade is a yield-curve bet. For example, consider the basis move in late July–early August of 1993. Interest rates were well below 8%, making the lower duration bonds cheaper to deliver, and that was indeed the case with the $11^3/_4$% 11/15/14, which was the CTD. The current long bond at the time was the $7^1/_8$% 2/15/23. A trader long that basis would, in effect, be long the $7^1/_8$ and short the $11^3/_4$. This basis was at $^{93}/_{32}$ on July 29. By August 10, it had risen all the way to $^{136}/_{32}$. Many observers attributed the move to the purchase of large strips, but it had much more to do with the flattening of the curve.

The basis is often market-directional: as the market trades up with an even yield move, the basis will increase because of the differing durations. In this case, the rally was coupled with the aforementioned flattening, especially between the 10-year note and the long bond, which flattened from 77.5 to 64 basis points during that interim. Thus, in this instance, it really was not due to any of the other complicated options but rather a simple yield-curve play.

New-Auction Option

The new-auction option's value is derived from the possibility that a new bond may be auctioned with a different coupon or maturity than any bond in the current basket and thus be a candidate for the exalted station of cheapest to deliver.

Look at the basket of bonds in Exhibit 53–5. Assuming that the prices and the different bases listed are typical of those currently in the marketplace, the calculations of CC prices are shown in Exhibit 53–5. As can be seen, the 11/27 is the cheapest, and the 8/17 is the most expensive.

EXHIBIT 53–5

Break-even Prices of the Deliverable Basket

Issue	Price	Yield	CF	CC(Price/CF)
8 7/8% 8/17	144.843	5.00%	1.3062	110.89
8 1/8% 8/19	138.33	5.02%	1.2405	111.51
6 1/2% 11/26	120.303	5.10%	1.0659	112.87
6 1/8% 11/27	114.304	5.15%	1.0167	112.43

Let us see how a newly auctioned issue can change the profitability of delivering the new bond. First, understand that bond yields must move from the current yields for the new bond to be attractive. For example, if the CTD is currently the most recently auctioned bond ($5^1/_8$% 2/15/30) and bond yields move to 5.23%, the new bond will still have a $5^1/_8$% coupon. Second, realize that if the current environment of rates is well below the 6% level, the probability of a newly auctioned bond becoming the cheapest is very low. This is so because this environment favors a low-duration bond. Because of the wide disparity of bond maturity dates in the market basket (from 5/17 to 5/ 30), it is difficult for a move in the yields to compensate for the difference in the lengths of maturities.

Consider a case in which the newly issued bond is the CTD, and there is an auction that would compete with it. These conditions suggest an environment of yields over 6% (remember that over 6%, the CTD usually tracks the highest duration bond). If the current bond is the 7.5% of 2/15/31 (for simplicity's sake, assume that it is the only bond deliverable into the March 2000 contract) and yields decrease to 6.5% before the February 2001 auction, the profit scenario would be as follows:

Issue	Price	Yield	Factor	CC
7 1/2% 2/15/23	113.13	6.5%	1.2078	93.66
6 1/2 5/15/23	100.00	6.5	1.0683	93.60

The simple addition of an extra deliverable should not have an impact on the price of the $7^1/_2$, but notice how this affects the *basis* of the one previously deliverable bond. For example, assume that the basis of that bond was $^{5.5}/_{32}$ before the new bond auction and that the futures price was $94^{19}/_{32}$. The newly auctioned bond is more deliverable than the old bond by $^2/_{32}$ (93.66 – 93.60). This means that the bond future price will fall by just that amount because that is now the new CC price (remember that CC does not include carry). This would occur as arbitrageurs bought the new bond and sold the futures price down to the CC. If the cash bond prices remained constant and the futures price fell by $^2/_{32}$, the basis on that old bond would increase by $^2/_{32}$ to $^7/_{32}$. Thus, as expected, the investor who is long the basis of the $7^1/_2$ profits by the introduction of the newly auctioned bond.

Notice that if the new bond does not create a potentially profitable switching opportunity, the trader long that basis loses only the value of the auction option. As with any other option, the largest amount of money an investor can lose is the value of that option, which in this case is worth very little, if anything.

It is evident that the new-auction option is most valuable when yields are above the switchover point and move down or when yields are below the switchover point and rise. The yield increase, however, must produce a coupon that compensates for the extra six months on the next bond auctioned.

The value of the option theoretically ends immediately after the bond auction results are posted, which is around 2 P.M. eastern time—approximately an hour after the auction itself. The bond futures price should adjust immediately, or there is ample room for arbitrage. However, one should not be misled into thinking that traders are on the edge of their seats waiting for the auction results to see if there will be a cheaper-to-deliver bond. Clearly, they are aware if there is a potential for the creation of a more profitable delivery, and the future's price will hover accordingly.

Also, reconsider the first instance of yields below 6%. If the auction results in a bond with a lower coupon, then the new bond could prove profitable to deliver if rates rise through 6%. Even though it was the new auction that created the issue, the potential option value would then be attributed to the yield-change option because it was not the auction itself that created the opportunity but rather the yield shift. However, there also would be no opportunity to switch into the new, cheaper bond if the bond is never created in an auction. Regardless, the categorization is a simple matter of semantics.

The Wildcard Options

The CF creates tails in one's position. If a trader is long \$50 million of the bond basis, he is required to deliver \$50 million in eligible bonds. If the bond has a coupon other than 6%, he will have a tail of some sort. For example, the $8^3/_4$% 8/20 has a CF of 1.3197 for the March 2000 contract. Thus, if a trader is long \$100 million of this basis, he would be short 1319 contracts. After he delivers the bonds to cover his 1319 short in the futures, he would still be short \$31.9 million cash bonds, which is his tail.

This wildcard, or late-day, option comes into play because of the tail and because the futures markets and cash markets do not trade simultaneously at all times. The CBT stops trading at 2 P.M. CST, whereas the cash market is open almost the entire day.[7] The short has until 8 P.M. CST to give notice of intention to deliver,

7. The only exception is on weekdays between 4:30 P.M. and 5:30 P.M. CST, which is the time between the close of the cash bond market in the United States and its opening in Tokyo, and on the weekends up until 5:30 P.M. CST Sunday.

but the futures price is stuck at the 2 P.M. close. This allows the short to buy the bond tail short after 2:00 if the market dips and allows the short to sell the bond tail long after 2:00 if the market rallies.

Although this option is available on many consecutive days, it does not cover those entire trading days but rather only the six-hour time frame between 2 P.M. and 8 P.M. If the short fails to give notice of intent to deliver by 8:00, that day's wildcard option expires worthless.

Wildcard Call Option

The call is in effect if the hedge ratio is less than 1. In this instance, the trader who is long the basis is also long the bond tail, which she will try to sell before delivering. Therefore, if the market rises after the 2:00 futures close, she will be able to sell that tail at a high price although the futures price is frozen at the 2:00 settlement price. However, not all rallies will do. The rally should be looked at as just a rally of the tail because the remainder is hedged and must be delivered. The size of the tail obviously is very important because the larger it is, the smaller the movement has to be to reach a profitable switching point or strike price. Remember that the tail is simply the CF minus one. The formula for how much it should rally is as follows:

$$S(\text{call}) = \text{BP} + \frac{(\text{BS} \times \text{CF})}{1 - \text{CF}}$$

where

S = strike or breakeven price
BP = bond price at 2 P.M. CST
BS = basis
CF = conversion factor

Wildcard Put Option

This option is in effect if the hedge ratio is greater than one. The short holds an implicit out-of-the-money put option on the bond. A hedge ratio greater than one means that the long basis trader possesses a futures tail that she must cover in the cash market. If the market falls after 2:00, the trader can buy back her cash at a lower price and still use the higher futures close to calculate her invoice price. However, this does not imply that any drop in the cash market will make it profitable to deliver. The strike price is determined by the following formula:

$$S(\text{put}) = \text{BP} - \frac{(\text{BS} \times \text{CF})}{(\text{CF} - 1)}$$

The following illustrates the wildcard put option scenario. Suppose that it is 4:25 on a Thursday afternoon. The market has begun to suspect that the Federal Reserve may begin an aggressive tightening campaign owing to recent economic strength. Federal Reserve Chairman Greenspan tells the New York Economics

Club that inflation is expected to be materially worse in the period ahead. The market quickly drops.

The calculation to determine how much it has to drop before the wildcard option is profitable is shown below:

Issue	Price	Futures Settlement	Basis	CF
8 1/2% 2/20	121 8/32	94 4/32	3 8/32	1.2869

$$S(\text{put}) = 121.25 - \frac{0.1187 \times 1.2869}{1.2869 - 1}$$
$$= 120.717$$
$$= 120\ 23/32$$

The issue has to drop $^{17}/_{32}$ ($121^{18}/_{32} - 120^{23}/_{32}$) before it is profitable to exercise this option. Certainly, this does not imply that a trader should buy the tail at 164-03. If he thinks the market will decline further, he should wait before purchasing the tail. If the market begins to rise after the initial decline, the trader has missed an opportunity for profit, but he has not lost any money. It is the asymmetric profit profile of not being able to lose any money besides the value of that day's wildcard option, which is usually infinitesimally small, and of having a large upside potential that makes this wildcard an option. If the market falls anywhere short of the 164-04 level, it would not be profitable to cover and give notice to deliver.

The wildcard option is enhanced by a few characteristics of the specific bond and the market in general. If the bond's coupon is significantly different from 8%, then the CF will be greatly different from one. This leaves a larger tail with which to cover the basis loss a trader gives up by exercising his option early. It then should be obvious that the smaller the basis at the time of exercise, the easier it is to cover the loss. Thus, if financing rates are close to the bond's yield (i.e., a relatively flat yield curve), the carry is small if positive at all, and thus the wildcard's strike price is not as far out of the money. Lastly, if the market is very volatile, that increases the value of the option because there is a greater potential for price jumps after 2 P.M. CST.

The wildcard option in the environment at the time of this writing usually does not come into play very often for a few reasons.

The first is that the market has to rise (or fall) enough to cover the value of the basis. The time frame in which a wildcard option can come into play is from the first notice day, which is two business days before the start of the delivery month, to the day before the last trading day. Also remember that the theoretical value of the basis must converge to zero by the end of the month. But because the basis stops trading eight days before the end of the month, and because the switching option is usually the most valuable, the basis on that eighth day is usually considerably more than zero. Consequently, it would take a substantial rise (or fall) to cover the value of the remaining basis.

The second reason is that the market generally tends to quiet down after the close of the futures market because of lack of liquidity (which can sometimes be the impetus of precipitous declines and explosive rallies) and lack of interest. The only news that comes out after 2 P.M., besides those occasional breaking world events, is the money supply announcement at 3:30 P.M. CST and sometimes a late Johnson Redbook report (a report on retail sales), which is usually released to its subscribers around 1:45 P.M. CST. Money supply is not the earthshaker it used to be even as recently as 1992,[8] and even though the Redbook reports have found a following, they are not usually impressive enough to move the market substantially. This is partly because both numbers generally have more relevance (in terms of yield) for the short end of the yield curve.

Switching Option

After the last day of the futures trading, the deliverer has the option to deliver another bond if it becomes more deliverable. In other words, he is looking to switch or change the bond he has currently taken with him "off the board" for a more profitable bond. This option, often referred to as the *end-of-the-month option,* is similar to the wildcard option in that much of the potential profitability depends on the futures settlement price being frozen on the last trading day's settlement at 1 P.M. while the cash prices are free to fluctuate. Thus he is guaranteed a fixed invoice price (the price he is paid to deliver those particular bonds) and will only "lose" the value of that basis if he delivers it and less than that if he delivers a cheaper bond. Like any other option, then, the maximum loss is the value of the net basis or the value of the option premium.

The switching option is different from the wildcard option in that if the trader is positioned in the basis when it goes "off the board" or stops trading, he will guarantee himself either of having to make delivery or of being delivered to. In fact, at 1 P.M. on that eighth-to-last business day, he should position himself to face amounts because that is what is required in delivery. Therefore, it is not as if there is a one-week option on the tail because the tail should be covered when the contracts go off the board. For example, assume that a trader is long $10 million of the 8³/₄% 5/20 basis and is short 132 contracts against the amount as a factor weight. He must either buy back 32 contracts right before they close or sell $3.2 million 8³/₄s. No tail means no wildcard.

Return to Exhibit 53–1, the original basket of deliverable bonds. Because yields are far below the 6% mark, the lower durations are clearly the CTDs. Now

8. Financial numbers tend to fall in and out of favor with Wall Street. Money supply, once considered by many to be the preeminent predictor of future economic strength, has been frowned on recently by some who question its true correlation with the growth rate. As recently as 1989, the release of merchandise trade figures used to move markets like nothing else. It now comes and goes with barely a whisper.

EXHIBIT 53–6

Analysis of Deliverability with Yields Rising Roughly 50 Basis Points

Issue	Price	Yield	CF	CC
8 7/8% 8/17	137.635	5.50%	1.3062	105.37
8 1/8% 8/19	130.88	5.52%	1.2405	105.51
6 1/2% 11/26	112.395	5.60%	1.0659	105.45
6 1/8% 11/27	105.159	5.75%	1.0167	103.43

assume that the futures stopped trading at 95.50 and yields rise 50 basis points during the seven-day window. This is obviously a hefty change in yields during a relatively short time span. As shown in Exhibit 53–6, however unlikely, the move is both possible and elucidating.

The switching profitability can be calculated easily to determine which issue should be swapped into and delivered. A trader should just follow the logical procession of switching by totaling the different cash flows involved and subtracting the value of the old invoice price, that is, the money forgone by switching to another bond.

1. Sell the old (previous) deliverable—Receive money (+).
2. Buy the new (cheaper) deliverable—Expend money (–).
3. Lose potential money on old deliverable—Money forgone (–).
4. Deliver the new bond at new invoice price—Receive money (+).

This analysis is shown in Exhibit 53–7. When calculating the profitability of swapping into different issues after the move in yields, it can be seen that the 6 1/8 is now the most profitable to switch into. The long basis trade in this case has resulted in a whopping $4.84 profit minus the value of the original basis. If the

EXHIBIT 53–7

Profitability of Switching Issues to Deliver

Issue	1. Sell Old	2. Buy New	3. Lose Potential	4. Deliver New	5. Net Gain (Loss)
8 7/8% 8/17	+$137.64	–$137.64	–$124.74	+$124.74	$0.0
8 1/8% 8/19	+$137.64	–$130.88	–$124.74	+$118.47	$0.49
6 1/2% 11/26	+$137.64	–$112.39	–$124.74	+$101.793	$2.30
6 1/8% 11/27	+$137.64	–$105.16	–$124.74	+ $97.095	$4.84

basis minus carry had been greater than \$4.84, then the entire trade would not have been profitable.

In the preceding scenario, every issue provides the opportunity for a profitable switch. If, for example, the 8 1/8's yield rose to only 5.42% because of large hedge fund buying, and the price fell to \$132.33, there would be a loss of \$0.96 in switching to the 8 1/8. Thus, if this were the case and the 8 1/8 were the only other deliverable bond, the trader simply should keep and deliver the 8 7/8 and just realize the switching option loss. This should illuminate the fact that the yield-spread option is extremely important during this end-of-the-month period.

Now view the trade from the basis short's perspective. The trader was hoping to make the premium of the option or the net basis. But the large and sudden drop in yields has netted him ownership of the 6 1/8 and a loss of \$4.84 minus the value of the outstanding basis.

Notice that there is no change if the trader stays with the 8 7/8 as expected. This implies that the maximum loss associated with not switching is zero. In other words, it has the same profit profile as an option. If the market rallies, and there exists a profitable swap opportunity, then the basis long owns an implied out-of-the-money call option, and if the market declines and there exists a profitable swap opportunity, then the trader owns an implied out-of-the-money put option. Both options have implied strikes at where the market must move to execute a profitable swap.

The degree to which the bonds are out of the money depends on the difference in deliverability of the bonds in the basket. If one bond is clearly the most deliverable under almost any circumstance, then both options are considerably out of the money. If the basket is tightly bunched as to profitability, and thus as to possibility of delivery, then the strikes are closer to the current market price. The aforementioned sell off clearly shows that the basis long owns an out-of-the-money call option.

In the case of neither of the two strikes being touched, the basis long loses the premium or the basis. If the basis long does indeed profit from both a market decline and rally, it is, in effect, long a strangle. However, even if it is a true strangle, that is, the out-of-the-money factor is the same for both the put and the call, equal price moves both up and down are still significant because, unlike an ordinary bond strangle, the payoff can often have an asymmetric profitability profile. Therefore, one should be careful to ascertain not only the probability of yields moving to a certain level, but also the profitability once through there.

To fully understand the risk inherent in any basis position, one must not only be able to calculate the profitability of switching but also ascertain at what point the profitable switch can occur. To determine exactly how far out of the money those strike prices are, that is, how much the yield curve has to move to enable a profitable switch (assuming a parallel yield move), one has to first observe the relative dollar durations (DD) of the two issues. Dollar duration is the *dollar* value change per 100 basis point change in yield, or approximately the present value of a basis point multiplied by 100. It is also the key to determining the profitability of switching because one should be more concerned with the *dollar* amount involved in switching than with the change as a percentage of price, which is what is measured by Macaulay's duration and modified duration.

Clearly, if two bonds are of equal maturity, the bond with the higher coupon will have the higher price. Thus, by definition, the higher-coupon bond often will have the higher dollar duration. Thus, if yields decline, the higher-coupon bond will jump in price more than the lower-coupon bond, and on a yield rise, the lower-coupon bond will lose more money. During the switching period, the implication is clear—on a rally, one can sell the higher-coupon bond and, with that money, buy the lower coupon. The converse is also true: if yields rise, the higher-dollar-duration bond will decline in price more and thus make it cheaper to deliver.

Because the price/yield relationship is not linear for larger price moves, convexity can play a major role. Convexity, the second derivative of the price/yield function simply implies that for equal yield movements, the price will increase more than it will decline. Thus any formula that measures price change simply by using duration will be inaccurate for large yield shifts. Of course, this problem can be rectified at least partially by simply including convexity in the calculation. For simplicity's sake, we will assume the prices are very good approximations and thus omit the effect of convexity.

Therefore, the formula to find the strike price of the implied option would simply equal the low and high coupons' DD multiplied by the yield shift. Obviously, only a small yield change is required to make it profitable to switch into another bond if the new bond's basis (BS) is only $^1/_{32}$ more expensive than the previous CTD. Consequently, one also must consider the two bonds' basis to determine how much the move must compensate. The following formula gives the strike price:

$$\text{Basis of high coupon} - (\Delta r \times DD_H) = \text{basis of low coupon} - (\Delta r \times DD_L)$$

where Δr is the parallel rate change required for the two issues to be equally deliverable. This reduces to

$$BS_H - BS_L = \Delta r(DD_H - DD_L)$$

Solving for Δr,

$$\Delta r = BS_H - BS_L/DD_H - DD_L$$

The following example shows how to determine the movement required for a profitable switch. Suppose that there are only two deliverable bonds—the $8^7/_8\%$ of 8/17, which is currently the cheapest, and the $6^1/_2\%$ of 11/26 which is the potential switching candidate. The yield shift required to make the two issues equally deliverable is calculated as follows.

Issue	Price	Yield	Dollar Duration	CF	Basis
8 7/8% 8/17	144.84	5.00%	14.95	1.3062	8/32
6 1/2% 11/26	120.3	5.10%	16.62	1.0659	14/32

$$\Delta r = \frac{^{14}\!/_{32} - {}^{8}\!/_{32}}{16.62 - 14.95} = \frac{(0.437 - .25)}{1.67} = 0.1419$$

EXHIBIT 53–8

Calendar of Delivery Month

June 2005

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
May 29 Yield-shift option*	May 30 *First Position Day* Wildcard option Yield-shift option	May 31 *First Notice Day*† Wildcard option Yield-shift option	1 *First Delivery Day* Wildcard option Yield-shift option	2 Wildcard option Yield-shift option	3 Wildcard option Yield-shift option	4 Wildcard option Yield-shift option
5 Wildcard option Yield-shift option	6 Wildcard option Yield-shift option	7 Wildcard option Yield-shift option	8 Wildcard option Yield-shift option	9 Wildcard option Yield-shift option	10 Wildcard option Yield-shift option	11 Wildcard option Yield-shift option
12 Wildcard option Yield-shift option	13 Wildcard option Yield-shift option	14 Wildcard option Yield-shift option	15 Wildcard option Yield-shift option	16 Wildcard option Yield-shift option	17 Wildcard option Yield-shift option	18 Wildcard option Yield-shift option
19 Wildcard option Yield-shift option	20 Wildcard option Yield-shift option	21 *Last Trading Day* Switching option Yield-shift option	22 Switching option	23 Switching option	24 Switching option	25 Switching option
26 Switching option	27 Switching option	28 *Last Position Day* Switching option	29 *Last Notice Day*	30 *Last Delivery Date*		

*Yield-shift option here also encapsulates the yield-spread option. It is in effect much before May 29 as it is the only option affected by a change in the overall yield environment, and this, obviously, can occur considerably before the month of June. The new-auction option is similar in that it is applicable any time before the auction of a new bond.

†Do not confuse the terminology. Some people refer to position day as first notice day. First notice day here refers to the first day the basis short can inform the CBT which bond is to be delivered.

Therefore, a profitable switch can be executed if yields fall more than 11.25 basis points. The further the sell-off, the greater will be the profit in switching and delivering the 6 1/2· Also remember, however, that the larger the shift, the greater is the error due to convexity.

CONCLUSION

As stated earlier, the value of the basis cannot be derived simply by adding all the deliverability options because some are mutually exclusive and some are interdependent. Accurate valuation is immensely difficult because of the many parameters that must be considered. Among them are market volatility, potential change in the financing rate, time to first and last delivery dates, the shape of the yield curve, whether or not an auction will be held in the interim, yield spreads between the deliverable bonds, and how they all interact with each other. The delivery process and options for the June 2005 contract shown in Exhibit 53–8 should prove helpful in conceptualizing the sequence of events in a delivery month.

A beginning in valuing the basis through a simplified approach is to take the expected value of the futures at the different stages of the delivery process and calculate the value of the basis at each final outcome. One first has to make an assumption about whether the future distribution of bond prices is normal, log normal, or any other shape. Then, by creating numerous scenarios of yield moves in both directions, one can observe which bond's net basis appears to be cheapest.

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CHAPTER
FIFTY-FOUR

THE BASICS OF INTEREST-RATE OPTIONS

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As the sophistication and diversity of investors have grown, the need for derivative instruments such as options has increased accordingly. Knowledge of option strategies, once the province of a few speculators, is now necessary for everyone who wishes to maintain a competitive edge in an increasingly technical market. Moreover, the new options technology has been applied with increasing success to securities with optionlike characteristics such as callable bonds and mortgage-backed securities.

In Chapter 51, option contracts were described: exchange-traded options on physical securities, exchange-traded options on futures, and over-the-counter (OTC) options. In this chapter we will review how options work, their risk/return profiles, the basic principles of option pricing, and some common trading and portfolio. A more detailed discussion of hedging strategies is provided in Chapter 57.

Throughout most of the discussion, our focus will be on options on physicals. The principles, however, are equally applicable to options on futures or futures options.

HOW OPTIONS WORK

An *option* is the right but not the obligation to buy or to sell a security at a fixed price. The right to buy is called a *call,* and the right to sell is called a *put;* a call makes money if prices rise and a put makes money if prices fall.

If the owner of an option uses the option to buy or to sell the underlying security, we say that the option has been *exercised.* Because the holder is never required to exercise an option, the holder can never lose more than the purchase price of the option—an option is a limited-liability instrument.

An option on a given security can be specified by giving its strike price and its expiration date. The *strike price* is the price on the optional purchase. For example, a call with a strike price of par is the right to buy that security at par. The *expiration date* is the last date on which the option can be exercised: after that, it is worthless, even if it had value on the expiration date. If an option is allowed to expire, it is said to be *terminated.* On or before the expiration date, the option holder may decide to sell the option for its market value. This is called a *pair-off.*

Some options can be exercised at any time until expiration: they are called *American* options. On the other hand, some options can only be exercised at expiration and are called *European* options. Because it is always possible to delay the exercise of an American option until expiration, an American option is always worth at least as much as its European counterpart. In practice, there are only a limited number of circumstances under which early exercise is advantageous, so the American option rarely costs significantly more than the European.

The easiest way to analyze a position in a security and options on that security is with a *profit/loss graph.* A profit/loss graph shows the change in a position's value between the *analysis date* ("now") and a *horizon date* for a range of security prices at the horizon.

Suppose that a call option struck at par is bought today for 1 point. At expiration, if the security is priced below par, the option will be allowed to expire worthless; the position has lost 1 point. If the security is above par at expiration, the option will be exercised; the position has made 1 point for every point the security is above par, less the initial one-point cost of the option. Exhibit 54–1 shows the resulting profit/loss graph.

EXHIBIT 54–1

Long Call versus Underlying Security Price
Call Struck at Par, at Expiration, with 1-Point Premium

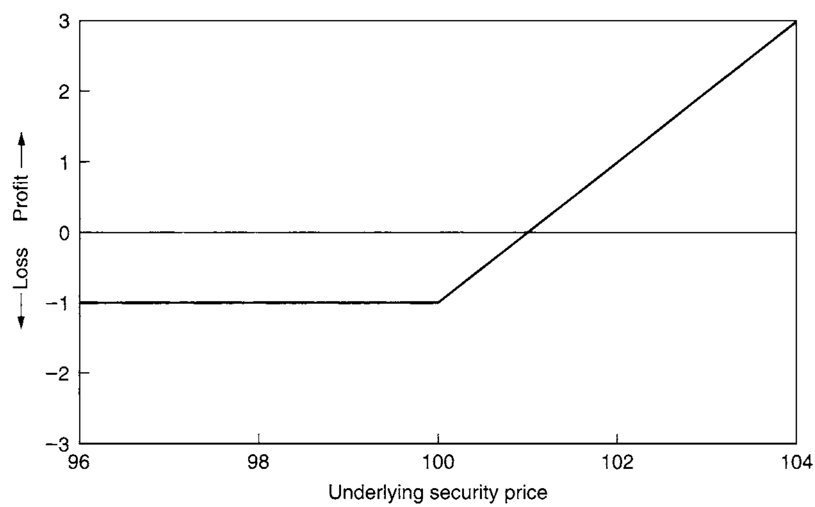
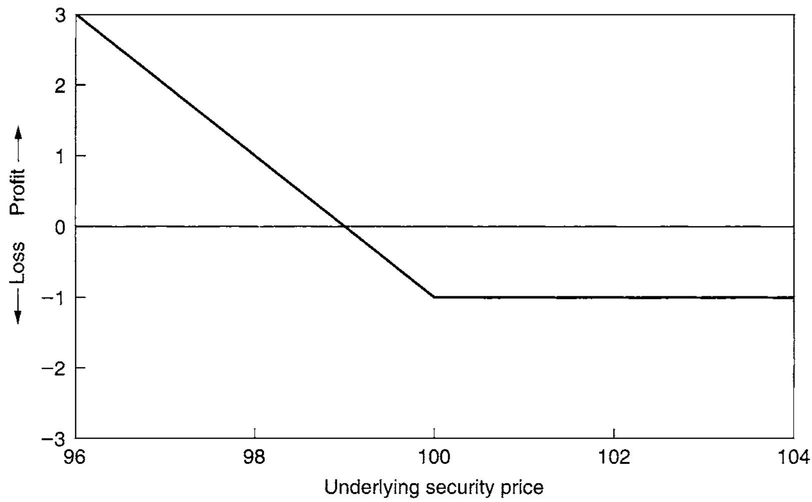


EXHIBIT 54–2

Long Put versus Underlying Security Price
Put Struck at Par, at Expiration, with 1-Point Premium



Note that if the price of the underlying increases by 1 point, the option purchase breaks even. This happens because the value of the option at expiration is equal to the initial purchase price. A price of 101 is the break-even price for the call: the call purchase will make money if the price of the underlying exceeds 101 at expiration.

A put is the reverse of a call. Look at Exhibit 54–2, which is the profit/loss graph of a put option struck at par bought for 1 point. At expiration, the put is worth nothing if the security's price is more than the strike price and is worth one point for every point that the security is priced below the strike price. The break-even price for this trade is 99, so the put purchase makes money if the underlying is priced below 99 at expiration.

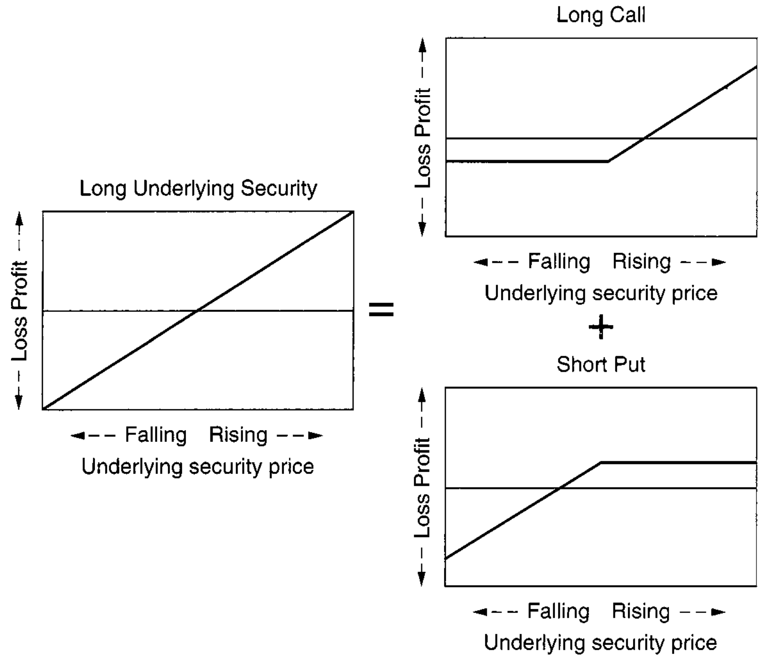
Put/Call Parity

A put and a call struck at the money split up the profit/loss diagram of the underlying security into two parts. Consider the position created by buying a call and selling a put such that the strike price of the two options is equal to the price of the underlying. If the price of the security goes up, the call will be exercised; if the price of the security goes down, the put will be exercised. In either case, at expiration the underlying is delivered at the strike price. Thus, in terms of profit and loss, owning the call and selling the put are the same as owning the underlying.

Exhibit 54–3 divides the profit/loss graph of the underlying security into graphs for a long call and a short put, respectively. The following three facts

EXHIBIT 54–3

Long Security = Long Call + Short Put



can be deduced:

Long security = long call + short put (Exhibit 54–3)

Long call = long security + long put (Exhibit 54–4)

Long put = short security + long call (Exhibit 54–5)

This relationship is called *put/call parity;* it is one of the foundations of the options markets. Using these facts, a call can be created from a put by buying the underlying, or a put made from a call by selling the underlying. This ability to convert between puts and calls at will is essential to the management of an options position.

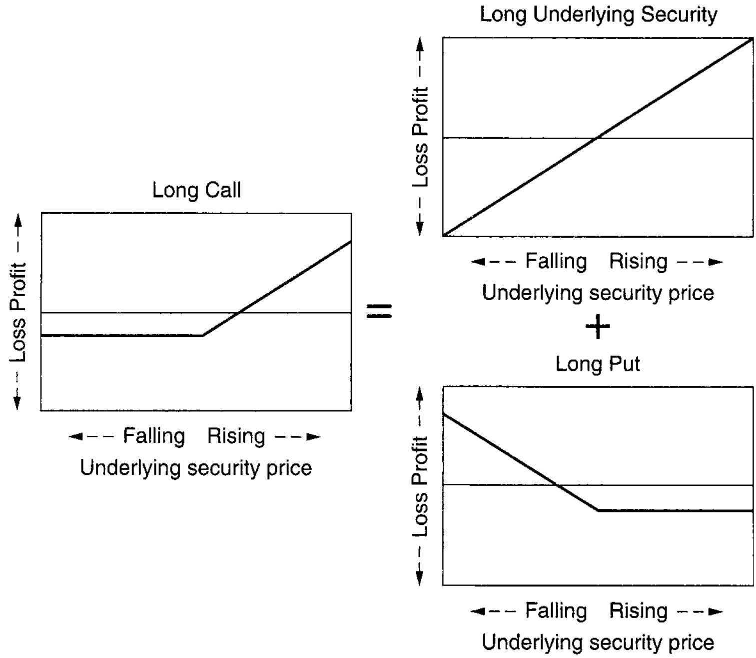
Valuing an Option

The first fact to determine about an option is its worth. There are many option valuation models for each class of options, each of which uses different parameters and returns slightly different values. However, the five main determinants of option value are the price of the underlying, the strike price of the option, the expiration of the option, the volatility of the underlying, and the cost of financing the underlying.

The most apparent component of option value is intrinsic value. The *intrinsic value* of an option is its value if it were exercised immediately. An option with

EXHIBIT 54–4

Long Call = Long Security + Long Put



intrinsic value is an *in-the-money* option. When the underlying security trades right at the strike price, the option is called *at-the-money.* Otherwise, an option with no intrinsic value is called *out-of-the-money.*

An option may have value over and above its intrinsic value, called *time value.* The intrinsic value is the value of the option if exercised immediately, whereas the time value is the remaining value in the option due to time expiration. Clearly, the more time there is to expiration, the greater is the time value.

Exhibit 54–6 graphs the value of an option as time to expiration increases. Exhibit 54–7 compares the value of an option at expiration with the values of options with one and three months to expiration. There is a sharp corner in the graph at the strike price that becomes more pronounced as the time to expiration decreases. This sharp corner makes an at-the-money option increasingly difficult to hedge as expiration approaches.

If the option is out-of-the-money, it has some time value because there is a chance that the option will expire in the money; as it gets further out of the money, this is less likely and the time value decreases.

If the option is in-the-money, its time value is due to the fact that it is better to hold the option than the corresponding position in the underlying security because if the security trades out-of-the-money the potential loss on the option is

EXHIBIT 54–5

Long Put = Short Security + Long Call

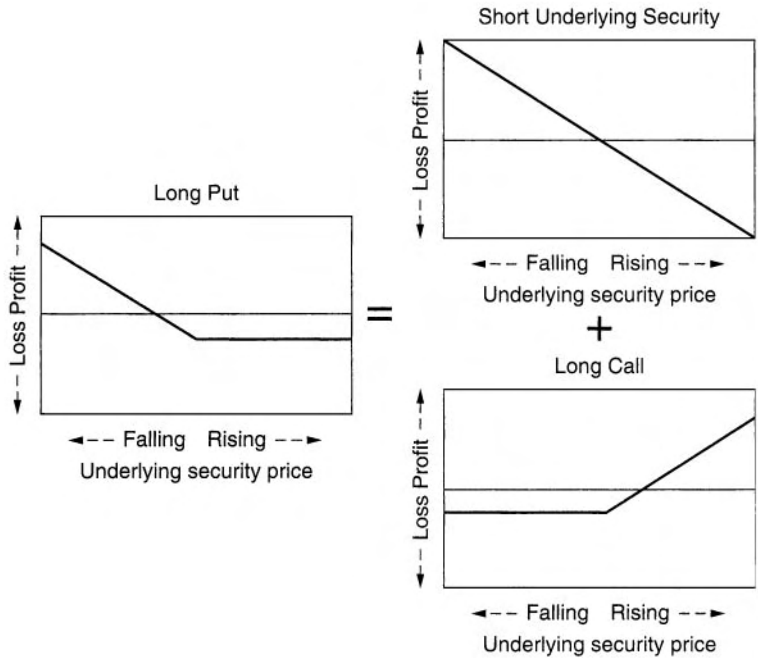


EXHIBIT 54–6

Call Option Value versus Time until Expiration
Three Calls: At-the-Money, 1 Point In-the-Money, 1 Point Out-of-the-Money

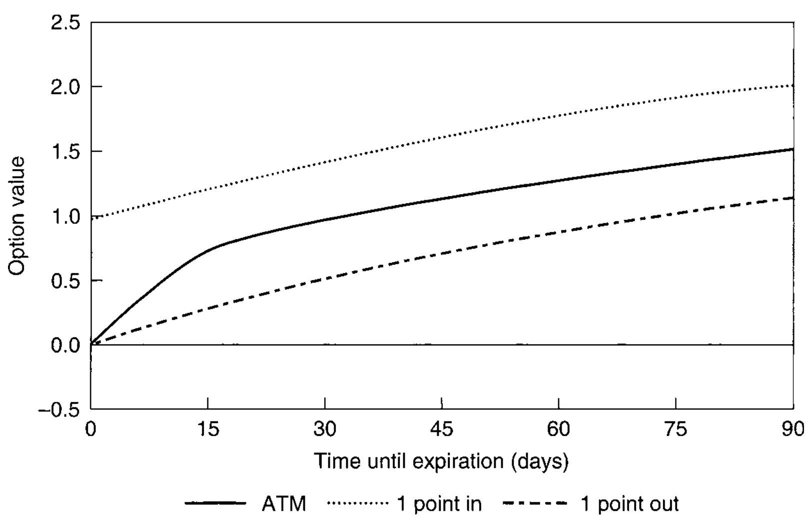
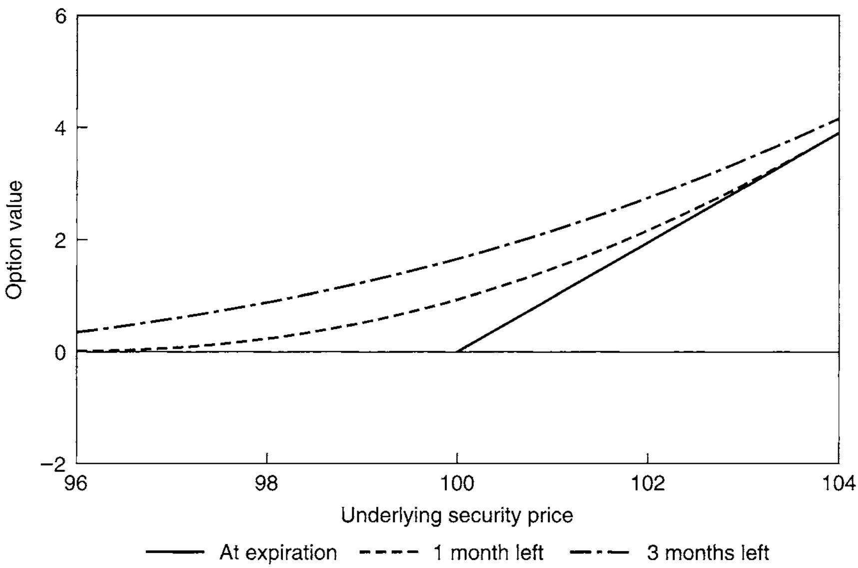


EXHIBIT 54–7

Call Option Value versus Underlying Security Price
Call Struck at Par with One and Three Months to Expiration



limited to the value of the option; as the option gets further in the money, this possibility becomes more farfetched and the time value decreases.

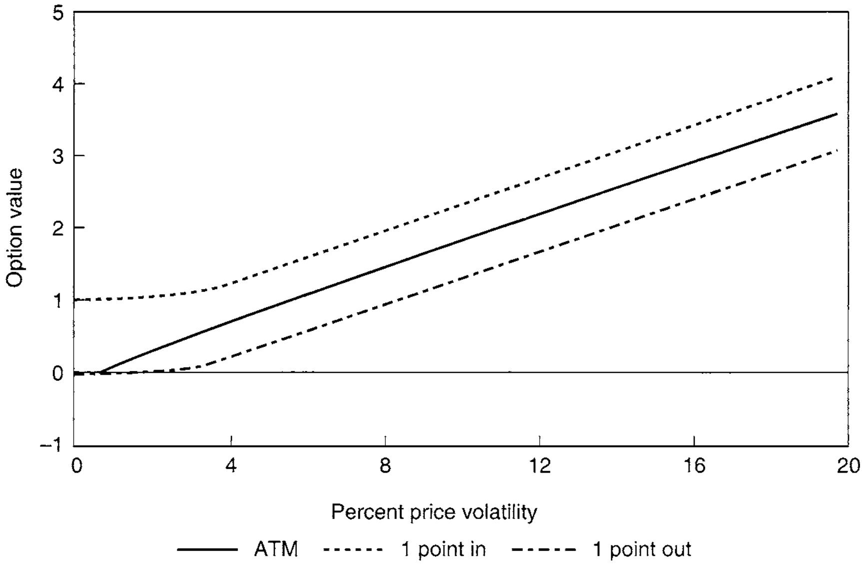
Either way, the time value depends on the probability that the security will trade through the strike price. In turn, this probability depends on how far from the strike price the security is trading and how much the security price is expected to vary until expiration.

Volatility measures the variability of the price or the yield of a security. It measures only the magnitude of the moves, not the direction. Standard option pricing models make no assumptions about the future direction of prices but only about the distribution of these prices. Volatility is the ideal parameter for option pricing because it measures how wide this distribution will be. We discuss volatility in more detail at the end of this chapter.

The higher the volatility of a security, the higher is the price of options on that security. If a security had no volatility, for example, that security would always have the same price at time of purchase of an option as at its expiration, so all options would be priced at their intrinsic value. Increasing the volatility of a security increases the time value of options on that security as the chance of the security price moving through the strike price increases. Increases in the value of an at-the-money option are approximately proportional to increases in the volatility of the underlying. Exhibit 54–8 shows how the price of an option behaves as the volatility of the underlying security increases.

EXHIBIT 54–8

Call Option Value versus Percent Price Volatility
Three Calls: At-the-Money, 1 Point In-the-Money, 1 Point Out-of-the-Money; Three Months from Expiration



The final factor that influences options prices is the *carry* on the underlying security. Carry is the difference between the value of the coupon payments on a security and the cost of financing that security's purchase price. With the usual upward-sloping yield curve, most securities have a positive carry.

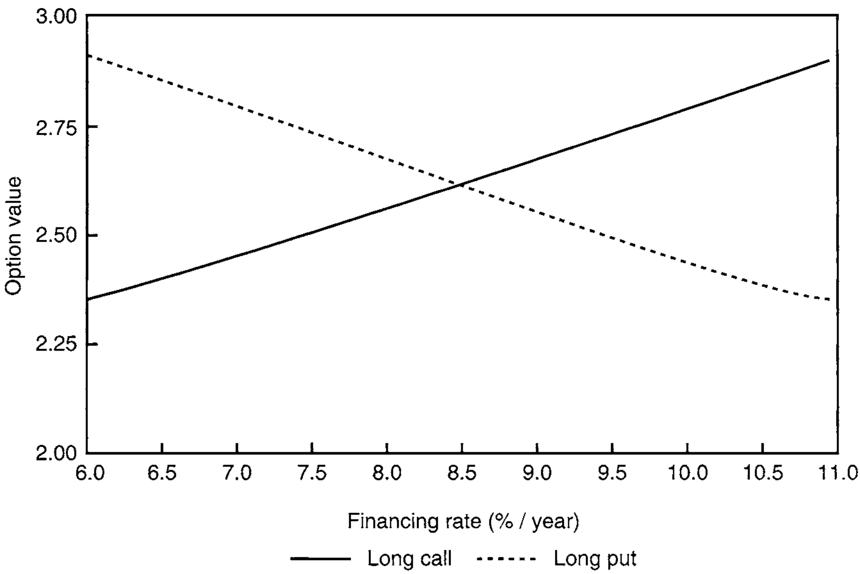
The effect of the carry can be seen by comparing the price of an at-the-money call with an at-the-money put where the underlying security has a positive carry. The writer of the call anticipates the chance of being required to deliver the securities and thus buys the underlying as a hedge; the put writer hedges by selling the underlying. The call writer earns the carry while the put writer loses the carry, so the call should cost less than the put. When the yield curve inverts and short-term rates are higher than long-term rates, carry becomes negative and calls cost more than puts.

By put/call parity, selling an at-the-money call and buying an at-the-money put are equivalent to shorting the underlying security. The cash taken out of the option trade, accounting for transaction costs, compensates the option holder for the carry on the position in the underlying until expiration. This trade is called a *conversion,* and it is used frequently to obtain the effect of a purchase or sale of securities when buying or selling the underlying is impossible for accounting reasons.

Exhibit 54–9 compares the cost of an at-the-money call and put for a range of financing rates. The two graphs intersect where the call and the put have the same value: this happens when the cost of financing the underlying is equal to the coupon

EXHIBIT 54–9

Treasury Option Value versus Financing Rate
Long Call, Long Put Struck at Par, Three Months to Expiration



yield on the security, so the carry is zero and there is no advantage to holding the underlying over shorting it.

Exhibit 54–10 summarizes the parameters that affect the value of an option and how much raising each parameter affects that value.

Delta, Gamma, and Theta: Hedging an Option Position

More precise quantitative ways to describe the behavior of an option are needed to manage an option position. Options traders have created the concepts of delta,

EXHIBIT 54–10

The Effect of an Increase of a Factor on Option Values

	Call	Put
Underlying price	Increase	Decrease
Strike price	Decrease	Increase
Carry	Decrease	Increase
Time to expiration	Increase	Increase
Volatility	Increase	Increase

gamma, and theta for this purpose. Delta measures the price sensitivity of an option, gamma the convexity of the option, and theta the change in the value of the option over time.

For a given option, the *delta* is the ratio of changes in the value of the option to changes in the value of the underlying for small changes in the underlying. A typical at-the-money call option would have a delta of 0.5; that means for a 1-cent increase in the price of the underlying the value of the call would increase by 0.5 cents. On the other hand, an at-the-money put would have a delta of –0.5; puts have negative deltas because they decrease in value as the price of the underlying increases (see Exhibit 54–10).

The standard method of hedging an options position is called *delta hedging,* which unsurprisingly makes heavy use of the delta. The idea behind delta hedging is that for small price moves, the price of an option changes in proportion with the change in price of the underlying, so the underlying can be used to hedge the option. For example, 1,000,000 calls with a delta of 0.25 would for small price movements track a position of 250,000 of the underlying bonds, so a position consisting of 1,000,000 of these long calls and 250,000 of the security sold short would be delta-hedged. The total delta of a position shows how much that position is long or short. In the preceding example, the total delta is

$$0.25 \times 1{,}000{,}000 - 1 \times 250{,}000 = 0$$

so the position is neither long nor short.

Intuitively, the delta of an option is the number of bonds that are expected to be delivered into this option. For example, an at-the-money call has a delta of 0.5, which means that one bond is expected to be delivered for every two calls that are held. In other words, an at-the-money call is equally as likely to be exercised as not. An option that is deeply out-of-the-money will have a delta that is close to 0 because there is almost no chance that the option will ever be exercised. An option that is deeply in the money almost certainly will be exercised. This means that a deeply in-the-money put has a delta of –1 because it is almost certain that the holder of the option will exercise the put and deliver one bond to the put writer.

Put/call parity tells us that a position in the underlying security may be duplicated by buying a call and selling a put with the same strike price and expiration date. Thus the delta of the call less the delta of the put should be the delta of the underlying. The delta for the underlying is 1, so we get the following equation:

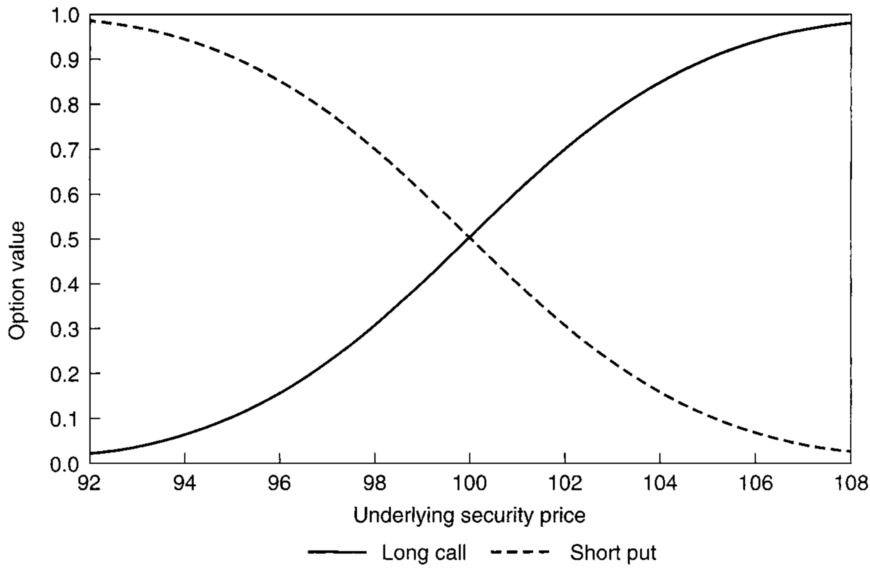
$$\text{Delta}(\mathit{call}) - \text{delta}(\mathit{put}) = 1$$

where call and put are options on the same security with the same strike price and expiration date. This says that once the call is bought and the put sold, the bond is certain to be delivered; if the call is out of the money, the put is in the money. Moreover, as the chance of having the underlying delivered into the call becomes smaller, the chance of having to accept delivery as the put is exercised becomes larger. Exhibit 54–11 compares the deltas for a long and a short put.

Making the position delta-neutral does not solve all hedging problems, however. This is demonstrated in Exhibit 54–12. Each of the three positions

EXHIBIT 54–11

Option Delta versus Underlying Security Price
Long Call, Short Put Struck at Par, Three Months to Expiration



shown is delta-neutral, but position 1 is clearly preferable to position 2, which is, in turn, better than position 3. The difference between these three positions is *convexity*. A position such as position 1 with a profit/loss graph that curves upward has a positive convexity, whereas position 3 has a graph that curves downward and thus has negative convexity.

Gamma measures convexity for options; it is the change in the delta for small changes in the price of the underlying. If a position has a positive gamma, then as the market goes up the delta of the position increases and as it declines the delta increases. Such a position becomes longer as the market trades up and shorter as the market trades down. A position like this is called *long convexity* or *long volatility.* These names come from the fact that if the market moves in either direction this position will outperform a position with the same delta and a lower gamma. Exhibit 54–13 shows this phenomenon.

A long option always has a positive gamma. The delta of a call increases from 0 to 1 as the security trades up, and the delta of a put increases also, moving from –1 to 0. Exhibits 54–1 and 54–2 show that the profit/loss graph of options curves upward. Because of this, options traders often speak of buying or selling volatility as a synonym for buying or selling options.

A position with a zero gamma is called *flat convexity* or *flat gamma.* Here, a change in the underlying security price does not change the delta of the position. Such a position trades like a position in the underlying with no options bought or sold. If the position has in addition a delta of zero, then its value is not affected by

EXHIBIT 54–12

Delta-Neutral Positions with Different Gamma

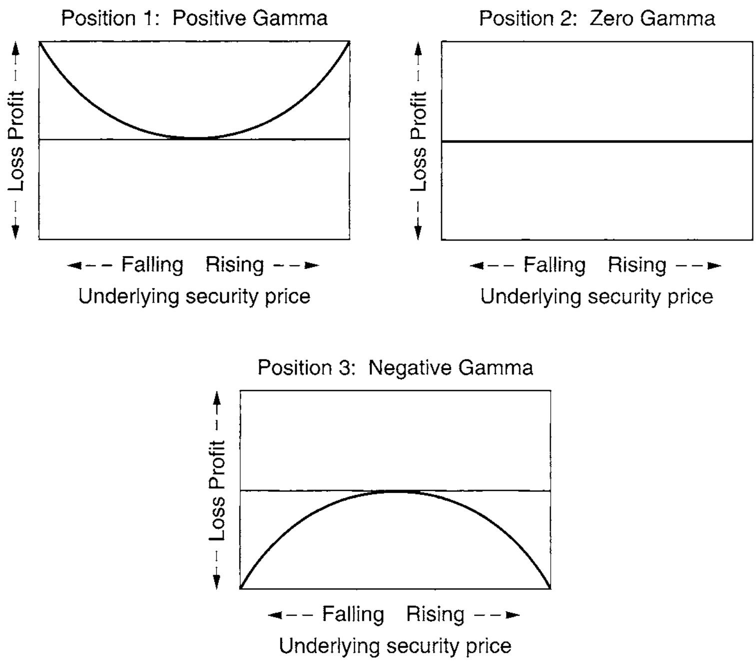
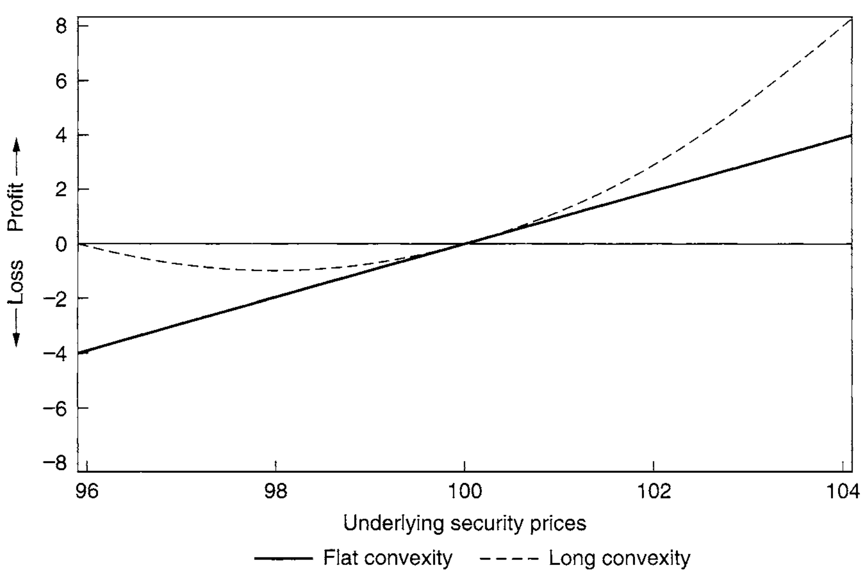


EXHIBIT 54–13

Profit/Loss Diagram with Convexity
Long Security with Flat and Long Convexity



small changes in the price of the underlying security in either direction. Position 2 in Exhibit 54–12 is a profit/loss graph for a position with no delta or gamma.

A position with negative gamma is called *short volatility* or *short convexity.* The profit/loss curve slopes downward in either direction from the current price on the underlying; thus the position gets longer as the market trades down and shorter as the market trades up. Either way, this position loses money if there are significant price movements. Position 3 demonstrates this behavior.

A position that is long volatility is clearly preferable to an otherwise identical position that is short volatility. The holder of the short-volatility position must be compensated for this. In order to create a position that is long volatility it is necessary to purchase options and spend money; moreover, if the market does not move, the values of the options will decrease as their time to expiration decreases, so the position loses money in a flat market.

Conversely, creating a position that is short volatility involves selling options and taking in cash. As time passes, the value of these options sold decreases because their time value falls, so the position makes money in a flat market. Large losses could be sustained in a volatile market, however.

To describe the time behavior of options, there is one last measure called *theta.* The theta of an option is the overnight change in value of the option if all other parameters (prices, volatilities) stay constant. This means that a long option has a negative theta because as expiration approaches, the time value of the option will erode to zero. For example, a 90-day at-the-money call that costs 2 points might have a theta of –0.45 ticks per day.

Exhibit 54–14 shows the effects of different volatility exposures.

EXHIBIT 54–14

Comparison of Different Volatility Positions (All Positions Are Delta-Neutral)

	Short Volatility	Flat Volatility	Long Volatility
Convexity	Position has negative convexity: gamma < 0	Position has no convexity: gamma = 0	Position has positive convexity: gamma > 0
Options purchased	More sold than bought	Sold as many as bought	More bought than sold
Time value	Position earns value as time passes: theta > 0	Position stays flat as time passes: theta = 0	Position loses value as time passes: theta < 0
Market moves	Position loses money if the market moves in either direction	Position is invariant with respect to market moves	Position makes money if the market moves in either direction

OPTIONS STRATEGIES—REORGANIZING THE PROFIT/LOSS GRAPH

Investors have many different goals: reducing risk, increasing rates of return, or capturing gains under expected market moves. Often these objectives are simply to rearrange the profit/loss graph of a position in accordance with the investor's expectations or desires. By increasing the minimum value of this graph, for example, the investor reduces risk.

Options provide a precise tool to accomplish this rearrangement. Because it is impossible to replicate the performance of an option position using just the underlying, options allow a much broader range of strategies to be used. The following characteristics of options provide an explanation.

Directionality

Both a put and a call are directional instruments. A put, for example, performs only in a decreasing market. This property makes options ideal for reducing directional risk on a position. Take, for example, a position that suffers large losses in a downward market and makes a consistent profit if prices rise. By purchasing a put option, some of these profits are given up in exchange for dramatically increased performance if the market declines.

Convexity

Buying and selling options makes it possible to adjust the convexity of a position in almost any fashion. Because OTC options can be purchased for any strike price and expiration, convexity can be bought or sold at any place in the profit/loss graph. For example, an investor holding mortgage-backed securities priced just over par might anticipate that prepayments on this security would start to increase dramatically if the market traded up, attenuating possible price gains. In other words, the investor feels that the position is short convexity above the market. To adjust the profit/loss graph, calls could be purchased with strike prices at or above the market. This trade sells some of the spread over Treasuries in exchange for increased performance in a rising market.

Fee Income

An investor who wishes to increase the performance of a position in a stable market can sell convexity by writing options and taking in fees. This increases the current yield of the position, at the cost of increasing volatility risk in some area of the profit/loss graph. A typical example of this is the venerable covered call strategy, where the manager of a portfolio sells calls on a portion of the portfolio, forgoing some profits in a rising market in exchange for a greater return in a stable or decreasing market.

Leveraged Speculation

Investors with a higher risk/reward profile wish to increase their upside potential and are willing to accept a greater downside risk. In this case, options can be used as a highly leveraged position to capture windfall profits under a very specific market move. A strongly bullish investor might purchase 1-point out-of-the-money calls with 30 days to expiration for $^1/_2$ point. If the market traded up 2 points by expiration, the option then would be worth 1 point, and the investor would have doubled the initial investment; a corresponding position in the underlying would have appreciated in value by only about 2%. Of course, if the market did not trade up by at least 1 point, the calls would expire worthless.

CLASSIC OPTION STRATEGIES

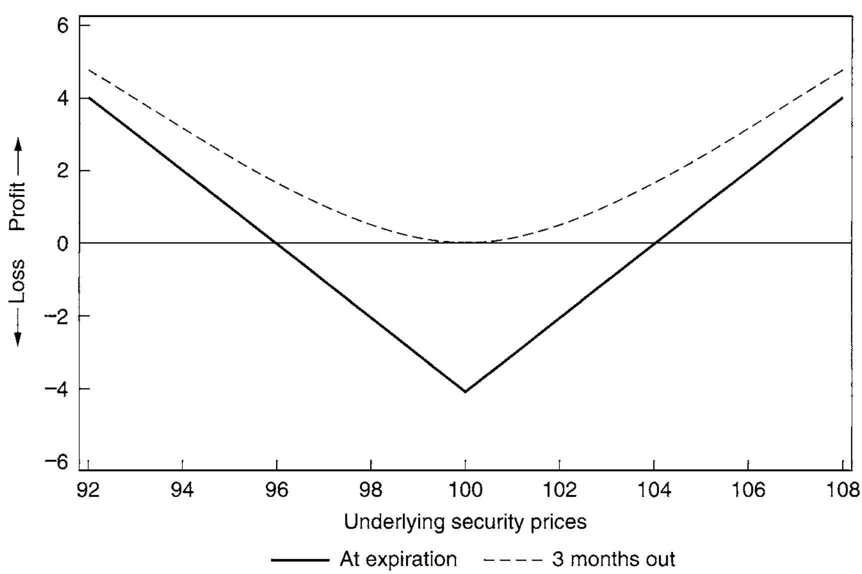
This section gives a brief explanation of some of the simplest pure options strategies.

Straddle

The most pure convexity trade is called a *straddle,* composed of one call and one put with the same strike price. Exhibit 54–15 shows the profit/loss graph of a straddle struck at the money at expiration and with three months to expiration.

EXHIBIT 54–15

Profit/Loss Diagram for a Long Straddle
Struck at Par, at Expiration, and Three Months Out



This position is delta-neutral because it implies no market bias. If the market stays flat, the position loses money as the options' time value disappears by expiration. If the market moves in either direction, however, either the put or the call will end up in-the-money, and the position will make money. This strategy is most useful for buying convexity at a specific strike price. Investors who are bearish on volatility and anticipate a flat market could sell straddles and make money from time value.

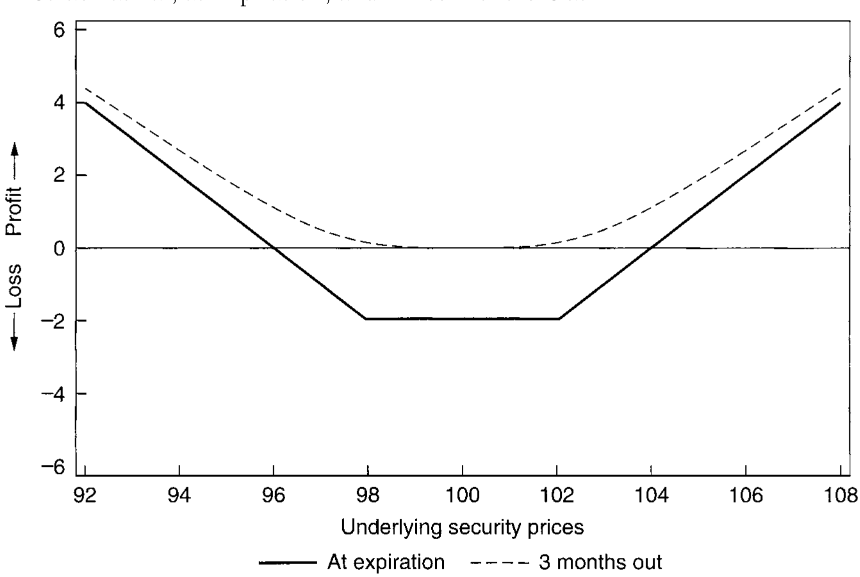
Strangle

A *strangle* is the more heavily leveraged cousin of a straddle. An at-the-money strangle is composed of an out-of-the-money call and an out-of-the-money put. The options are struck so that they are both equally out-of-the-money, and the current price of the security is halfway between the two strikes. The profit/loss graph is found in Exhibit 54–16.

Just like a straddle, a strangle is a pure volatility trade. If the market stays flat, the position loses time value, whereas if the market moves dramatically in either direction the position makes money from either the call or the put. Because the options in this position are both out-of-the-money, the market has to move significantly before either option moves into the money. The options are much cheaper, however, so it is possible to buy many more options for the same money.

EXHIBIT 54–16

Profit/Loss Diagram for a Long Strangle
Struck at Par, at Expiration, and Three Months Out



This is the ideal position for the investor who is heavily bullish on volatility and wants windfall profits in a rapidly moving market.

Writing strangles is a very risky business. Most of the time the market will not move enough to put either option much into the money, and the writer of the strangle will make the fee income. Occasionally, however, the market will plummet or spike, and the writer of the strangle will suffer catastrophic losses. This accounts for the picturesque name of this trade.

Spread Trades

Spread trades involve buying one option and funding all or part of this purchase by selling another. A *bull spread* can be created by owning the underlying security, buying a put struck below the current price, and selling a call above the current price. Because both options are out-of-the-money, it is possible to arrange the strikes so that the cost of the put is equal to the fee for the call. If the security price falls below the put strike or rises above the call strike, the appropriate option will be exercised and the security will be sold. Otherwise, any profit or loss will just be that of the underlying security. In other words, this position is analogous to owning the underlying security except that the final value of the position at expiration is forced to be between the two strikes. Exhibit 54–17 shows the profit/loss graph of this position at expiration and with three months left of time value.

EXHIBIT 54–17

Profit/Loss Diagram for a Bull Spread
Struck at Par, at Expiration, and Three Months Out

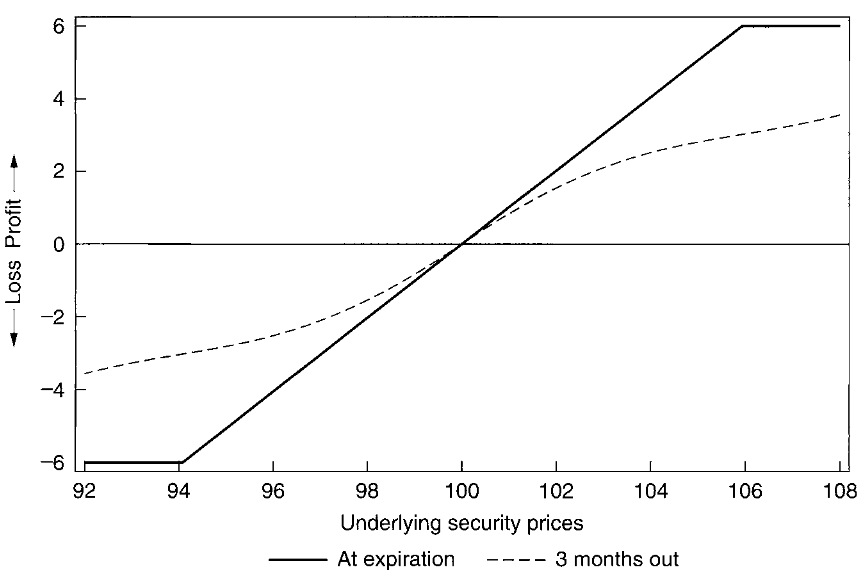
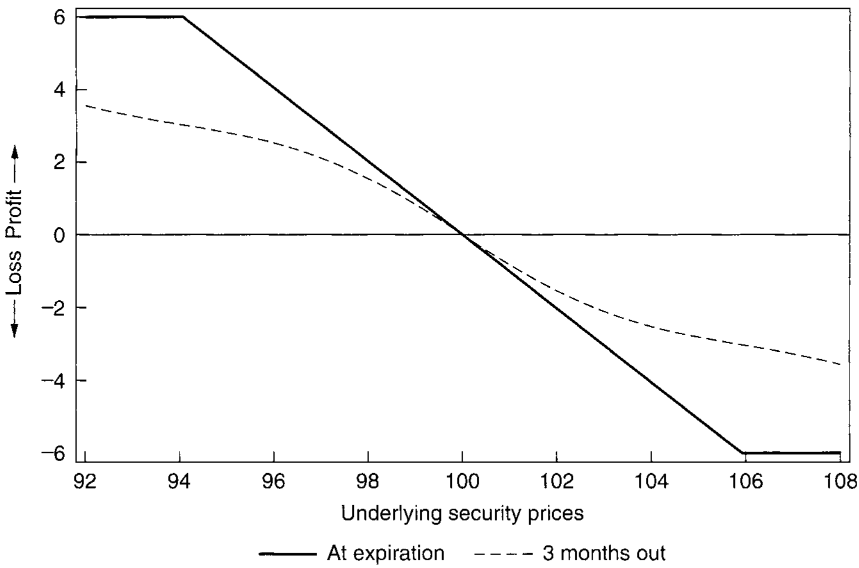


EXHIBIT 54–18

Profit/Loss Diagram for a Bear Spread Struck at Par, at Expiration, and Three Months Out



The other spread trade is a *bear spread:* It is the reverse of a bull spread. It can be created by selling a bull spread. Using put/call parity, it also can be set up by holding the underlying security, buying an in-the-money put, and selling an in-the-money call. A bear spread is equivalent to a short position in the underlying, where the position must be closed out at a price between the two strike prices. Exhibit 54–18 shows the profit/loss graph of a bear spread.

PRACTICAL PORTFOLIO STRATEGIES

The strategies discussed in the preceding section are the basic techniques used by speculators to trade options. The usual fixed income investor has a lower risk/reward profile than the speculator and specific objectives that must be accomplished; a floor on rate of return or an increase in current yield, for example. Such investors need a class of strategies different from that needed by speculators; even though the same strategies are often used, the risk is carefully controlled.

Portfolio Insurance

This is the most obvious and one of the most commonly used options strategies. An investor with a portfolio of securities who fears a decreasing market buys puts on some or all of the portfolio; if the market falls, the puts are exercised, and the securities are sold at the strike price. Alternatively, the investor may keep the underlying security and pair off the in-the-money puts, receiving cash in compensation for the decreased value of the security. Either way, the investor has limited losses on the portfolio in exchange for selling off return in a stable or rising market.

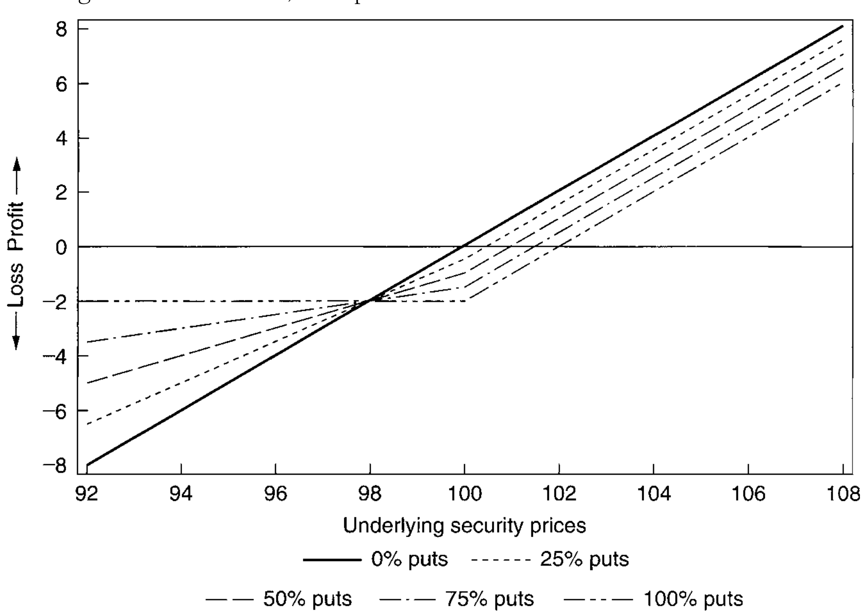
As the strike price of the put increases, so does its cost and the resulting impact on the stable market rate of return. Often, out-of-the-money options are used; the floor on returns is lower because the strike price is lower, but the lower cost of the options means that less return is given up if the market is flat or rises. By put/call parity, such a position is equivalent to holding a call option struck at or in the money.

Another popular strategy is to buy at-the-money options on a portion of the portfolio. This reduces but does not eliminate downside risk: Exhibit 54–19 shows the profit/loss graphs at expiration for positions with different percentages of the portfolio hedged with an at-the-money put. Note that all the graphs intersect at a single point. This is the point where the initial cost of the option is equal to the value of the option at expiration, which is the break-even price for this trade.

It is not possible to buy options on many classes of securities that may well be held in a portfolio. Perfect insurance for such securities is unattainable, but cross-market hedging often will permit a reduction in downside risk to acceptable levels. This is discussed further in Chapter 57.

EXHIBIT 54–19

Hedged Underlying Security with Puts
Long Puts Struck at Par, at Expiration



Covered Calls

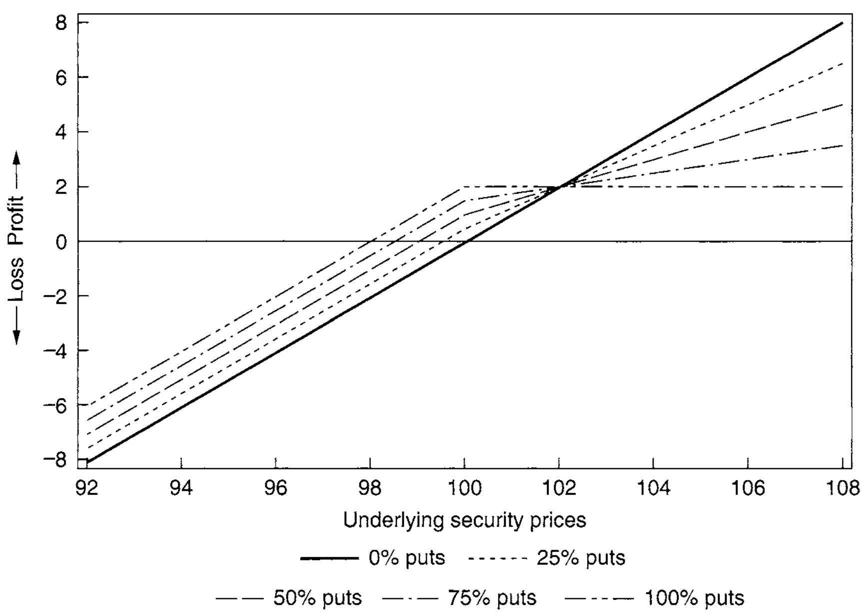
Writing covered calls is a strategy that sells volatility in return for fees. An investor who holds a portfolio sells calls on some or all of the portfolio in return for fees. If the market stays the same or falls, the investor pockets the option fees. If the market increases until the calls are in-the-money, the investor is called out by the option holder. In other words, possible gains on the portfolio are sold for fee income.

Often the investor wishes to preserve some upside potential. Just as in the portfolio insurance example, there are two different ways to do this. The calls can be struck out-of-the-money, that is, above the current market price. This strategy allows all gains up to the strike price to be captured. If the bonds in the portfolio are currently trading below the original purchase price, a popular strategy is to sell calls struck at this purchase price. This provides fee income and increased current yield but prevents the possibility that the bonds will be called at a price below the original purchase price and the portfolio will book a capital loss.

Otherwise, calls can be sold on a portion of the portfolio. This allows unlimited price gains to be captured on the remainder. Exhibit 54–20 shows the profit/loss graph of a covered call program where different portions of the portfolio have calls sold against them.

EXHIBIT 54–20

Covered Call Writing Program
Short Calls Struck at Par, at Expiration



Buy-Writes and Writing Puts

Buy-writes and writing puts are two very closely related strategies for selling volatility that most investors think of as entirely different. To execute a buy-write, a bond is purchased, and simultaneously, a call is written on this bond to the same dealer for the fee income. If the security is trading above the strike price at expiration, the security is called, and the investor is left with just the option fee. If the price of the security has fallen, the investor is left holding the security, but the total cost of the security is reduced by the fee from the call. By put/call parity, this trade is identical to writing a put struck at the money. In both cases, the investor is delivered the security only if the price of the security is lower than the price of the original sale.

In the MBS market, a buy-write is composed of forward purchases and short calls on forward delivery contracts (standard TBA transactions). If the call is exercised, it offsets the forward sale, and the buyer never takes delivery of the security, keeping the fee income. Otherwise, the buyer will receive the security on the forward settlement date for the original forward sale price, although the total price is decreased by the value of the option fee.

Put writing is a more general strategy that applies to all fixed income options markets. The investor writes a put for the fee income and receives the underlying instrument at expiration if the security trades below the strike price. This can be a very effective strategy if carefully structured. An investor may feel that a security offers real value if bought at a certain price below the market. The investor could then write puts struck at that price. If the security falls below the strike, it is delivered at a price that is more agreeable than the current price. Otherwise, the investor simply pockets the fee income.

Volatility

Volatility plays a key role in the valuation of options and in option strategies. In this section we focus on methods for estimating volatility.

Statistically, volatility is a measure of the dispersion or spread of observations around the mean of the set of observations. If volatility seems strangely like a standard deviation, then you remember your statistics. When people speak of volatility, all they really are talking about is a standard deviation.

For fixed income securities, volatility is expressed in yield or price units, either on a percentage or on an absolute basis. Price volatilities can be computed for any security. Yield volatilities should be computed only for those securities with a consistent method for computing yield. Given the complexity of calculating a yield on a MBS and the variation of results, the predominant volatility measure in the MBS market is price volatility. The government bond market, where yields are easily calculated, favors yield volatility.

There are two types of volatility: empirical volatility and implied volatility. Each is described below.

Empirical Volatility

Empirical volatility is the actual, historical market volatility of a specific security. These numbers typically are calculated for various time periods (10 days, 30 days, 360 days) and usually are annualized.[1] Calculating an empirical volatility is nothing more than calculating the standard deviation of a time series. Thus an absolute volatility is the annualized standard deviation of daily price or yield changes, assuming a normal distribution.

Percentage volatility is the annualized standard deviation of the daily change in the log of prices or yields, assuming a lognormal distribution of prices or yields. Similar to the daily absolute yield changes, the logs of the daily yield changes have a slight bias toward lower yields. The intuitive approach to calculating a percentage volatility is to find the standard deviation of daily *returns,* assuming a normal distribution. This approach is equivalent to the lognormal assumption as long as the distribution can be characterized as being equally normal and log normal and, the changes in prices are taken on a small interval, such as daily.

As mentioned previously, empirical volatility can be measured over various time periods. The most common interval on which the standard deviation is taken is 30 days; other common intervals are 10 days and 360 days. The choice of interval determines how quickly and to what degree an empirical volatility responds to deviations. As the time period shortens, volatility increasingly reflects current conditions but is more unstable as each sample asserts greater influence in the deviation. Conversely, as the interval increases, more of a lag and a smoothing are introduced into the calculation.

The interval used to calculate an empirical volatility should be chosen to match the length of the option contract. This provides the investor with an indication of how volatile the underlying security has been recently and how this relates to the volatility employed to price the option.

With no industry standard for volatility units, converting between the price and yield expression of absolute or percentage volatility is a useful skill. The path to follow to convert from one unit to the next is shown in Exhibit 54–21. The modified duration of a security provides the link between price and yield volatilities. Modified duration is defined as the percentage change in price divided by the absolute change in yield.

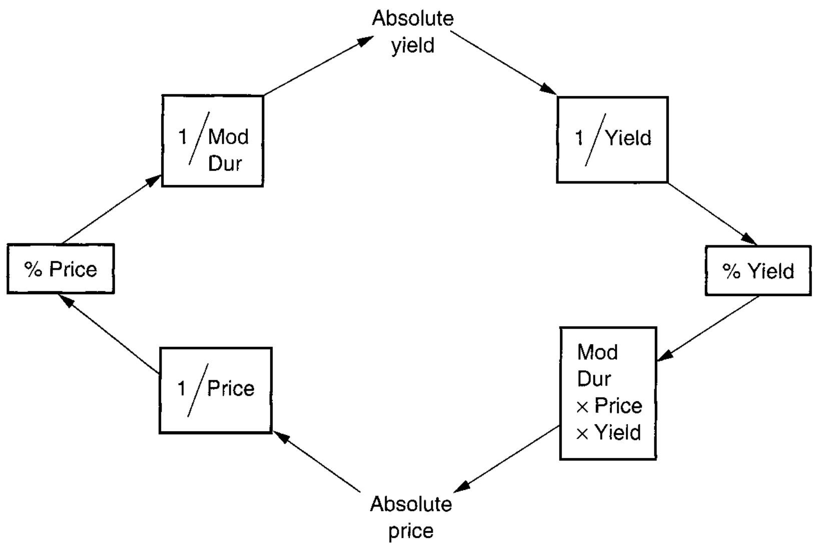
Implied Volatility

Implied volatility is merely the market's expectation of future volatility over a specified time period. An option's price is a function of the volatility employed,

1. When annualizing a volatility, certain assumptions are inherent to the calculation. To convert from daily to yearly volatility, for example, the daily volatility is multiplied by the square root of the number of business days in the year, approximately 250.

EXHIBIT 54–21

Converting Volatility Measures



so where an option's price is known, the implied volatility can be derived. Although it sounds straightforward, calculating an implied volatility is far more complicated than calculating an empirical volatility because expectations cannot be observed directly. An option pricing model along with a mathematical method to infer the volatility must be employed. The result of this calculation is a percentage price volatility that can be converted to the various types of volatility measures discussed previously (see Exhibit 54–21).

Owing to the existence and liquidity of fixed income options, proxies for implied volatilities can be derived from Treasuries. Options on Treasury futures listed on the Chicago Board of Trade (CBOT) are often the best vehicles for implied volatility calculations. Of these, the bond contract provides the best information necessary to calculate an implied volatility. The resulting implied volatility provides a good indication of the market's expected volatility for the Treasuries with maturities similar to that of the particular bond futures contract in question. The implied volatility on the 20-year bond future contract, for example, is a useful proxy for the market's expected volatility on long-term Treasury securities.

CONCLUSION

Options are no longer merely toys for speculators and dealers. Any investor with specific goals can use option strategies to tailor the performance of a portfolio. Because it is impossible to obtain the effects of options by using only the underlying securities, a whole new universe of strategic possibilities is opened up. In particular, investors with contingent liabilities cannot create an adequate hedge without the use of options.

Increased liquidity in the options markets and a better understanding of the properties of options make option strategies more accessible to the average investor and allow these strategies to be used for a wider range of securities. In particular, the over-the-counter options markets allow the purchase and sale of options with any desired strike price and expiration date.

Refinements to option valuation technology continue to improve cross-market arbitrage trades where securities and options in one market can duplicate securities in another. As options trading removes the arbitrages, the relationships between the various markets are reinforced.

CHAPTER
FIFTY-FIVE

INTEREST-RATE SWAPS AND SWAPTIONS

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Swaps and swaptions are also used extensively by market participants to control interest-rate risk. The most prevalent swap contract is an *interest-rate swap*. An interest-rate swap contract provides a vehicle for market participants to transform the nature of cash flows and the interest-rate exposure of a portfolio or balance sheet. In this chapter we explain how to analyze interest-rate swaps. We will describe a generic interest-rate swap, the parties to a swap, the risk and return of a swap, and the economic interpretation of a swap. Then we look at how to compute the floating-rate payments and calculate the present value of these payments. Next, we will see how to calculate the fixed-rate payments given the swap rate. Before we look at how to calculate the value of a swap, we will see how to calculate the swap rate. Given the swap rate, we will then see how the value of a swap is determined after the inception of a swap. We also will discuss other types of swaps as well as options on swaps called *swaptions*. Swaptions are used ever more frequently as a tool for investors to control their interest-rate risk. These instruments are described in the latter part of the chapter.

DESCRIPTION OF AN INTEREST-RATE SWAP

In an *interest-rate swap,* two parties (called *counterparties*) agree to exchange periodic interest payments. The dollar amount of the interest payments exchanged is based on some predetermined dollar principal, which is called the *notional* *amount*. The dollar amount each counterparty pays to the other is the agreed-on periodic interest rate times the notional amount. The only dollars that are exchanged between the parties are the interest payments, not the notional amount. Accordingly, the notional principal serves only as a scale factor to translate an interest rate into a cash flow. In the most common type of swap, one party agrees to pay the other party fixed interest payments at designated dates for the life of the contract. This party is referred to as the *fixed-rate payer*. The other party, who agrees to make interest-rate payments that float with some reference rate, is referred to as the *floating-rate payer*.

The reference rates that have been used for the floating rate in an interest-rate swap are various money market rates: Treasury bill rate, the London Interbank Offered Rate (LIBOR), commercial paper rate, bankers acceptances rate, certificates of deposit rate, the federal funds rate, and the prime rate. The most common is the LIBOR. LIBOR is the rate at which prime banks offer to pay on Eurodollar deposits available to other prime banks for a given maturity. There is not just one rate but a rate for different maturities. For example, there is a one-month LIBOR, three-month LIBOR, and six-month LIBOR.

To illustrate an interest-rate swap, suppose that for the next five years party *X* agrees to pay party *Y* 10% per year, while party *Y* agrees to pay party *X* six-month LIBOR (the reference rate). Party *X* is a fixed-rate payer/floating-rate receiver, while party *Y* is a floating-rate payer/fixed-rate receiver. Assume that the notional amount is $50 million and that payments are exchanged every six months for the next five years. This means that every six months, party *X* (the fixed-rate payer/floating-rate receiver) will pay party *Y* $2.5 million (10% times $50 million divided by 2). The amount that party *Y* (the floating-rate payer/fixed-rate receiver) will pay party *X* will be six-month LIBOR times $50 million divided by 2. If 6-month LIBOR is 7%, party *Y* will pay party *X* $1.75 million (7% times $50 million divided by 2). Note that we divide by 2 because one-half year's interest is being paid.

Interest-rate swaps are over-the-counter (OTC) instruments. This means that they are not traded on an exchange. An institutional investor wishing to enter into a swap transaction can do so through either a securities firm or a commercial bank that transacts in swaps. These entities can do one of the following. First, they can arrange or broker a swap between two parties that want to enter into an interest-rate swap. In this case, the securities firm or commercial bank is acting in a brokerage capacity.

The second way in which a securities firm or commercial bank can get an institutional investor into a swap position is by taking the other side of the swap. This means that the securities firm or the commercial bank is a dealer rather than a broker in the transaction. Acting as a dealer, the securities firm or the commercial bank must hedge its swap position in the same way that it hedges its position in other securities. Also, it means that the swap dealer is the counterparty to the transaction.

The risks that the two parties take on when they enter into a swap is that the other party will fail to fulfill its obligations as set forth in the swap agreement. That is, each party faces default risk. The default risk in a swap agreement is called *counterparty risk*. In any agreement between two parties that must perform according to the terms of a contract, counterparty risk is the risk that the other party will default. With futures and exchange-traded options, the counterparty risk is the risk that the clearinghouse will default. Market participants view this risk as small. In contrast, counterparty risk in a swap can be significant.

Because of counterparty risk, not all securities firms and commercial banks can be swap dealers. Several securities firms have established subsidiaries that are separately capitalized so that they have a high credit rating that permits them to enter into swap transactions as a dealer.

Thus it is imperative to keep in mind that any party who enters into a swap is subject to counterparty risk.

INTERPRETING A SWAP POSITION

There are two ways that a swap position can be interpreted: (1) a package of forward/futures contracts and (2) a package of cash flows from buying and selling cash market instruments.

Package of Forward Contracts

Consider the hypothetical interest rate swap used earlier to illustrate a swap. Let's look at party *X*'s position. Party *X* has agreed to pay 10% and receive six-month LIBOR. More specifically, assuming a $50 million notional amount, *X* has agreed to buy a commodity called "six-month LIBOR" for $2.5 million. This is effectively a six-month forward contract where *X* agrees to pay $2.5 million in exchange for delivery of six-month LIBOR. The fixed-rate payer is effectively long a six-month forward contract on six-month LIBOR. The floating-rate payer is effectively short a six-month forward contract on six-month LIBOR. There is therefore an implicit forward contract corresponding to each exchange date.

Consequently, interest-rate swaps can be viewed as a package of more basic interest-rate derivative instruments—forwards. The pricing of an interest-rate swap then will depend on the price of a package of forward contracts with the same settlement dates in which the underlying for the forward contract is the same reference rate.

While an interest-rate swap may be nothing more than a package of forward contracts, it is not a redundant contract for several reasons. First, maturities for forward or futures contracts do not extend out as far as those of an interest-rate swap; an interest-rate swap with a term of 15 years or longer can be obtained. Second, an interest-rate swap is a more transactionally efficient instrument. By this we mean that in one transaction an entity can effectively establish a payoff equivalent to a package of forward contracts. The forward contracts would each have to be negotiated separately. Third, the interest-rate swap market has grown in liquidity since its establishment in 1981; interest-rate swaps now provide more liquidity than forward contracts, particularly long-dated (i.e., long-term) forward contracts.

Package of Cash-Market Instruments

To understand why a swap also can be interpreted as a package of cash-market instruments, consider an investor who enters into the transaction below:

- Buy $50 million par value of a five-year floating-rate bond that pays six-month LIBOR every six months
- Finance the purchase by borrowing $50 million for five years at a 10% annual interest rate paid every six months.

The cash flows for this transaction are set forth in Exhibit 55–1. The second column of the exhibit shows the cash flows from purchasing the five-year floating-rate bond. There is a $50 million cash outlay and then 10 cash inflows. The amount of the cash inflows is uncertain because they depend on future levels of six-month LIBOR. The next column shows the cash flows from borrowing $50 million on a fixed-rate basis. The last column shows the net cash flows from the entire transaction.

EXHIBIT 55–1

Cash Flows for the Purchase of a Five-Year Floating-Rate Bond Financed by Borrowing on a Fixed-Rate Basis

Transaction:

- Purchase for $50 million a five-year floating-rate bond:
  Floating rate = LIBOR, semiannual pay
- Borrow $50 million for five years:
  Fixed rate = 10%, semiannual payments

Six-Month Period	Cash Flow (in Millions of Dollars) from		
	Floating-Rate Bond*	Borrowing Cost	Net
0	–$50	+$50.0	$0
1	+ $(LIBOR_1/2) \times 50$	–2.5	+ $(LIBOR_1/2) \times 50 - 2.5$
2	+ $(LIBOR_2/2) \times 50$	–2.5	+ $(LIBOR_2/2) \times 50 - 2.5$
3	+ $(LIBOR_3/2) \times 50$	–2.5	+ $(LIBOR_3/2) \times 50 - 2.5$
4	+ $(LIBOR_4/2) \times 50$	–2.5	+ $(LIBOR_4/2) \times 50 - 2.5$
5	+ $(LIBOR_5/2) \times 50$	–2.5	+ $(LIBOR_5/2) \times 50 - 2.5$
6	+ $(LIBOR_6/2) \times 50$	–2.5	+ $(LIBOR_6/2) \times 50 - 2.5$
7	+ $(LIBOR_7/2) \times 50$	–2.5	+ $(LIBOR_7/2) \times 50 - 2.5$
8	+ $(LIBOR_8/2) \times 50$	–2.5	+ $(LIBOR_8/2) \times 50 - 2.5$
9	+ $(LIBOR_9/2) \times 50$	–2.5	+ $(LIBOR_9/2) \times 50 - 2.5$
10	+ $(LIBOR_{10}/2) \times 50 + 50$	–52.5	+ $(LIBOR_{10}/2) \times 50 - 2.5$

*The subscript for LIBOR indicates the six-month LIBOR as per the terms of the floating-rate bond at time *t*.

As the last column indicates, there is no initial cash flow (the cash inflow and cash outlay offset each other). In all 10 six-month periods, the net position results in a cash inflow of LIBOR and a cash outlay of $2.5 million. This net position, however, is identical to the position of a fixed-rate payer/floating-rate receiver.

It can be seen from the net cash flow in Exhibit 55–1 that a fixed-rate payer has a cash market position that is equivalent to a long position in a floating-rate bond and a short position in a fixed-rate bond—the short position being the equivalent of borrowing by issuing a fixed-rate bond.

What about the position of a floating-rate payer? It can be easily demonstrated that the position of a floating-rate payer is equivalent to purchasing a fixed-rate bond and financing that purchase at a floating rate, where the floating rate is the reference rate for the swap. That is, the position of a floating-rate payer is equivalent to a long position in a fixed-rate bond and a short position in a floating-rate bond.

TERMINOLOGY, CONVENTIONS, AND MARKET QUOTES

Here we review some of the terminology used in the swaps market and explain how swaps are quoted. The *trade date* for a swap is the date on which the swap is transacted. The terms of the trade include the fixed interest rate, the maturity, the notional amount of the swap, and the payment bases of both legs of the swap. The date from which floating interest payments are determined is the *reset* or *setting date,* which also may be the trade date. In the same way as for FRAs (discussed in Chapter 51), the rate is fixed two business days before the interest period begins. The second (and subsequent) reset date will be two business days before the beginning of the second (and subsequent) swap periods. The *effective date* is the date from which interest on the swap is calculated, and this is typically two business days after the trade date. In a *forward-start swap,* the effective date will be at some point in the future, specified in the swap terms. The floating interest rate for each period is fixed at the start of the period, so the interest payment amount is known in advance by both parties (the fixed rate is known, of course, throughout the swap by both parties).

While our illustrations assume that the timing of the cash flows for both the fixed-rate payer and floating-rate payer will be the same, this is rarely the case in a swap. An agreement may call for the fixed-rate payer to make payments annually but the floating-rate payer to make payments more frequently (semiannually or quarterly). Also, the way in which interest accrues on each leg of the transaction differs. Normally, the fixed interest payments are paid on the basis of a 30/360 day count. Floating-rate payments for dollar and euro-denominated swaps use an actual/360-day count similar to other money market instruments in those currencies. Sterling-denominated swaps use an actual/365-day count.

Accordingly, the fixed interest payments will differ slightly owing to the differences in the lengths of successive coupon periods. The floating payments will differ owing to day counts as well as movements in the reference rate.

The terminology used to describe the position of a party in the swap markets combines cash-market jargon and futures-market jargon, given that a swap position can be interpreted either as a position in a package of cash-market instruments or a package of futures/forward positions. As we have said, the counterparty to an interest-rate swap is either a fixed-rate payer or floating-rate payer.

The fixed-rate payer receives floating-rate interest and is said to be "long" or to have "bought" the swap. The long side has conceptually purchased a floating-rate note (because it receives floating-rate interest) and issued a fixed-coupon bond (because it pays out fixed interest at periodic intervals). In essence, the fixed-rate payer is borrowing at fixed rate and investing in a floating-rate asset. The floating-rate payer is said to be "short" or to have "sold" the swap. The short side has conceptually purchased a coupon bond (because it receives fixed-rate interest) and issued a floating-rate note (because it pays floating-rate interest). A floating-rate payer is borrowing at floating rate and investing in a fixed-rate asset.

The convention that has evolved for quoting swaps levels is that a swap dealer sets the floating rate equal to the reference rate and then quotes the fixed rate that will apply. To illustrate this convention, consider the following 10-year swap terms available from a dealer:

- *Floating-rate payer:* Pay floating rate of three-month LIBOR quarterly. Receive fixed rate of 8.75% semiannually.
- *Fixed-rate payer:* Pay fixed rate of 8.85% semiannually. Receive floating rate of three-month LIBOR quarterly.

The offer price that the dealer would quote the fixed-rate payer would be to pay 8.85% and receive LIBOR "flat." (The word *flat* means with no spread.) The bid price that the dealer would quote the floating-rate payer would be to pay LIBOR flat and receive 8.75%. The bid-offer spread is 10 basis points.

In order to solidify our intuition, it is useful to think of the swap market as a market where two counterparties trade the floating reference rate in a series of exchanges for a fixed price. In effect, the swap market is a market to buy and sell LIBOR. Thus, buying a swap (pay fixed/receive floating) can be thought of as buying LIBOR on each reset date for the fixed rate agreed to on the trade date. Conversely, selling a swap (receive fixed/pay floating) is effectively selling LIBOR on each reset date for a fixed rate agreed to on the trade date. In this framework, a dealer's bid-offer spread can be easily interpreted. Using the numbers presented earlier, the bid price of 8.75% is the price the dealer will pay to the counterparty to receive three-month LIBOR. In other words, buy LIBOR at the bid. Similarly, the offer price of 8.85% is the price the dealer receives from the counterparty in exchange for three-month LIBOR. In other words, sell LIBOR at the offer.

The fixed rate is some spread above the Treasury yield curve with the same term-to-maturity as the swap. In our illustration, suppose that the 10-year Treasury yield is 8.35%. Then the offer price that the dealer would quote to the fixed-rate payer is the 10-year Treasury rate plus 50 basis points versus receiving LIBOR flat. For the floating-rate payer, the bid price quoted would be LIBOR flat versus the 10-year Treasury rate plus 40 basis points. The dealer would quote such a swap as 40-50, meaning that the dealer is willing to enter into a swap to receive LIBOR and pay a fixed rate equal to the 10-year Treasury rate plus 40 basis points, and he would be willing to enter into a swap to pay LIBOR and receive a fixed rate equal to the 10-year Treasury rate plus 50 basis points.

VALUING INTEREST-RATE SWAPS

In an interest-rate swap, the counterparties agree to exchange periodic interest payments. The dollar amount of the interest payments exchanged is based on the notional principal. In the most common type of swap, there is a fixed-rate payer and a fixed-rate receiver. The convention for quoting swap rates is that a swap dealer sets the floating rate equal to the reference rate and then quotes the fixed rate that will apply.

Computing the Payments for a Swap

In the preceding section we described in general terms the payments by the fixed-rate payer and fixed-rate receiver, but we did not give any details. That is, we explained that if the swap rate is 6% and the notional amount is $100 million, then the fixed-rate payment will be $6 million for the year, and the payment is then adjusted based on the frequency of settlement. Thus, if settlement is semi-annual, the payment is $3 million. If it is quarterly, it is $1.5 million. Similarly, the floating-rate payment would be found by multiplying the reference rate by the notional amount and then scaling based on the frequency of settlement.

It was useful to illustrate the basic features of an interest-rate swap with simple calculations for the payments such as described earlier and then explain how the parties to a swap either benefit or hurt when interest rates change. However, we will show how to value a swap in this section. To value a swap, it is necessary to determine both the present value of the fixed-rate payments and the present value of the floating-rate payments. The difference between these two present values is the value of a swap. As will be explained below, whether the value is positive (i.e., an asset) or negative (i.e., a liability) will depend on the party.

At the inception of the swap, the terms of the swap will be such that the present value of the floating-rate payments is equal to the present value of the fixed-rate payments. That is, the value of the swap is equal to zero at its inception. This is the fundamental principle in determining the swap rate (i.e., the fixed rate that the fixed-rate payer will make).

Here is a roadmap of the presentation. First, we will look at how to compute the floating-rate payments. We will see how the future values of the reference rate are determined to obtain the floating rate for the period. From the future values of the reference rate we will then see how to compute the floating-rate payments, taking into account the number of days in the payment period. Next, we will see how to calculate the fixed-rate payments given the swap rate. Before we look at how to calculate the value of a swap, we will see how to calculate the swap rate. This will require an explanation of how the present value of any cash flow in an interest-rate swap is computed. Given the floating-rate payments and the present value of the floating-rate payments, the swap rate can be determined by using the principle that the swap rate is the fixed rate that will make the present value of the fixed-rate payments equal to the present value of the floating-rate payments. Finally, we will see how the value of swap is determined after the inception of a swap.

Calculating the Floating-Rate Payments

For the first floating-rate payment, the amount is known. For all subsequent payments, the floating-rate payment depends on the value of the reference rate when the floating rate is determined. To illustrate the issues associated with calculating the floating-rate payment, we will assume that

- A swap starts today, January 1 of year 1 (swap settlement date).
- The floating-rate payments are made quarterly based on "actual/360."
- The reference rate is three-month LIBOR.
- The notional amount of the swap is $100 million.
- The term of the swap is three years.

The quarterly floating-rate payments are based on an actual/360-day count convention. Recall that this convention means that 360 days are assumed in a year and that in computing the interest for the quarter, the actual number of days in the quarter is used. The floating-rate payment is set at the beginning of the quarter but paid at the end of the quarter—that is, the floating-rate payments are made in arrears.

Suppose that today three-month LIBOR is 4.05%. Let's look at what the fixed-rate payer will receive on March 31 of year 1—the date when the first quarterly swap payment is made. There is no uncertainty about what the floating-rate payment will be. In general, the floating-rate payment is determined as follows:

$$\text{Notional amount} \times (\text{three-month LIBOR}) \times \frac{\text{no. of days in period}}{360}$$

In our illustration, assuming a nonleap year, the number of days from January 1 of year 1 to March 31 of year 1 (the first quarter) is 90. If three-month LIBOR is 4.05%, then the fixed-rate payer will receive a floating-rate payment on March 31 of year 1 equal to

$$\$100{,}000{,}000 \times 0.0405 \times \frac{90}{360} = \$1{,}012{,}500$$

Now the difficulty is in determining the floating-rate payment after the first quarterly payment. That is, for the three-year swap, there will be 12 quarterly floating-rate payments. Thus, while the first quarterly payment is known, the next 11 are not. However, there is a way to hedge the next 11 floating-rate payments by using a futures contract. Specifically, the futures contract used to hedge the future floating-rate payments in a swap whose reference rate is three-month LIBOR is the Eurodollar CD futures contract.

Determining Future Floating-Rate Payments

Now let's determine the future floating-rate payments. These payments can be locked in over the life of the swap using the Eurodollar CD futures contract. We will show how these floating-rate payments are computed using this contract.

We will begin with the next quarterly payment—from April 1 of year 1 to June 30 of year 1. This quarter has 91 days. The floating-rate payment will be determined by three-month LIBOR on April 1 of year 1 and paid on June 30 of year 1. Where might the fixed-rate payer look today (January 1 of year 1) to project what three-month LIBOR will be on April 1 of year 1? One possibility is the Eurodollar CD futures market. There is a three-month Eurodollar CD futures contract for settlement on June 30 of year 1. That futures contract will express the market's expectation of three-month LIBOR on April 1 of year 1. For example, if the futures price for the three-month Eurodollar CD futures contract that settles on June 30 of year 1 is 95.85, then as explained earlier, the three-month Eurodollar futures rate is 4.15%. We will refer to that rate for three-month LIBOR as the "forward rate." Therefore, if the fixed-rate payer bought 100 of these three-month Eurodollar CD futures contracts on January 1 of year 1 (the inception of the swap) that settle on June 30 of year 1, then the payment that will be locked in for the quarter (April 1 to June 30 of year 1) is

$$\$100,000,000 \times 0.0415 \times \frac{91}{360} = \$1,049,028$$

Note that each futures contract is for $1 million, and hence 100 contracts have a notional amount of $100 million.

Similarly, the Eurodollar CD futures contract can be used to lock in a floating-rate payment for each of the next 10 quarters. Once again, it is important to emphasize that the reference rate at the beginning of period t determines the floating rate that will be paid for the period. However, the floating-rate payment is not made until the end of period t.

Exhibit 55–2 shows this for the three-year swap. Shown in column (1) is when the quarter begins and in column (2) when the quarter ends. The payment will be received at the end of the first quarter (March 31 of year 1) and is $1,012,500. This is the known floating-rate payment, as explained earlier. It is the only payment that is known. The information used to compute the first payment

EXHIBIT 55–2

Floating-Rate Payments Based on Initial LIBOR and Eurodollar CD Futures

(1) Quarter Starts	(2) Quarter Ends	(3) Number of Days in Quarter	(4) Current Three-Month LIBOR	(5) Eurodollar CD Futures Price	(6) Forward Rate	(7) Period = End of Quarter	(8) Floating-Rate Payment at End of Quarter
Jan 1 year 1	Mar 31 year 1	90	4.05%		—	1	1,012,500
Apr 1 year 1	June 30 year 1	91		95.85	4.15%	2	1,049,028
July 1 year 1	Sept 30 year 1	92		95.45	4.55%	3	1,162,778
Oct 1 year 1	Dec 31 year 1	92		95.28	4.72%	4	1,206,222
Jan 1 year 2	Mar 31 year 2	90		95.10	4.90%	5	1,225,000
Apr 1 year 2	June 30 year 2	91		94.97	5.03%	6	1,271,472
July 1 year 2	Sept 30 year 2	92		94.85	5.15%	7	1,316,111
Oct 1 year 2	Dec 31 year 2	92		94.75	5.25%	8	1,341,667
Jan 1 year 3	Mar 31 year 3	90		94.60	5.40%	9	1,350,000
Apr 1 year 3	June 30 year 3	91		94.50	5.50%	10	1,390,278
July 1 year 3	Sept 30 year 3	92		94.35	5.65%	11	1,443,889
Oct 1 year 3	Dec 31 year 3	92		94.24	5.76%	12	1,472,000

is in column (4), which shows the current three-month LIBOR (4.05%). The payment is shown in the last column, column (8).

Notice that column (7) numbers the quarters from 1 through 12. Look at the heading for column (7). It identifies each quarter in terms of the end of the quarter. This is important because we will eventually be discounting the payments (cash flows). We must take care to understand when each payment is to be exchanged in order to properly discount. Thus, for the first payment of $1,012,500, it is going to be received at the end of quarter 1. When we refer to the time period for any payment, the reference is to the end of quarter. Thus the fifth payment of $1,225,000 would be identified as the payment for period 5, where period 5 means that it will be exchanged at the end of the fifth quarter.

Calculating the Fixed-Rate Payments

The swap will specify the frequency of settlement for the fixed-rate payments. The frequency need not be the same as the floating-rate payments. For example, in the three-year swap we have been using to illustrate the calculation of the floating-rate payments, the frequency is quarterly. The frequency of the fixed-rate payments could be semiannual rather than quarterly.

In our illustration we will assume that the frequency of settlement is quarterly for the fixed-rate payments, the same as with the floating-rate payments. The day-count convention is the same as for the floating-rate payment, actual/360. The equation for determining the dollar amount of the fixed-rate payment for the period is

$$\text{Notional amount} \times (\text{swap rate}) \times \frac{\text{no. of days in period}}{360}$$

It is the same equation as for determining the floating-rate payment except that the swap rate is used instead of the reference rate (three-month LIBOR in our illustration).

For example, suppose that the swap rate is 4.98% and the quarter has 90 days. Then the fixed-rate payment for the quarter is

$$\$100,000,000 \times 0.0498 \times \frac{90}{360} = \$1,245,000$$

If there are 92 days in a quarter, the fixed-rate payment for the quarter is

$$\$100,000,000 \times 0.0498 \times \frac{92}{360} = \$1,272,667$$

Note that the rate is fixed for each quarter, but the dollar amount of the payment depends on the number of days in the period.

Exhibit 55–3 shows the fixed-rate payments based on different assumed values for the swap rate. The first three columns of the exhibit show the same information as in Exhibit 55–2—the beginning and end of the quarter and the number of days in the quarter. Column (4) simply uses the notation for the period. That is, period 1 means the end of the first quarter, period 2 means the end of the

EXHIBIT 55–3

Fixed-Rate Payments for Several Assumed Swap Rates

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quarter Starts	**Quarter Ends**	**Number of Days in Quarter**	**Period = End of Quarter**	***Fixed-Rate Payment if Swap Rate Is Assumed to Be***				
				4.9800%	**4.9873%**	**4.9874%**	**4.9875%**	**4.9880%**
Jan 1 year 1	Mar 31 year 1	90	1	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 1	June 30 year 1	91	2	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 1	Sept 30 year 1	92	3	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 1	Dec 31 year 1	92	4	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Jan 1 year 2	Mar 31 year 2	90	5	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 2	June 30 year 2	91	6	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 2	Sept 30 year 2	92	7	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 2	Dec 31 year 2	92	8	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Jan 1 year 3	Mar 31 year 3	90	9	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 3	June 30 year 3	91	10	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 3	Sept 30 year 3	92	11	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 3	Dec 31 year 3	92	12	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711

second quarter, and so on. The other columns of the exhibit show the payments for each assumed swap rate.

Calculation of the Swap Rate

Now that we know how to calculate the payments for the fixed-rate and floating-rate sides of a swap where the reference rate is three-month LIBOR given (1) the current value for three-month LIBOR, (2) the expected three-month LIBOR from the Eurodollar CD futures contract, and (3) the assumed swap rate, we can demonstrate how to compute the swap rate.

At the initiation of an interest-rate swap, the counterparties are agreeing to exchange future payments, and no upfront payments are made by either party. This means that the swap terms must be such that the present value of the payments to be made by the counterparties must be at least equal to the present value of the payments that will be received. In fact, to eliminate arbitrage opportunities, the present value of the payments made by a party will be equal to the present value of the payments received by that same party. *The equivalence (or no arbitrage) of the present value of the payments is the key principle in calculating the swap rate.*

Since we will have to calculate the present value of the payments, let's show how this is done.

Calculating the Present Value of the Floating-Rate Payments

As explained earlier, we must be careful about how we compute the present value of payments. In particular, we must carefully specify (1) the timing of the payment and (2) the interest rates that should be used to discount the payments. We have already addressed the first issue. In constructing the exhibit for the payments, we indicated that the payments are at the end of the quarter. Thus we denoted the time periods with respect to the end of the quarter.

Now let's turn to the interest rates that should be used for discounting. First, every cash flow should be discounted at its own discount rate using a spot rate. Thus, if we discounted a cash flow of \$1 using the spot rate for period t, the present value would be

$$\text{Present value of \$1 to be received in period } t = \frac{\$1}{(1 + \text{spot rate for period } t)^t}$$

Second, forward rates are derived from spot rates, so if we discounted a cash flow using forward rates rather than spot rates, we would come up with the same value. That is, the present value of \$1 to be received in period t can be rewritten as

$$\text{Present value of \$1 to be received in period } t$$

$$= \frac{\$1}{(1 + \text{forward rate for period 1})(1 + \text{forward rate for period 2}) \cdots (1 + \text{forward rate for period } t)}$$

We will call the present value of $1 to be received in period t as the *forward discount factor*. In our calculations involving swaps, we will compute the forward discount factor for a period using the forward rates. These are the same forward rates that are used to compute the floating-rate payments—those obtained from the Eurodollar CD futures contract. We must make just one more adjustment. We must adjust the forward rates used in the formula for the number of days in the period (i.e., the quarter in our illustrations) in the same way that we made this adjustment to obtain the payments. Specifically, the forward rate for a period, which we will call the *period forward rate,* is computed using the following equation:

$$\text{Period forward rate} = \text{annual forward rate} \times \left(\frac{\text{days in period}}{360}\right)$$

For example, look at Exhibit 55–2. The annual forward rate for period 4 is 4.72%. The period forward rate for period 4 is

$$\text{Period forward rate} = 4.72\% \times \left(\frac{92}{360}\right) = 1.2062\%$$

Column (5) in Exhibit 55–4 shows the annual forward rate for all 12 periods (reproduced from Exhibit 55–3), and column (6) shows the period forward rate for all 12 periods. Note that the period forward rate for period 1 is 4.05%, the known rate for three-month LIBOR.

Also shown in Exhibit 55–4 is the forward discount factor for all 12 periods. These values are shown in the last column. Let's show how the forward discount factor is computed for periods 1, 2, and 3. For period 1, the forward discount factor is

$$\text{Forward discount factor} = \frac{\$1}{(1.010125)} = 0.98997649$$

For period 2,

$$\text{Forward discount factor} = \frac{\$1}{(1.010125)(1.010490)} = 0.97969917$$

For period 3,

$$\text{Forward discount factor} = \frac{\$1}{(1.010125)(1.010490)(1.011628)} = 0.96843839$$

Given the floating-rate payment for a period and the forward discount factor for the period, the present value of the payment can be computed. For example, from Exhibit 55–2 we see that the floating-rate payment for period 4 is $1,206,222. From Exhibit 55–4, the forward discount factor for period 4 is 0.95689609. Therefore, the present value of the payment is

$$\begin{aligned}\text{Present value of period 4 payment} &= \$1{,}206{,}222 \times 0.95689609 \\ &= \$1{,}154{,}229\end{aligned}$$

EXHIBIT 55–4

Calculating the Forward Discount Factor

(1) Quarter Starts	(2) Quarter Ends	(3) Number of Days in Quarter	(4) Period = End of Quarter	(5) Forward Rate	(6) Period Forward Rate	(7) Forward Discount Factor
Jan 1 year 1	Mar 31 year 1	90	1	4.05%	1.0125%	0.98997649
Apr 1 year 1	June 30 year 1	91	2	4.15%	1.0490%	0.97969917
July 1 year 1	Sept 30 year 1	92	3	4.55%	1.1628%	0.96843839
Oct 1 year 1	Dec 31 year 1	92	4	4.72%	1.2062%	0.95689609
Jan 1 year 2	Mar 31 year 2	90	5	4.90%	1.2250%	0.94531597
Apr 1 year 2	June 30 year 2	91	6	5.03%	1.2715%	0.93344745
July 1 year 2	Sept 30 year 2	92	7	5.15%	1.3161%	0.92132183
Oct 1 year 2	Dec 31 year 2	92	8	5.25%	1.3417%	0.90912441
Jan 1 year 3	Mar 31 year 3	90	9	5.40%	1.3500%	0.89701471
Apr 1 year 3	June 30 year 3	91	10	5.50%	1.3903%	0.88471472
July 1 year 3	Sept 30 year 3	92	11	5.65%	1.4439%	0.87212224
Oct 1 year 3	Dec 31 year 3	92	12	5.76%	1.4720%	0.85947083

Exhibit 55–5 shows the present value for each payment. The total present value of the 12 floating-rate payments is \$14,052,917 Thus the present value of the payments that the fixed-rate payer will receive is \$14,052,917, and the present value of the payments that the fixed-rate receiver will make is \$14,052,917.

Determination of the Swap Rate

The fixed-rate payer will require that the present value of the fixed-rate payments that must be made based on the swap rate not exceed the \$14,052,917 payments to be received from the floating-rate payments. The fixed-rate receiver will require that the present value of the fixed-rate payments to be received is at least as great as the \$14,052,917 that must be paid. This means that both parties will require a present value for the fixed-rate payments to be \$14,052,917. If this is the case, the present value of the fixed-rate payments is equal to the present value of the floating-rate payments, and therefore, the value of the swap is zero for both parties at the inception of the swap. The interest rates that should be used to compute the present value of the fixed-rate payments are the same interest rates as those used to discount the floating-rate payments.

To show how to compute the swap rate, we begin with the basic relationship for no arbitrage to exist:

$$PV \text{ of floating-rate payments} = PV \text{ of fixed-rate payments}$$

We know the value for the left-hand side of the equation.

If we let

$$SR = \text{swap rate}$$

and

$$\text{Days}_t = \text{number of days in the payment period } t$$

then the fixed-rate payment for period t is equal to

$$\text{Notional amount} \times SR \times \frac{\text{days}_t}{360}$$

The present value of the fixed-rate payment for period t is found by multiplying the previous expression by the forward discount factor. If we let FDF_t denote the forward discount factor for period t, then the present value of the fixed-rate payment for period t is equal to

$$\text{Notional amount} \times SR \times \frac{\text{days}_t}{360} \times FDF_t$$

We can now sum up the present value of the fixed-rate payment for each period to get the present value of the floating-rate payments. Using the Greek symbol sigma (Σ) to denote summation, and letting N be the number of periods

EXHIBIT 55–5

Present Value of the Floating-Rate Payments

(1) Quarter Starts	(2) Quarter Ends	(3) Period = End of Quarter	(4) Forward Discount Factor	(5) Floating-Rate Payment at End of Quarter	(6) PV of Floating-Rate Payment
Jan 1 year 1	Mar 31 year 1	1	0.98997649	1,012,500	1,002,351
Apr 1 year 1	June 30 year 1	2	0.97969917	1,049,028	1,027,732
July 1 year 1	Sept 30 year 1	3	0.96843839	1,162,778	1,126,079
Oct 1 year 1	Dec 31 year 1	4	0.95689609	1,206,222	1,154,229
Jan 1 year 2	Mar 31 year 2	5	0.94531597	1,225,000	1,158,012
Apr 1 year 2	June 30 year 2	6	0.93344745	1,271,472	1,186,852
July 1 year 2	Sept 30 year 2	7	0.92132183	1,316,111	1,212,562
Oct 1 year 2	Dec 31 year 2	8	0.90912441	1,341,667	1,219,742
Jan 1 year 3	Mar 31 year 3	9	0.89701471	1,350,000	1,210,970
Apr 1 year 3	June 30 year 3	10	0.88471472	1,390,278	1,229,999
July 1 year 3	Sept 30 year 3	11	0.87212224	1,443,889	1,259,248
Oct 1 year 3	Dec 31 year 3	12	0.85947083	1,472,000	1,265,141
TOTAL					14,052,917

in the swap, then the present value of the fixed-rate payments can be expressed as

$$\sum_{t=1}^{N} \text{notional amount} \times SR \times \frac{\text{days}_t}{360} \times FDF_t$$

This also can be expressed as

$$SR \sum_{t=1}^{N} \text{notional amount} \times \frac{\text{days}_t}{360} \times FDF_t$$

The condition for no arbitrage is that the present value of the fixed-rate payments as given by the preceding expression is equal to the present value of the floating-rate payments. That is,

$$SR \sum_{t=1}^{N} \text{notional amount } \times \frac{\text{days}_t}{360} \times FDF_t = PV \text{ of floating-rate payments}$$

Solving for the swap rate,

$$SR = \frac{PV \text{ of floating-rate payments}}{\sum_{t=1}^{N} \text{ notional amount} \times \frac{\text{days}_t}{360} \times FDF_t}$$

All the values needed to compute the swap rate are known.

Let's apply the formula to determine the swap rate for our three-year swap. Exhibit 55–6 shows the calculation of the denominator of the formula. The forward discount factor for each period shown in column (5) is obtained from column (4) of Exhibit 55–5. The sum of the last column in Exhibit 55–6 shows that the denominator of the swap-rate formula is \$281,764,282. We know from Exhibit 55–5 that the present value of the floating-rate payments is \$14,052,917. Therefore, the swap rate is

$$SR = \frac{\$14{,}052{,}917}{\$281{,}764{,}282} = 0.049875 = 4.9875\%$$

Given the swap rate, the *swap spread* can be determined. For example, since this is a three-year swap, the convention is to use the three-year on-the-run Treasury rate as the benchmark. If the yield on that issue is 4.5875%, the swap spread is 40 basis points (4.9875% – 4.5875%).

The calculation of the swap rate for all swaps follows the same principle: equating the present value of the fixed-rate payments to that of the floating-rate payments.

Valuing a Swap

Once the swap transaction is completed, changes in market interest rates will change the payments of the floating-rate side of the swap. The value of an interest-rate swap is the difference between the present value of the payments of the two sides of the

EXHIBIT 55–6

Calculating the Denominator for the Swap-Rate Formula

(1) Quarter Starts	(2) Quarter Ends	(3) Number of Days in Quarter	(4) Period = End of Quarter	(5) Forward Discount Factor	(6) Days/360	(7) Forward Discount Factor × Days/360 × Notional
Jan 1 year 1	Mar 31 year 1	90	1	0.98997649	0.25000000	24,749,412
Apr 1 year 1	June 30 year 1	91	2	0.97969917	0.25277778	24,764,618
July 1 year 1	Sept 30 year 1	92	3	0.96843839	0.25555556	24,748,981
Oct 1 year 1	Dec 31 year 1	92	4	0.95689609	0.25555556	24,454,011
Jan 1 year 2	Mar 31 year 2	90	5	0.94531597	0.25000000	23,632,899
Apr 1 year 2	June 30 year 2	91	6	0.93344745	0.25277778	23,595,477
July 1 year 2	Sept 30 year 2	92	7	0.92132183	0.25555556	23,544,891
Oct 1 year 2	Dec 31 year 2	92	8	0.90912441	0.25555556	23,233,179
Jan 1 year 3	Mar 31 year 3	90	9	0.89701471	0.25000000	22,425,368
Apr 1 year 3	June 30 year 3	91	10	0.88471472	0.25277778	22,363,622
July 1 year 3	Sept 30 year 3	92	11	0.87212224	0.25555556	22,287,568
Oct 1 year 3	Dec 31 year 3	92	12	0.85947083	0.25555556	21,964,255
TOTAL						281,764,282

swap. The three-month LIBOR forward rates from the current Eurodollar CD futures contracts are used to (1) calculate the floating-rate payments and (2) determine the discount factors at which to calculate the present value of the payments.

To illustrate this, consider the three-year swap used to demonstrate how to calculate the swap rate. Suppose that one year later, interest rates change as shown in columns (4) and (6) in Exhibit 55–7. Column (4) shows the current three-month LIBOR. In column (5) are the Eurodollar CD futures price for each period. These rates are used to compute the forward rates in column (6). Note that the interest rates have increased one year later because the rates in Exhibit 55–7 are greater than those in Exhibit 55–2. As in Exhibit 55–2, the current three-month LIBOR and the forward rates are used to compute the floating-rate payments. These payments are shown in column (8) of Exhibit 55–7.

In Exhibit 55–8, the forward discount factor is computed for each period. The calculation is the same as in Exhibit 55–4 to obtain the forward discount factor for each period. The forward discount factor for each period is shown in the last column of Exhibit 55–8.

In Exhibit 55–9, the forward discount factor (from Exhibit 55–8) and the floating-rate payments (from Exhibit 55–7) are shown. The fixed-rate payments need not be recomputed. They are the payments shown in column (8) of Exhibit 55–3. These are fixed-rate payments for the swap rate of 4.9875% and are reproduced in Exhibit 55–9. Now the two payment streams must be discounted using the new forward discount factors. As shown at the bottom of Exhibit 55–9, the two present values are as follows:

Present value of floating rate payments	$11,459,495
Present value of fixed rate payments	$9,473,390

The two present values are not equal, and therefore, for one party, the value of the swap increased, and for the other party, the value of the swap decreased. Let's look at which party gained and which party lost.

The fixed-rate payer will receive the floating-rate payments. And these payments have a present value of $11,459,495. The present value of the payments that must be made by the fixed-rate payer is $9,473,390. Thus the swap has a positive value for the fixed-rate payer equal to the difference in the two present values of $1,986,105. This is the value of the swap to the fixed-rate payer. Notice, consistent with what we said earlier, that when interest rates increase (as they did in our illustration), the fixed-rate payer benefits because the value of the swap increases.

In contrast, the fixed-rate receiver must make payments with a present value of $11,459,495 but will only receive fixed-rate payments with a present value equal to $9,473,390. Thus the value of the swap for the fixed-rate receiver is –$1,986,105. Again, as explained earlier, the fixed-rate receiver is adversely affected by a rise in interest rates because it results in a decline in the value of a swap.

The same valuation principle applies to more complicated swaps. For example, there are swaps whose notional amount changes in a predetermined way

EXHIBIT 55–7

Rates and Floating-Rate Payments One Year Later if Rates Increase

(1) Quarter Starts	(2) Quarter Ends	(3) Number of Days in Quarter	(4) Current Three-Month LIBOR	(5) Eurodollar Futures Price	(6) Forward Rate	(7) Period = End of Quarter	(8) Floating-Rate Payments at End of Quarter
Jan 1 year 2	Mar 31 year 2	90	5.25%			1	1,312,500
Apr 1 year 2	June 30 year 2	91		94.27	5.73%	2	1,448,417
July 1 year 2	Sept 30 year 2	92		94.22	5.78%	3	1,477,111
Oct 1 year 2	Dec 31 year 2	92		94.00	6.00%	4	1,533,333
Jan 1 year 3	Mar 31 year 3	90		93.85	6.15%	5	1,537,500
Apr 1 year 3	June 30 year 3	91		93.75	6.25%	6	1,579,861
July 1 year 3	Sept 30 year 3	92		93.54	6.46%	7	1,650,889
Oct 1 year 3	Dec 31 year 3	92		93.25	6.75%	8	1,725,000

EXHIBIT 55–8

Period Forward Rates and Forward Discount Factors One Year Later if Rates Increase

(1) Quarter Starts	(2) Quarter Ends	(3) Number of Days in Quarter	(4) Period = End of Quarter	(5) Forward Rate	(6) Period Forward Rate	(7) Forward Discount Factor
Jan 1 year 2	Mar 31 year 2	90	1	5.25%	1.3125%	0.98704503
Apr 1 year 2	June 30 year 2	91	2	5.73%	1.4484%	0.97295263
July 1 year 2	Sept 30 year 2	92	3	5.78%	1.4771%	0.95879023
Oct 1 year 2	Dec 31 year 2	92	4	6.00%	1.5333%	0.94431080
Jan 1 year 3	Mar 31 year 3	90	5	6.15%	1.5375%	0.93001186
Apr 1 year 3	June 30 year 3	91	6	6.25%	1.5799%	0.91554749
July 1 year 3	Sept 30 year 3	92	7	6.46%	1.6509%	0.90067829
Oct 1 year 3	Dec 31 year 3	92	8	6.75%	1.7250%	0.88540505

EXHIBIT 55–9

Valuing the Swap One Year Later if Rates Increase

(1) Quarter Starts	(2) Quarter Ends	(3) Forward Discount Factor	(4) Floating Cash Flow at End of Quarter	(5) PV of Floating Cash Flow	(6) Fixed Cash Flow at End of Quarter	(7) PV of Fixed Cash Flow
Jan 1 year 2	Mar 31 year 2	0.98704503	1,312,500	1,295,497	1,246,875	1,230,722
Apr 1 year 2	June 30 year 2	0.97295263	1,448,417	1,409,241	1,260,729	1,226,630
July 1 year 2	Sept 30 year 2	0.95879023	1,477,111	1,416,240	1,274,583	1,222,058
Oct 1 year 2	Dec 31 year 2	0.94431080	1,533,333	1,447,943	1,274,583	1,203,603
Jan 1 year 3	Mar 31 year 3	0.93001186	1,537,500	1,429,893	1,246,875	1,159,609
Apr 1 year 3	June 30 year 3	0.91554749	1,579,861	1,446,438	1,260,729	1,154,257
July 1 year 3	Sept 30 year 3	0.90067829	1,650,889	1,486,920	1,274,583	1,147,990
Oct 1 year 3	Dec 31 year 3	0.88540505	1,725,000	1,527,324	1,274,583	1,128,523
TOTAL				11,459,495		9,473,390

Summary	Fixed-Rate Payer	Fixed-Rate Receiver
PV of payments received	11,459,495	9,473,390
PV of payments made	9,473,390	11,459,495
Value of swap	1,986,105	–1,986,105

over the life of the swap. These include amortizing swaps, accreting swaps, and roller-coaster swaps. Once the payments are specified, the present value is calculated as described earlier simply by adjusting the payment amounts by the changing notional amounts—the methodology does *not* change.

PRIMARY DETERMINANTS OF SWAP SPREADS

The swap spread is determined by the same factors that drive the spread over Treasuries on instruments that replicate a swap's cash flows, i.e., produce a similar return or funding profile. As discussed below, the swap spread's key determinant for swaps with tenors (i.e., maturities) of five years or less is the cost of hedging in the Eurodollar CD futures market. Although listed contracts exist with delivery dates out to 10 years, the liquidity of the Eurodollar CD futures market diminishes considerably after about five years. For longer tenor swaps, the swap spread is largely driven by credit spreads in the corporate bond market. Specifically, longer-dated swaps are priced relative to rates paid by investment-grade credits in traditional fixed- and floating-rate markets.

Given that a swap is a package of futures/forward contracts, the shorter-term swap spreads respond directly to fluctuations in Eurodollar CD futures prices. As noted, there is a liquid market for Eurodollar CD futures contracts with maturities every three months for approximately five years. A market participant can create a synthetic fixed-rate security or a fixed-rate funding vehicle by taking a position in a bundle of Eurodollar CD futures contracts (i.e., a position in every three-month Eurodollar CD futures contract up to the desired maturity date).

For example, consider a financial institution that has fixed-rate assets and floating-rate liabilities. Both the assets and liabilities have a maturity of three years. The interest rate on the liabilities resets every three months based on three-month LIBOR. This financial institution can hedge this mismatched asset/liability position by buying a three-year bundle of Eurodollar CD futures contracts. By doing so, the financial institution is receiving LIBOR over the three-year period and paying a fixed dollar amount (i.e., the futures price). The financial institution is now hedged because the assets are fixed-rate, and the bundle of long Eurodollar CD futures synthetically creates a fixed-rate funding arrangement. From the fixed dollar amount over the three years, an effective fixed rate that the financial institution pays can be computed. Alternatively, the financial institution can synthetically create a fixed-rate funding arrangement by entering into a three-year swap in which it pays fixed and receives three-month LIBOR. Other things equal, the financial institution will use the vehicle that delivers the lowest cost of hedging the mismatched position. That is, the financial institution will compare the synthetic fixed rate (expressed as a percentage over U.S. Treasuries) to the three-year swap spread. The difference between the synthetic spread and the swap spread should be within a few basis points under normal circumstances.

For swaps with tenors greater than five years, we cannot rely on the Eurodollar CD futures owing to diminishing liquidity of such contracts. Instead, longer-dated swaps are priced using rates available for investment-grade corporate borrowers in fixed-rate and floating-rate debt markets. Since a swap can be interpreted as a package of long and short positions in a fixed-rate bond and a floating-rate bond, it is the credit spreads in those two market sectors that will be the primary determinant of the swap spread. Empirically, the swap curve lies above the U.S. Treasury yield curve and below the on-the-run yield curve for AA-rated banks.[1] Swap fixed rates are lower than AA-rated bond yields due to their lower credit risk due to netting and offsetting of swap positions.

In addition, there are a number of other technical factors that influence the level of swap spreads.[2] While the impact of some these factors is ephemeral, their influence can be considerable in the short run. Included among these factors are (1) the level and shape of the Treasury yield curve, (2) the relative supply of fixed- and floating-rate payers in the interest-rate swap market, (3) the technical factors that affect swap dealers, and (4) the level of asset-based swap activity.

The level, slope, and curvature of the U.S. Treasury yield curve are important influences on swap spreads at various maturities. The reason is that embedded in the yield curve are the market's expectations of the direction of future interest rates. While these expectations are sometimes challenging to extract, the decision to borrow at a fixed rate or a floating rate will be based, in part, on these expectations. The relative supply of fixed- and floating-rate payers in the interest-rate swap market also should be influenced by these expectations. For example, many corporate issuers—financial institutions and federal agencies in particular—swap their newly issued fixed-rate debt into floating using the swap market. Consequently, swap spreads will be affected by the corporate debt issuance calendar. In addition, swap spreads, like credit spreads, also tend to increase with the swap's tenor or maturity.

Swap spreads are also affected by the hedging costs faced by swap dealers. Dealers hedge the interest-rate risk of long (short) swap positions by taking a long (short) position in a Treasury security with the same maturity as the swap's tenor and borrowing funds (lending funds) in the repo market. As a result, the spread between LIBOR and the appropriate repo rate will be a critical determinant of the hedging costs. When on-the-run Treasuries go "on special," it is correspondingly more expensive to use these Treasuries as a hedge. This increase in hedging costs results in wider swap spreads.[3]

1. For a discussion of this point, see Andrew R. Young, *A Morgan Stanley Guide to Fixed Income Analysis* (New York: Morgan Stanley, 1997).
2. See Ellen L. Evans and Gioia Parente Bales, "What Drives Interest Rate Swap Spreads," Chapter 13 in Carl R. Beidleman (ed.), *Interest Rate Swaps* (Burr Ridge, IL: Irwin Professional Publishing, 1991).
3. Traders often use the repo market to obtain specific securities to cover short positions. If a security is in short supply relative to demand, the repo rate on a specific security used as collateral in repo transaction will be below the general (i.e., generic) collateral repo rate. When a particular security's repo rate falls markedly, that security is said to be "on special." Investors who own these securities are able to lend them out as collateral and borrow at bargain basement rates.

Another influence on the level of swap spreads is the volume of asset-based swap transactions. An asset-based swap transaction involves the creation of a synthetic security via the purchase of an existing security and the simultaneous execution of a swap. For example, after the Russian debt default and devaluation in August 1998, risk-averse investors sold corporate bonds and fled to the relative safety of U.S. Treasuries. Credit spreads widened considerably and liquidity diminished. A contrary-minded floating-rate investor (like a financial institution) could have taken advantage of these circumstances by buying newly issued investment-grade corporate bonds with relatively attractive coupon rates and simultaneously taking a long position in an interest-rate swap (pay fixed/receive floating). Accordingly, the financial institution ends up with a synthetic floating-rate asset with a spread above LIBOR.

By similar reasoning, investors can use swaps to create a synthetic fixed-rate security. For example, during the mid-1980s, many banks issued perpetual floating-rate notes in the Eurobond market. A perpetual floating-rate note is a security that delivers floating-rate cash flows forever. The coupon is reset and paid usually every three months with a coupon formula equal to the reference rate (e.g., three-month LIBOR) plus a spread. When the perpetual floating-rate note market collapsed in late 1986, the contagion spread into other sectors of the floaters market.[4] Many floaters cheapened considerably. As before, contrary-minded fixed-rate investors could exploit this situation through the purchase of a relatively cheap (from the investor's perspective) floater while simultaneously taking a short position in an interest-rate swap (pay floating/receive fixed) thereby creating a synthetic fixed-rate investment. The investor makes floating-rate payments (say, based on LIBOR) to the counterparty and receives fixed-rate payments equal to the Treasury yield plus the swap spread. Accordingly, the fixed rate on this synthetic security is equal to the sum of the following: (1) the Treasury bond yield that matches the swap's tenor, (2) the swap spread, and (3) the floater's index spread.

NONGENERIC INTEREST-RATE SWAPS

The swap market is very flexible, and instruments can be tailor-made to fit the requirements of individual customers. A wide variety of swap contracts are traded in the market. Although the most common reference rate for the floating leg of a swap is six-month LIBOR for a semiannual-paying floating leg, other reference rates that have been used include three-month LIBOR, the prime rate (for dollar swaps), the one-month commercial paper rate, the Treasury bill rate, and the municipal bond rate.

The term of a swap need not be fixed; swaps may be *extendible* or *putable*. In an extendible swap, one of the parties has the right but not the obligation to extend

4. Suresh E. Krishman, "Asset-Based Interest Rate Swaps," Chapter 8 in *Interest Rate Swaps*.

the life of the swap beyond the fixed maturity date, whereas in a putable swap one party has the right to terminate the swap prior to the specified maturity date.

It is also possible to transact options on swaps, known as *swaptions*. A swaption is the right to enter into a swap agreement at some point in the future during the life of the option. Essentially a swaption is an option to exchange a fixed-rate bond cash flow for a floating-rate bond cash-flow structure. Swaptions will be described in more detail later.

Other swaps are described below.

Constant-Maturity Swap

In a constant-maturity swap, the parties exchange a LIBOR rate for a fixed swap rate. For example, the terms of the swap might state that six-month LIBOR is exchanged for the five-year swap rate on a semiannual basis for the next five years or for the five-year government bond rate. In the U.S. market, the second type of constant-maturity swap is known as a *constant-maturity Treasury swap*.

Accreting and Amortizing Swaps

In a plain-vanilla swap, the notional principal remains unchanged during the life of the swap. However it is possible to trade a swap where the notional principal varies during its life. An accreting (or step-up) swap is one in which the principal starts off at one level and then increases in amount over time. The opposite, an amortizing swap, is one in which the notional reduces in size over time. An accreting swap would be useful where, for instance, a funding liability that is being hedged increases over time. The amortizing swap might be employed by a borrower hedging a bond issue that featured sinking-fund payments, where a part of the notional amount outstanding is paid off at set points during the life of the bond. If the principal fluctuates in amount, for example, increasing in one year and then reducing in another, the swap is known as a *roller-coaster swap*. Another application of an amortizing swap is as a hedge for a loan that is itself an amortizing one. Frequently this is combined with a forward-starting swap to tie in with the cash flows payable on the loan. The pricing and valuation of an amortizing swap are no different in principle to a vanilla interest-rate swap; a single swap rate is calculated using the relevant discount factors, and at this rate the net present value of the swap cash flows will equal zero at the start of the swap.

Basis Swap

In a conventional swap, one leg comprises fixed-rate payments and the other floating-rate payments. In a *basis swap,* both legs are floating rate but linked to different money market indexes. One leg is normally linked to LIBOR, while the other might be linked to the CD rate or the commercial paper rate. This type of swap would be used by a bank in the United States that had made loans that paid at the prime rate and funded its loans at LIBOR. A basis swap would eliminate the basis risk between the bank's income and interest expense. Other basis swaps are traded in which both legs are linked to LIBOR, but at different maturities; for instance, one leg might be at three-month LIBOR and the other at six-month LIBOR. In such a swap, the basis is different as is the payment frequency: One leg pays out semiannually, while the other would be paying on a quarterly basis.

Off-Market Swap

When a swap is transacted, its fixed rate is quoted at the current market rate for that maturity. When the fixed rate is different from the market rate, this type of swap is an *off-market swap,* and a compensating payment is made by one party to the other. An off-market rate may be used for particular hedging requirements, for example, or when a bond issuer wishes to use the swap to hedge the bond as well as to cover the bond's issue costs.

Forward-Start Swap

A *forward-start swap* is an obligation where two counterparties agree to enter into a swap contract at some future date under terms negotiated today.[5] Accordingly, the swap's effective (i.e., start) date is not the usual one or two days after the trade date but some time afterwards, say, six months after the trade date: for example, an interest-rate swap with a tenor of three years that has an effective date one year from today. Once the effective date is reached, a forward-start swap is identical to a normal interest-rate swap. Earlier in the chapter we noted that it is useful to think of the generic interest-rate swap market as one where two counterparties trade the floating reference rate in a series of exchanges for a fixed price. Extending this intuition, the forward-start interest-rate swap market is a forward market for trading the floating reference rate as opposed to the spot market.

A forward-start swap contract will specify the swap's fixed rate at which the two counterparties agree to exchange cash flows during the swap's life which begins on some future effective date. This rate is referred to as the *forward swap fixed rate*.

Overnight Interest-Rate Swaps and Eonia/SONIA Swaps

Overnight-index swaps (OIS) are interest-rate swaps that are traded in the money markets because of their short-term maturity but are generically identically to interest-rate swaps and so also may be considered a capital market instrument.

We saw earlier in this chapter that an interest-rate swap contract, which is generally regarded as a capital market instrument, is an agreement between two

5. Forward-start swaps are also referred to as *forward swaps, delayed swaps,* and *deferred swaps.*

counterparties to exchange a fixed-interest-rate payment in return for a floating-interest-rate payment, calculated on a notional swap amount, at regular intervals during the life of the swap. A swap may be viewed as being equivalent to a series of successive forward contracts, with each forward contract starting as the previous one matures. The basis of the floating interest rate is agreed as part of the contract terms at the inception of the trade. Conventional swaps index the floating interest rate to LIBOR; however an exciting recent development in the money markets has been the OIS. In the sterling market they are known as *sterling overnight interest rate average swaps,* or SONIA, while Eurocurrency OIS are known as *Eonia*. In this section we review OIS swaps, which are used extensively by commercial and investment banks.

SONIA is the average interest rate of interbank (unsecured) overnight sterling deposit trades undertaken before 15:30 hours each day between members of the London Wholesale Money Brokers' Association. Recorded interest rates are weighted by volume. A SONIA swap is a swap contract that exchanges a fixed interest rate (the swap rate) against the geometric average of the overnight interest rates that have been recorded during the life of the contract. Exchange of interest takes place on maturity of the swap. SONIA swaps are used to speculate on or to hedge against interest rates at the very short end of the sterling yield curve; in other words, they can be used to hedge an exposure to overnight interest rates.[6] The swaps themselves are traded in maturities of one week to one year, although two-year SONIA swaps have also been traded.

Conventional swap rates are calculated off the government bond yield curve and represent the credit premium over government yields of interbank default risk. Essentially, they represent an average of the forward rates derived from the government spot (zero-coupon) yield curve. The fixed rate quoted on a SONIA swap represents the average level of the overnight interest rates expected by market participants over the life of the swap. In practice, the rate is calculated as a function of the Bank of England's repo rate. This is the two-week rate at which the Bank conducts reverse repo trades with banking counterparties as part of its open market operations. In other words, this is the Bank's base rate. In theory, one would expect the SONIA rate to follow the repo rate fairly closely, since the credit risk on an overnight deposit is low. However, in practice, the spread between the SONIA rate and the Bank repo rate is very volatile, and for this reason, the swaps are used to hedge overnight exposures.

Overnight index swaps dealt in U.S. dollars are linked to the federal funds rate. Since this rate is considerably below the overnight LIBOR rate, it means that the swap is not always used by banks to hedge overnight interest rate liability exposure, especially when the latter is linked to LIBOR.

6. Traditionally, overnight rates fluctuate in a very wide range during the day, depending on the day's funds shortage, and although volatility has reduced since the introduction of gilt repo, it is still unpredictable on occasion.

CANCELING A SWAP

When financial institutions enter into a swap contract in order to hedge interest-rate liabilities, the swap will be kept in place until its expiration. However, circumstances may change, or a financial institution may alter its view on interest rates, and so circumstances may arise such that it may be necessary to terminate the swap. The most straightforward option is for the corporation to take out a second contract that negates the first. This allows the first swap to remain in place, but there may be residual cash flows unless the two swaps cancel each other out precisely. The terms for the second swap, being nonstandard (and unlikely to be exactly whole years to maturity, unless traded on the anniversary of the first), also may result in it being more expensive than a vanilla swap. Since it is unlikely that the second swap will have the same rate, the two fixed legs will not net to zero. And if the second swap is not traded on an anniversary, payment dates will not match.

For these reasons, an entity may wish to cancel the swap entirely. To do this, it will ask a swap market maker for a quotation on a *cancellation fee*. The bank will determine the cancellation fee by calculating the net present value of the remaining cash flows in the swap using the relevant discount factor for each future cash flow. In practice just the fixed leg will be present valued and then netted with LIBOR. The net present value of all the cash flows is the fair price for canceling the swap. The valuation principles we established earlier will apply; that is, if the fixed rate payer is asking to cancel the swap when interest rates have fallen, he will pay the cancellation fee, and vice versa if rates have risen.

CREDIT RISK

The rate quoted for swaps in the interbank market assumes that the counterparty to the transaction has a lending line with the swap bank, so the swap rate therefore reflects the credit risk associated with an interbank quality counterparty. This credit risk is reflected in the spread between the swap rate and the equivalent-maturity government bond, although, as noted, the spread also reflects other considerations such as liquidity and supply and demand. The credit risk of a swap is separate from its interest-rate risk or market risk, and arises from the possibility of the counterparty to the swap defaulting on its obligations. If the present value of the swap at the time of default is net positive, then a bank is at risk of loss of this amount. While market risk can be hedged, it is more problematic to hedge credit risk. The common measures taken include limits on lending lines, collateral, and diversification across counterparty sectors, as well as a form of credit value-at-risk to monitor credit exposures.

A bank therefore is at risk of loss due to counterparty default for all its swap transactions. If at the time of default, the net present value of the swap is positive, this amount is potentially at risk and will probably be written off. If the value of the swap is negative at the time of default, in theory this amount is a potential gain to the bank, although in practice the counterparty's administrators will try to recover the value for their client. In this case, then, there is no net gain or loss to the swap bank. The credit risk management department of a bank will therefore often assess the ongoing credit quality of counterparties with whom the swap transactions are currently positive in value.

SWAPTIONS

We conclude this chapter with a discussion of swaptions. A *swaption* is an option to establish a position in an interest-rate swap at some future date. The swaption contract specifies the swaption's expiration date, as well as the fixed rate and tenor of the underlying swap. The swap's fixed rate is called the swaption's *strike rate*. There are two types of swaptions—pay fixed or receive fixed. A pay (receive) fixed swaption gives the buyer the right to establish a position in an interest-rate swap where she will pay (receive) the fixed-rate cash flows and receive (pay) the floating-rate cash flows.

When valuing interest-rate derivatives or bonds with embedded options, it is essential to model expected future interest-rate volatility. Accordingly, the lattice approach discussed in Chapter 37 is a commonly used method to value swaptions. A swaption's value will depend on a few critical parameters that include market inputs (e.g., the current yield curve) as well as terms of the swaption contract (e.g., time to expiration). To solidify our intuition about how swaptions work, we examine how changes in key factors affect swaption values. In particular, we will consider changes in the following: yield curve (level and slope), volatility, strike rate, and time to expiration.

Changes in the Yield Curve

As with conventional call and put options, pay-fixed or receive-fixed swaptions tend to react in an opposite manner to changes in the underlying parameters. For example, a pay-fixed swaption increases in value with an upward parallel shift in the yield curve, and a receive-fixed swaption becomes more valuable with a downward parallel shift in the yield curve. To see this, consider a one-year European pay-fixed swaption on a five-year generic interest-rate swap. The notional principal is $10 million, and the strike rate is 6%. On the expiration date, the buyer will either exercise it (i.e., enter into the five-year swap to pay 6% fixed-rate cash flows and receive floating-rate cash flows) or let the swaption expire. If the five-year swap rate is above 6% on the expiration date, the buyer of this pay-fixed swaption will exercise it. Conversely, if the five-year swap rate is below 6%, the pay-fixed swaption will expire worthless. The principle is the same for a receive swaption, only in reverse.

Next, we consider the impact of a change in the yield curve's shape on swaption values. In particular, we will discuss the impact of a steepening and an inverting yield curve. If the yield curve steepens, the value of a pay-fixed swaption increases, and the value of a receive-fixed swaption decreases. The intuition is straightforward. A steepening yield curve indicates that the implied forward rates are increasing at a faster rate than suggested by the initial yield curve. The higher rates indicate that the floating-rate cash flows of the underlying swap contract are going to be higher than previously expected. This effect works to the advantage of the pay-fixed swaption buyer because she will receive higher floating-rate cash flows if the swaption is exercised. The opposite is true for a receive-fixed swaption buyer. By analogous reasoning, an inverted yield curve indicates that the implied forward rates are decreasing. If this occurs, the value of a pay-fixed swaption decreases, and the value of a receive-fixed swaption increases.

Volatility

There is a positive relationship between swaption values and the assumed interest-rate volatility. If interest volatility increases, all else held constant, chances are greater that underlying swap's value will move in a favorable direction (i.e., higher floating-rate cash flows for the pay-fixed swaption and higher fixed-rate cash flows for the receive-fixed swaption). Vega measures the impact of a change in interest-rate volatility on an option's value. For a swaption, vega tells us the sensitivity of the swaption's value (in basis points) to a 1% change in the assumed interest-rate volatility.

Strike Rate

The value of a swaption is essentially the difference between the strike rate and prevailing swap rate at the time it is being valued. At expiration, a pay-fixed swaption is only exercised when the swap rate is higher than the strike rate. Conversely, at expiration, a receive-fixed swaption is only exercised when the swap rate is lower than the strike rate. Given this backdrop, it is apparent that as the strike rate changes, a pay-fixed swaption and a receive-fixed swaption will behave in an opposite manner. An increase in the strike rate, all else equal, will decrease the value of a pay-fixed swaption and increase the value of a receive-fixed swaption. The reasoning is as follows: As the strike rate increases, the pay-fixed swaption buyer will pay higher fixed-rate cash flows over the swap's life if the swaption is exercised. This is obviously less valuable than paying a lower fixed rate for the same floating-rate cash flows in return. For the receive-fixed swaption buyer, an increase in the strike rate means that the receive-fixed swaption buyer will receive higher fixed-rate cash flows over the swap's life if the swaption is exercised. For decreases in the strike rate, the effects are reversed.

Time to Expiration

For most options (calls and puts) traded in the financial markets, increasing the option's time to expiration makes it more valuable. This is not the case for swaptions. Increasing a swaption's time to expiration can either increase or decrease its value. This ambiguity is due to the interaction of increasing the time to expiration and the other variables that drive a swaption's value—the current yield curve, volatility, and the strike rate.

CHAPTER
FIFTY-SIX

INTEREST-RATE CAPS AND FLOORS AND COMPOUND OPTIONS

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Interest-rate caps and floors provide asymmetric interest-rate risk management capabilities similar to those provided by options, except that protection can be customized to a much greater degree. As indicated by the nomenclature, *interest-rate caps,* also referred to as *interest-rate ceilings,* allow the purchaser to "cap" the contractual rate associated with a liability. Alternatively, interest-rate floors allow the purchaser to protect the total rate of return of an asset. The seller of the cap pays the purchaser any amount above the periodic capped rate on the settlement date. Conversely, the purchaser of the floor receives from the seller any amount below the periodic protected rate on the relevant date. The protection provided by caps and floors is asymmetric, in that the purchaser is protected from adverse moves in the market but maintains the advantage of beneficial moves in market rates. In this respect, caps and floors differ from interest-rate swaps. Recall that interest-rate swaps seek to insulate the user from the economic effects of interest-rate volatility, regardless of the direction of interest rates.

Interest-rate protection obtained by purchasing caps and floors can be customized by selecting various contractual features. In this chapter, the decision variables commonly used in determining the parameters of either interest-rate caps or floors are described.

FEATURES OF INTEREST-RATE CAPS AND FLOORS

The *underlying index* from which the contractual payments will be determined can be chosen from a set of indexes based on LIBOR, commercial paper, prime rate, Treasury bills, or certificates of deposit. Because these instruments are originated along several maturities, an additional variable associated with the index concerns the maturity of the index.

The *strike rate* is the rate at which the cash flows will be exchanged between the purchaser and seller of the customized interest-rate protection instrument. Caps with a higher strike rate have lower upfront premiums, although the trade-off between the premium and the strike rate is not directly proportional. Similarly, floors with a lower strike rate have a lower upfront premium. Increasing (decreasing) the strike rate does not result in a proportionate decrease in the upfront fee for interest-rate caps (floors).

The term of the protection may range from several months to about 30 years, although the liquidity of longer dated caps is not sufficiently high.

The *settlement frequency* refers to the frequency with which the strike rate will be compared to the underlying index to determine the periodic contractual rate for the interest-rate protection agreement. The most common frequencies are monthly, quarterly, and semiannually. At settlement, the cash flows exchanged could be determined on either the average daily rate prevalent during the repricing interval or the spot rate on the settlement date.

The *notional amount* of the agreement on which the cash flows are exchanged is usually fixed, unless the terms of the agreement call for the amortization of the notional amount. For instance, in "spread enhancement" strategies, which involve the purchase of an amortizing asset, such as a fixed-rate mortgage-backed security funded by floating-rate capped liabilities, amortization of the cap notional amount may be necessary in order to maintain the spread. Unless the amortization feature is included in the design of the cap, the spread between the asset cash flows and the liability costs will be eroded.

PRICING OF CAPS AND FLOORS

The *upfront premium* is the fee paid by the purchaser to the seller of the interest-rate agreement at the inception of the contract. This fee is similar to the premium paid to purchase options and is determined by factors such as the strike rate, volatility of the underlying index, the length of the agreement, the notional amount, and any special features, such as amortization of the notional principal.

The pricing of both caps and floors draws heavily on option pricing theory; for instance, an increase in market volatility results in a higher premium for both the cap and the floor. The strike rate for a cap is inversely related to the premium paid for the cap because rates have to advance before the cap is in the money or the payoff is positive. On the other hand, the strike rate for interest-rate floors is directly related to the upfront premium. A higher strike indicates that the likelihood of the index falling below this rate is greater, which indicates a higher likelihood of positive payoff from the floor. The longer the term-to-maturity, the greater the premium because optional protection is available for a longer period of time. Hence there is a higher probability that the payoff associated with these instruments will be positive. With respect to the payment frequency, the agreement with a shorter payment frequency will command a higher premium because there is a greater likelihood of payoff and the payments are determined only on the settlement date. This may be an important determinant of cash flows, especially in highly volatile markets. Any advantageous changes in market volatility for interest-rate agreements with longer settlement frequencies may not result in a payoff for the purchaser of the agreement because the option-like characteristics of caps and floors are European rather than American in design.

There also may be additional contractual features, such as variable premiums, cost of termination options prior to stated maturity, conversion privileges from one program to another, and purchase of a combination of programs, such as *interest-rate collars* and *corridors.*

INTEREST-RATE CAPS

As noted earlier, an interest-rate cap can be used to create an upper limit on the cost of floating-rate liabilities. The purchaser of the cap pays an upfront fee to establish a ceiling on a particular funding rate. If the market rate exceeds the strike rate of the cap on the settlement date, the seller of the cap pays the difference. As an illustration, consider the following example, where an institution purchases an interest-rate cap to hedge the coupon rate of LIBOR-indexed liabilities, which reprice every three months.

Notional amount:	\$10,000,000
Underlying index:	Three-month LIBOR
Maturity:	Three years
Cap strike level:	10%
Premium:	145 basis points or 1.45% of \$10,000,000 = \$145,000
Settlement frequency:	Quarterly
Day count:	Actual/360

The upfront premium can be converted to an annual basis point equivalent by treating \$145,000 as the present value of a stream of equal quarterly payments with a future value of zero at the maturity of the cap. Ideally, this should be computed at the rate at which the upfront premium can be funded for three years. Assuming that this premium can be funded at a rate of 9% and the cap has 12 reset periods, the annual basis point equivalent of the upfront premium is 56 basis points.[1]

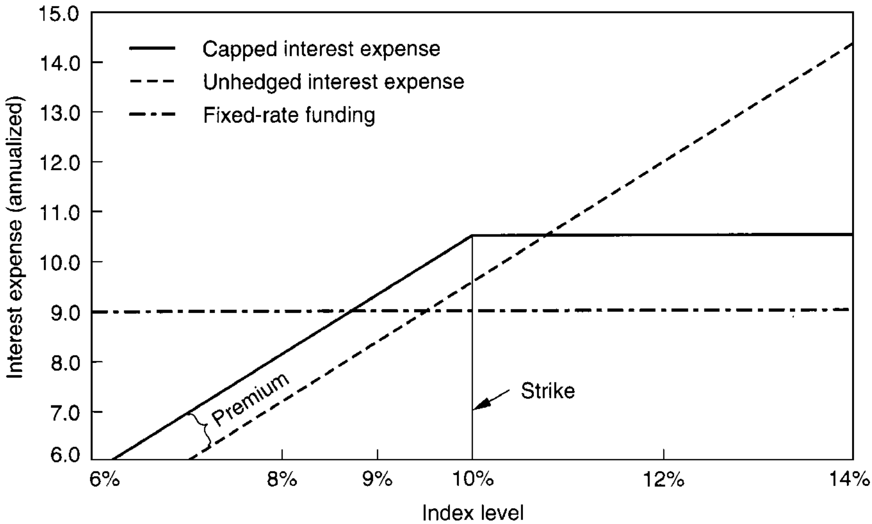
In this example, the payments to the purchaser of the cap by the seller can be determined as the quarterly difference between the three-month LIBOR index and the cap strike rate of 10% times the notional amount of the agreement. Specifically, the cap payments are computed as follows:

(Index rate – strike rate) × (days in settlement period/360) × notional amount

1. This represents the annuity over three years, which when discounted quarterly at an annual rate of 9% equals the upfront premium of 145 basis points.

EXHIBIT 56–1

Effective Interest Expense of a Capped Liability



For instance, where three-month LIBOR is 11%, the payments made by the cap seller, assuming 90 days in the settlement period, would be determined as follows:

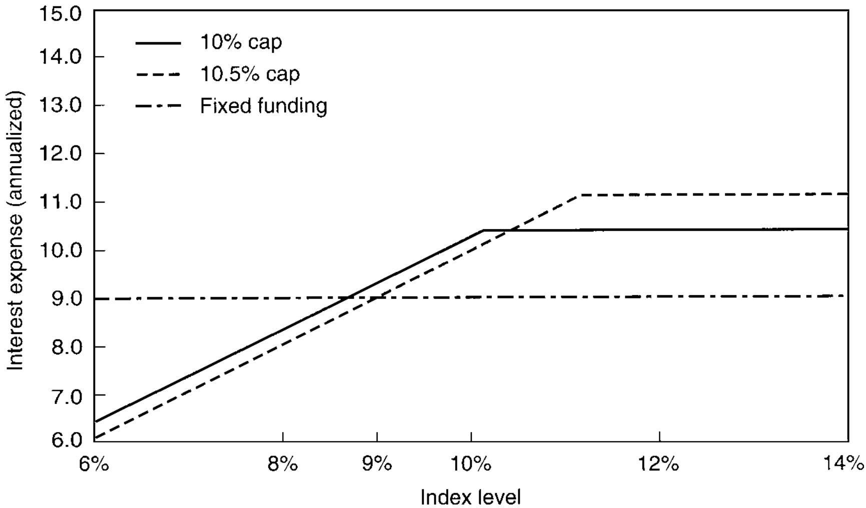
$$(11\% - 10\%) \times (90/360) \times 10{,}000{,}000 = \$25{,}000$$

The purchaser does not receive any payments when the reference rate, as indicated by the value of three-month LIBOR, is below the strike rate of 10%. The payoff profile of this capped liability is illustrated in Exhibit 56–1. Because the annual amortized premium of the cap is 56 basis points, the maximum rate associated with the capped liability at a strike of 10% is 10.56%. In interest-rate scenarios where the value of three-month LIBOR is below 10%, the interest expense of the capped liability is higher than the unhedged interest expense by the amount of the amortization of the upfront premium. Given that the maximum risk exposure associated with the purchase of the cap is limited to the upfront premium, the dynamics of caps are similar to those of debt options. On a more specific basis, because the purchaser of the cap benefits in rising rate scenarios, the conceptual options analog is a strip of put options. However, caps can be purchased for maturities longer than those associated with a strip of puts. By increasing the strike rate of the cap, say, from 10% to 10.5%, the upfront premium (and hence the annual amortized premium) can be reduced. However, as illustrated in Exhibit 56–2, the maximum interest expense of the capped liability increases with a higher cap strike rate.

There are several advantages associated with the use of the cap in protecting the interest expense of a floating-rate liability. The purchaser of the cap can obtain protection against higher rates and also fund the liabilities at a floating rate to take advantage of lower interest rates. In this respect, the capped liability strategy can result in a lower cost of funds than certain fixed-rate alternatives.

EXHIBIT 56–2

Effective Interest Cost under Two Cap Levels



In addition to capping the cost of liabilities, interest-rate caps also can be used to synthetically strip embedded caps in floating-rate instruments such as CMO floaters and adjustable-rate mortgages. For instance, consider the case of an institution owning a CMO floater bond that reprices monthly at a spread of 60 basis points over LIBOR, with a cap of 600 basis points over the initial coupon rate. If the initial coupon rate is 9.60%, the coupon is capped at 15.60%. Because the only sources of cash flow available to CMO bonds are the principal, interest, and prepayment streams of the underlying mortgages, CMO floaters are, by definition, capped. In this respect, CMO floaters are different from other LIBOR-indexed bonds, such as floating-rate notes. The institution could strip off the embedded cap in the CMO floater by buying a cap at a strike rate of 15% or 16%. With a strike rate about 600 to 700 basis points out-of-the-money, the cap could be purchased quite inexpensively. As interest rates increase, the loss in coupon by the embedded cap feature of the CMO bonds would be compensated by the cash inflows from the cap. The same strategy could be applied to strip caps inherent in adjustable-rate mortgages. However, the exercise of stripping caps associated with adjustable-rate mortgages is somewhat more difficult because of the existence of periodic and lifetime caps. While there is theoretical appeal in this strategy, the efficacy of the process may be hampered by unexpected prepayments associated with the assets.

PARTICIPATING CAPS

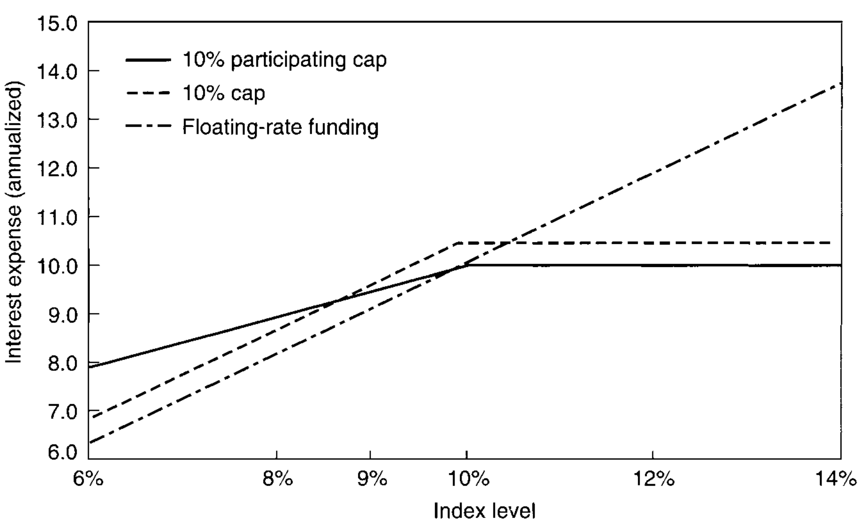
It is difficult to pinpoint the exact nature of financial instruments labeled as participating caps. A common theme in the definition of such instruments is the absence of an upfront fee used to purchase the cap. The confusion in definition arises from the variations of the term *participating.* One type of participating cap involves the purchase of cap protection where the buyer obtains full protection in the event that interest rates rise. However, in order to compensate the seller of the cap for this bearish protection, the buyer shares a percentage (the participation) of the difference between the capped rate and the level of the floating-rate index in the event that interest rates fall.

For illustrative purposes, assume that a firm purchases a LIBOR participating cap at a strike rate of 10% with a participation rate of 60%. If LIBOR increases to levels greater than 10%, the firm will receive cash flows analogous to a nonparticipating cap. However, if LIBOR is below the capped rate, say, 8%, then the firm gives up 60% of the difference between LIBOR and the capped rate, that is, (10% − 8%) × 0.6 = 1.2%. In this case the effective interest expense would be 9.20% (8.00% + 1.20%) instead of LIBOR plus the annual amortized premium, as in a nonparticipating cap. In bullish interest-rate scenarios, the effective interest expense using a participating cap would be higher than a nonparticipating cap owing to the participation feature. However, in bearish interest-rate scenarios, the effective interest cost of the floating-rate liability would be higher for a nonparticipating cap owing to the annualized cost of the upfront premium. An illustration of the effective interest costs using both hedging alternatives is presented in Exhibit 56-3.

Other participating instruments, also known as *participating swaps,* combine the analytical elements of interest-rate swaps and caps to create a hedge for floating-rate liability costs. In a participating cap structure, the firm uses interest-rate swaps to convert the floating liability rate to a fixed rate and uses caps to create a maximum upper limit on the remainder of the interest expense of the floating-rate

EXHIBIT 56–3

Effective Interest Expense for Participating Cap



liability. However, what distinguishes this structure is that the caps are purchased without paying an upfront fee. The purchase is funded by executing the swap (fixed-rate payer/floating-rate receiver) at an off-market rate involving a higher spread than the current market rate for equivalent maturity swaps. Such participations can be structured in one of the following ways:

- The buyer decides the maximum rate on the floating-rate liability, which leads to the problem of determining the mixture of notional amounts of caps and swaps.
- The buyer decides on the relative mix of swaps and caps, which leads to the problem of determining the maximum rate level that can be attained with this combination.

Regardless of the choice by the buyer, the following relationship should hold in this type of participating structure:

$$\begin{aligned}&(\text{Present value of annuity at } r_o - r_m,\ t) \times (\%\text{ of swap})\\ &\quad = \text{cap premium} \times (\%\text{ of cap})\end{aligned}$$

or

$$\begin{aligned}&(\text{Present value of annuity at } r_o - r_m,\ t) \times (\%\text{ of swap})\\ &\quad = \text{cap premium} \times (1 - \%\text{ of swap})\end{aligned}$$

or

$$\%\text{ of cap} = \frac{\text{present value of annuity at } r_o - r_m,\ t}{\text{cap premium} + \text{present value of annuity at } r_o - r_m,\ t}$$

where

r_m = current market swap fixed rate for t periods
r_o = off-market swap fixed rate for t periods

As an example, consider the case of an institution desiring to cap a floating-rate liability expense that floats at a spread of 10 basis points over three-month LIBOR at a maximum rate of around 10% for a period of five years using this type of participating cap structure. The current market rate on a five-year pay-fixed and receive-floating (three-month LIBOR) swap is 80 basis points over the five-year Treasury yield at a rate of 9.40%. The current level of LIBOR is 9% and off-market five-year swaps are priced at a fixed rate of 10%. The cap premium for a five-year cap indexed off three-month LIBOR at a strike rate of 10% is 200 basis points, or 2% of notional amount.

The value of the annuity for five years is the difference between the off-market and the current market swap rate (that is, 10% – 9.40% = 0.60%). The present value of this annuity for five years at a discount rate of 9.4% (current swap rate) is 2.37185%. Therefore, using the preceding equation for participating structures, the amount of the caps is defined as [2.37185/(2.37185 + 2.0000)] = 54%. Hence the amount of swaps is (1 – 0.54) = 0.46, or 46%. Using

EXHIBIT 56–4

Effective Interest Expenses Using Participating Cap Structure

LIBOR	Unhedged	Capped-Rate 54% Caps	Synthetic Fixed-Rate 46% Swaps	Blended Rate
11.0%	11.10%	10.10%	10.00%	10.046%
9.0	9.10	10.10	9.00	9.506
7.0	7.10	10.10	7.00	8.426

this structure, the effective liability expense in various interest-rate scenarios is presented in Exhibit 56–4. In this example, the synthetic fixed rate using swaps is based on the higher off-market rate, whereas the blended rate is determined as a weighted average of the cap and the swap fixed rate.

In bullish interest-rate scenarios, the blended rate is higher than the unhedged expense owing to the existence of the swap. The full benefit of the fall in rates is attained only partially by the portion of the liability mix that is capped. As interest rates increase, the blended rate is also higher than current market swaps owing to the existence of the higher-priced off-market swap that is used to fund the cap premium.

INTEREST-RATE FLOORS

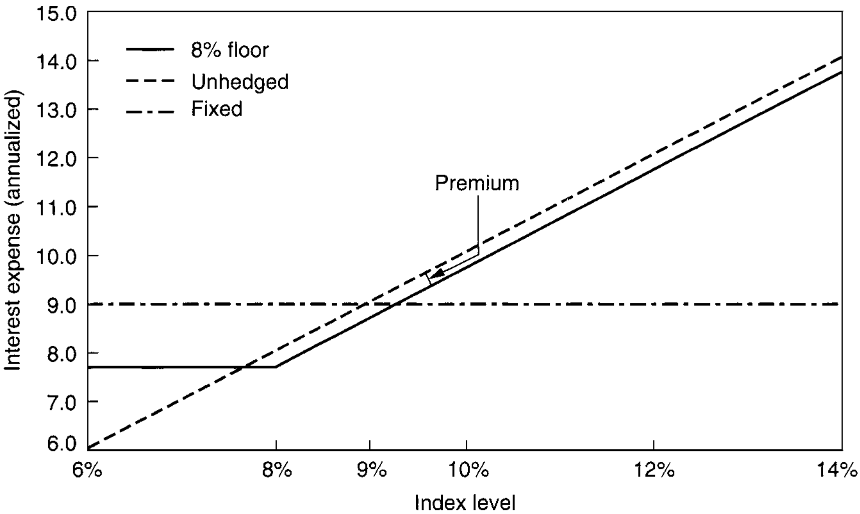
Interest-rate floors are used to protect the overall rate of return associated with a floating-rate asset. As an example, consider the case of a financial institution that owns adjustable-rate mortgages in its portfolio. In the event that interest rates decrease, the coupon payments on floating-rate assets will be lower because the repricing of variable-coupon assets is based on a floating-rate index. In order to protect the asset rate of return in bullish interest-rate scenarios, the firm could purchase an interest-rate floor. Analogous to caps, the protective features of a floor can be customized by choosing various attributes of interest-rate protection.

As an illustration, consider the following interest-rate floor purchased by an institution to protect the return on Treasury bill–indexed floating-rate assets:

Notional amount:	$10,000,000
Underlying index:	Three-month Treasury bill
Maturity:	Three years
Floor strike level:	8%
Premium:	85 basis points or 0.85% of $10,000,000 = $85,000
Settlement frequency:	Quarterly
Day count:	Actual/360

EXHIBIT 56–5

Effective Return of a Floored Asset



The cash-flow dynamics of interest-rate floors are opposite to those of interest-rate caps, as illustrated in Exhibit 56–5. As can be seen in this illustration, a floor is beneficial in bullish interest-rate scenarios. Hence, purchasing a floor is analogous to buying a strip of call options. In bearish interest-rate scenarios, the floating-rate asset earns returns constrained only by the contractual features of such instruments (if any), such as embedded caps. However, the asset return is reduced marginally by the amortization of the floor premium. In bullish interest-rate scenarios, where the asset returns are subject to erosion, the seller of the floor pays the buyer the difference between the strike rate of the floor and the value of the underlying index, adjusted for the days in the settlement period to compensate for the loss in asset coupon.

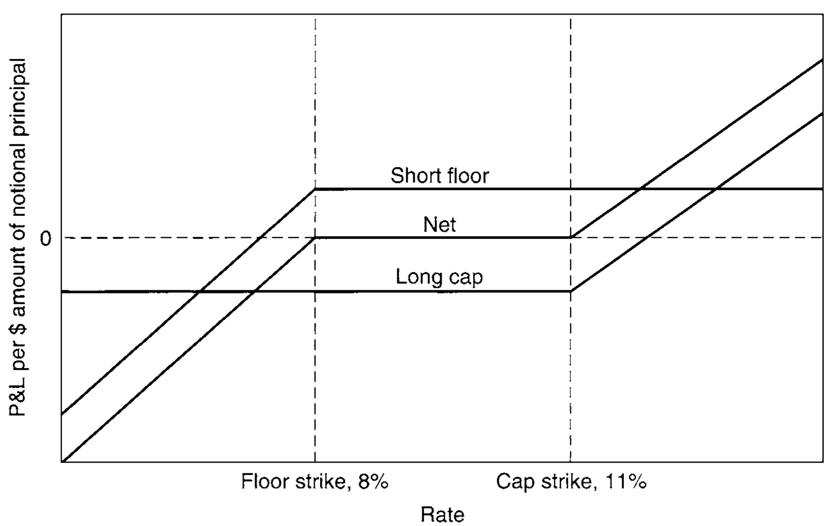
INTEREST-RATE COLLARS

Interest-rate collars involve the purchase of a cap to hedge a floating-rate liability at a higher strike rate and the sale of a floor at a lower strike rate to offset the cost of purchasing the cap. If the underlying index rate exceeds the capped rate on the reference date, the seller of the cap pays the firm the amount above the capped rate; if the market rate is less than the floor strike rate, the firm pays the buyer the difference between the floor rate and the index level. If the market rate is between the strike rate of the cap and the strike rate of the floor, the effective interest costs of the firm are normal floating-rate funding costs plus the amortized cap premium (outflow) less the amortized floor premium (inflow). The net effect of this strategy is to limit the coupon rate of the floating-rate liability between the floor strike rate and the cap strike rate. The coupon liability rate is adjusted by the net amount of the amortized cap premium paid and the amortized floor premium received to determine the effective interest cost.

For example, assume that a firm has floating-rate liabilities that are indexed at three-month LIBOR. In order to cap this floating-rate liability for one year, the firm purchases an interest-rate floor at a strike rate of 11% for a premium of 85 basis points. In order to offset this cost, the firm sells a floor at a strike rate of 8% for a premium of 60 basis points. The profit and loss profile of this strategy is presented in Exhibit 56–6. As interest rates rise above the cap strike rate, the firm receives cash flows from the seller of the cap offsetting the higher outflow on the floating-rate liability. As interest rates fall below the floor strike rate, the falling interest expenses associated with the floating-rate liability are offset by the cash outflows to the buyer of the floor. In interest-rate scenarios between the floor and cap strike rate, there are no cash outflows or inflows associated with the hedges. This results in interest expenses associated with the floating-rate liability equal to normal borrowing costs. However, effective interest costs will be slightly higher to account for the net cap less floor premium, unless the collar is structured with a zero premium. In zero premium collars, the idea is to equate the premium paid for the premium received. However, this strategy could be potentially risky as a higher notional amount may have to be sold to equate the premia. In view of this consideration, the short side of the zero premium strategy involves notional amounts greater than the notional amount of the long side of the strategy.

EXHIBIT 56–6

Interest-Rate Collar



The main benefit from an interest-rate collar is that the firm obtains protection from interest-rate increases at a considerably lower cost than with the purchase of a cap. However, in return for the benefit of lower-cost interest-rate protection, the firm gives up the benefit from market rallies below the floor strike rate. Because the interest-rate protection is obtained without fixing rates, interest-rate collars are sometimes also described as *swapping into a bond.* However, this is an inefficient form of creating a collar because of the bid-ask volatility spread[2] associated with the structure. Given that the strategy involves buying a cap and selling a floor, the premium paid for the cap is based on a higher offer volatility, whereas the premium received for the floor is based on a lower bid volatility.

INTEREST-RATE CORRIDORS

An alternative strategy to reduce the cost of the cap premium is to buy a cap at a particular strike rate and sell a cap at a higher strike rate, reducing the cost of the lower strike cap and hedging the interest expense of a floating-rate liability. In contrast to an interest-rate collar, the firm maintains all the benefit of falling interest rates, because there is no sale of a floor. As long as rates are below the strike rate of the lower strike cap, the effective interest expense of the firm is limited to normal borrowing cost plus the amortized net cap premium. As interest rates increase above the lower strike rate, the interest cost to the firm is capped until market rates are above the higher strike cap. As interest rates rise above the strike rate of the second cap, interest costs increase by the amount of the outflow of the cap.

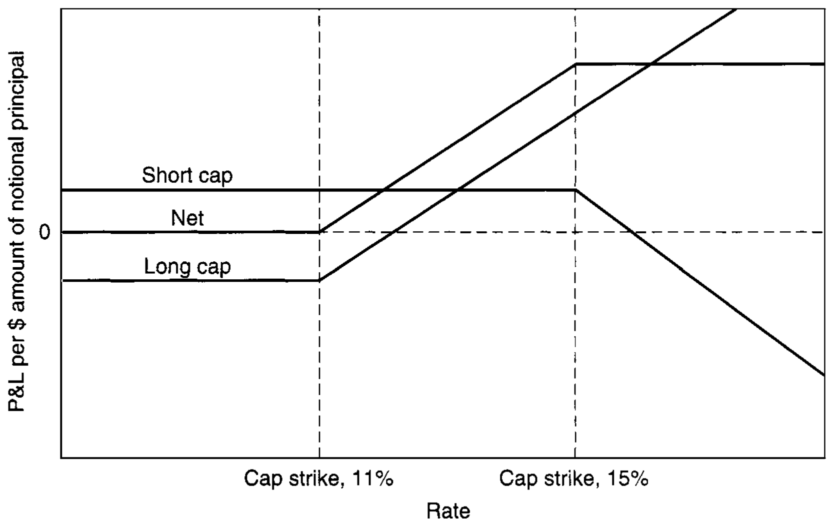
As an illustration, consider the case of a firm that purchases a cap at a strike rate of 11% and sells a cap at a strike rate of 15% to offset the cost of the first cap. The profit and loss profile of this strategy is presented in Exhibit 56–7. At market rates below 11%, the caps are out of the money, and the firm's effective interest cost floats at normal borrowing costs plus the net amortized cap premium. As interest rates increase above 11%, the first cap is in the money and starts paying cash flows to the firm to offset the higher coupon associated with the floating-rate liability. This allows the firm to cap the effective interest expense at a rate of 11% plus the net amortized cap premium. However, at rates higher than 15%, the second cap becomes in the money, and the firm has to start paying cash flows to the cap buyer. The net effect of this development is to increase the liability costs by the amount of cash outflows associated with the second cap.

Although interest-rate collars allow the firm to offset the cost of capping floating-rate liabilities, a word of caution is in order, especially if the caps are struck under the auspices of a zero-premium strategy. Cap premiums are determined by principles of option pricing theory; consequently, the premium received for a 15% cap will be less than the premium paid for the 11% cap because of the higher strike rate and bid-offer volatility spreads. Therefore, in a zero-premium strategy, to

2. See the discussion on termination of caps and floors later in this chapter.

EXHIBIT 56–7

Interest-Rate Corridor



equate the premium received for the higher strike cap to that paid for the lower strike cap, the notional amount of caps sold must be larger than the notional amount of caps purchased. Although this allows the firm to cap the liability rate at zero cost up to the strike rate of 15%, the firm is exposed to tremendous risk in a high-interest-rate, or "doomsday," scenario. As market interest rates increase to over 15%, the cash outflows paid to the buyer of the higher-strike cap may negate any cash flows received from the lower-strike cap and result in much higher interest costs than the lower-strike cap rate. The extent of this offsetting effect will be an inverse function of the ratio of the notional amount of higher-strike to lower-strike caps—the greater this ratio, the smaller will be the effect of the cash inflows of the lower-strike cap and the higher will be the effective interest cost.

CAP/FLOOR PARITY

Similar to put/call parity for options, which essentially specifies the relationship between these types of options and the price of the underlying security, caps and floors are related to interest-rate swaps. As an example, consider a strategy that involves buying a cap at 9.50% and selling a floor at 9.50%, both based off the same index, for example, LIBOR. This is equivalent to entering into an interest-rate swap, paying fixed at 9.5%, and receiving floating payments based on LIBOR. If interest rates increase to above the cap level, say 11%, the cap will pay 1.5%. At the same level, the holder of the swap will receive LIBOR at 11%. This translates into a positive cash flow of the difference between LIBOR and the fixed rate of the swap, that is, 11% − 9.5% = 1.5%. If interest rates decrease to below the floor level, say 7.5%, the holder of the floor pays the difference between the index and the floor strike rate, that is, 9.5% − 7.5% = 2%. At the same level, the swap holder loses the difference between the swap fixed rate and LIBOR, that is, 2%. Therefore, the cap/floor swap parity may be stated as

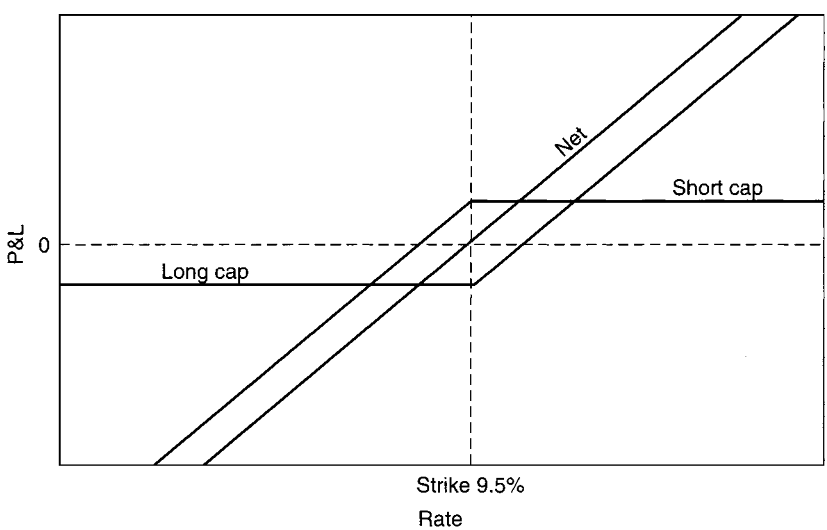
Long cap + short floor = fixed swap

However, for cap/floor swap parity to hold, the fixed rate of the swap should be paid on the same basis (actual/360 days, 30/360 days, or actual/365 days) as the floating rate, not a varying basis on the two rates. A graphic illustration of cap/floor swap parity is presented in Exhibit 56–8.

The cost of a market swap is zero because no premium cash flows are exchanged at inception. Therefore, using cap/floor swap parity, the cost of a cap should be the same as the cost of a floor struck at the same rate on an identical index. This relationship should hold irrespective of the pricing model used to value the caps and floors. Unless this relationship is true at every point, an arbitrage exists in these markets that could be used to emulate the characteristics of the overpriced instrument. For instance, if caps are overpriced, a synthetic cap could be created by buying a floor and entering into an interest-rate swap, paying fixed at the floor strike rate and receiving floating using the same underlying index as the floor. Such arbitrage possibilities due to deviation from cap/floor swap parity also ensure efficient pricing in these markets.

EXHIBIT 56–8

Synthetic Swap Cap/Floor Swap Parity



TERMINATION OF CAPS AND FLOORS

As is apparent from the discussion on the characteristics of caps (floors), these instruments are essentially a strip of put (call) options on forward interest rates. Hence caps and floors are priced using the same theoretical and analytical concepts involved in pricing options. The termination value of caps and floors can be determined using concepts similar to those involved in determining the market value of options (premium) prior to expiration; in interest-rate swaps, where the termination of swaps is based on the bid-ask spread to the Treasury yield, the bid-ask spread for caps and floors is stated in terms of volatility. On a practical basis, this is a much "cleaner" method of determining bid-ask spreads in the cap and floor market than deriving forward curves using bid and ask yield spreads. In order to compensate the financial intermediary for the market-making function, the offer volatility is higher than the bid volatility. Because option premiums are directly related to volatility, the difference between the offer premium and bid premium for either a cap or floor prior to maturity will be directly related to the magnitude of the spread between bid and offer volatility.

COMPOUND OPTIONS

Interest-rate protection provided by conventional options, such as puts and calls, and derivative optionlike instruments, such as caps and floors, extends over a specified period of time. During this time period, the option may be either "exercised," terminated prior to maturity, or allowed to expire worthless. The exercise (or lack thereof) is triggered by movements either in the price of the underlying security (as in the case of debt options) or in the underlying index (as in the case of caps and floors). However, any termination of the optional contract prior to maturity is incurred at the expense of the bid-offer spread. Given that swaps, caps, and floors are usually longer in maturity than conventional put and call options, termination costs are likely to be higher for such instruments. Additionally, the interest-rate protection provided by swaps, caps, and floors falls more in the category of passive hedging because, with the exception of the exchange of cash flows, there is no ongoing active management of the hedge.

For a shorter time horizon where the holding (outstanding) period of the asset (liability) is subject to change, firms can use interest-rate debt options. Such options can be used to manage asset/liability spreads or offset short-term opportunity losses associated with long-term interest-rate protection instruments. For instance, in rising interest-rate scenarios, where liability costs rise more quickly than the return on assets or the return on assets is fixed, put options can be used to offset the erosion in spread. The benefit of falling rates is still maintained as the loss on puts is limited to the upfront premium. Entities paying fixed in an interest-rate swap would be able to offset the opportunity loss in falling-rate scenarios by purchasing calls on Treasuries. In recent years, an important innovation known as *compound options* or *split-fee options* has allowed investors to limit losses of such short-term option strategies by permitting them to assess market conditions before purchasing additional optional coverage.

Compound options, which are essentially options on options, allow the firm to purchase a window on the market by paying a premium that is less than the premium on a conventional option on the same underlying instrument. The optional coverage can be extended at expiration of the window period by paying another premium. In essence, compound options provide an additional element of risk management by providing the opportunity to further limit downside losses associated with asymmetric coverage without sacrificing the essential ingredients of optional coverage.

Compound options allow the investor to purchase an option to exercise another option by paying a fee known as the *upfront premium* for a specified period of time. At the end of this period, known as the *window date,* the investor may exercise the option on the option by paying another fee known as the *back-end fee.* Therefore, the label *split-fee* stems from the dichotomous nature of the fees paid for the combined option. Split-fee options also have been labeled *up and on* options; this terminology refers to the upfront fee and the back-end fee paid on the window date.

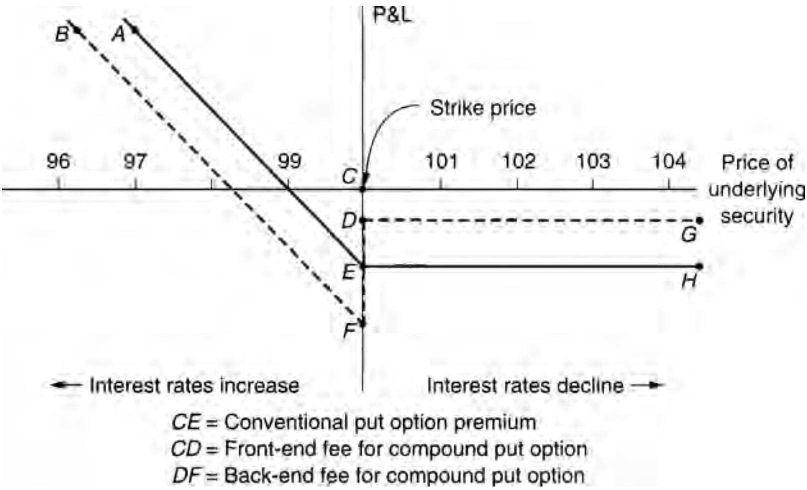
Comparison with Conventional Option Strategies

Compound options offer several advantages over conventional options, such as additional leverage and greater risk-management capabilities. This point is illustrated by contrasting the coverage provided by compound puts and calls with conventional options. The graphic representation of the profit profile of a long put versus a compound put is illustrated in Exhibit 56–9. As indicated in the graph, the net profit profile of a long put is the standard textbook representation. As interest rates decline, causing increases in the value of the underlying security, the losses associated with the purchase of an at-the-money conventional put are limited to the upfront premium (*CE*). As interest rates increase, resulting in a fall in the price of the underlying security, the option can be exercised and the underlying security sold at the higher strike price. The net profit from exercising the option is the difference between the strike price and the value of the underlying security less the cost of the option. The net profit profile of the conventional put option in bullish and bearish interest-rate scenarios is denoted by *HEA*.

However, with the compound put option, the same degree of protection afforded by the conventional put is available in bullish interest-rate scenarios at a much lower cost, as indicated by the upfront premium of *CD* in Exhibit 56–9. In the event that interest rates continue to decline, the compound option can be allowed to expire unexercised. On the other hand, if interest rates are expected to increase, the optional coverage can be extended by exercising the second leg of the compound option. The total profit from the exercise of the compound option may be less than that obtained from exercising the conventional put if the sum of the upfront fee and the back-end fee is greater than the upfront put premium.

EXHIBIT 56–9

Long Put versus Split-Fee Option



In the event that the compound option is not exercised at the window date, the profit profile of the split-fee option strategy will be discontinuous, as indicated by *GD* in the graph. If the back-end fee is paid and the option exercised on the window date, the profit profile of the compound put is *HEFB.*

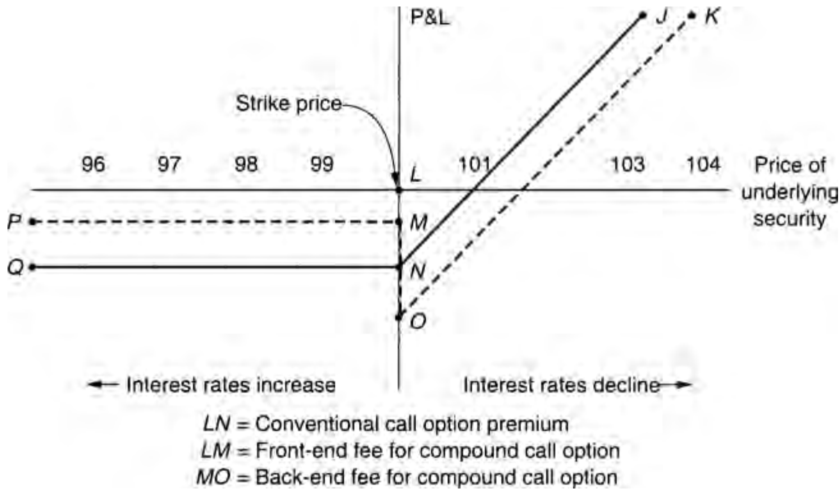
Portfolio managers frequently will purchase call options to profit from impending bullish changes in the market. The rationale underlying this strategy is based on the expectation that if interest rates decline, leading to an increase in the price of the underlying security, the portfolio manager will be able to purchase the asset at the lower strike price. The profit profile of this conventional call option is compared with that of a compound call in Exhibit 56–10. As indicated in the illustration, if interest rates remain unchanged or increase, the losses of a conventional call strategy are limited to the upfront call premium. The profit profile of the call is labeled *QNJ* in the graph; the call strategy is profitable in bullish interest-rate scenarios. In bearish interest-rate scenarios, the use of split-fee options results in losses lower than those associated with the conventional call strategy because of the lower upfront premium. However, if at the window date interest rates are lower, resulting in the exercise of the compound option, the profit profile of the compound call is denoted by *PMOK.* If the compound call is not exercised, the profit profile of the split-fee option will be denoted by *PM.*

Uses of Compound Options

Compound options have been used mainly to hedge mortgage pipeline risk, especially the risk of applicants seeking alternative sources of financing or canceling the

EXHIBIT 56–10

Long Call versus Split-Fee Option



loan. This risk, known as *fallout risk,* is usually hedged by purchasing put options. The ramifications of fallout risk are especially severe if the expected mortgage production has already been sold forward. If interest rates fall and mortgage loans fall out of the pipeline, the mortgage lender can let the option expire unexercised. On the other hand, if rates increase, the lender can participate in the upside movement of the market by selling originated loans at the higher put strike price. With a compound put option, the mortgage lender can obtain the same optional protection at a much lower cost and retain the flexibility of extending the protection after assessing market conditions. If at the window date there is no need for put protection, the loss is lower than that of the premium of a conventional put. On the other hand, if additional protection is required, it can be purchased by either extending the compound option or by purchasing a conventional put option. For instance, it is possible that if forward market prices are higher (lower) on the window date, the purchase of a put (call) may be cheaper than exercising the option on the option.

Portfolios using active call-buying programs as yield-enhancement vehicles may purchase compound calls when there is uncertainty regarding an impending fall in interest rates. Instead of purchasing a higher-premium conventional call, the compound call allows the portfolio manager to purchase a window on the market for a lower cost. At the window date, if there is a greater degree of certainty regarding bullish market conditions, the compound options can be extended. However, if the degree of uncertainty increases, the loss is limited to the lower upfront premium.

Compound options, such as calls, also can be used in conjunction with longer-term instruments, such as fixed interest-rate swaps, to offset short-term opportunity losses caused by a fall in interest rates. However, perhaps the largest potential use of compound option technology lies in the application of these concepts to the cap and floor market in designing long-term options on options. Recall that caps (floors) are essentially a package of European puts (calls) on forward interest rates. The market for options on caps and floors, which allow the buyer to either cancel or initiate customized interest-rate protection, is still fairly undeveloped, but the potential uses of such instruments are enormous. As with any optional coverage, the development of such options on a series of options will add another element of flexibility provided by customized risk-management instruments.

CONCLUDING COMMENTS

Swaps, floors, and compound options are customized risk-management instruments. Whereas interest-rate swaps are intended to insulate the user from changes in interest-rate volatility, caps and floors are designed to provide asymmetric coverage in capping liability costs and protecting the rate of return on assets. In either case, the user retains the right to participate in upside movements of the market. In order to reduce the upfront cost of purchasing caps and floors, the user can either enter into participating agreements that involve giving up a proportional share of beneficial market moves or enter into agreements, such as collars and corridors, that are analogous to option spread strategies.

Because the termination of such agreements involves exit costs, these instruments may prove beneficial for passive hedging where interest-rate protection is desired for longer periods of time. By the same token, these agreements also should not be used if the holding period of either the asset or liability is flexible or subject to change. For shorter periods of time, the user may decide to use split-fee options, which provide greater leverage and risk-management capabilities similar to conventional options, although contemporary use of splitfee options has been mainly in mortgage pipeline hedging. However, compound option technology can be applied readily to develop options on caps and floors, thereby adding an additional element of flexibility for these instruments in designing customized interest-rate protection.

CHAPTER
FIFTY-SEVEN

CONTROLLING INTEREST-RATE RISK WITH FUTURES AND OPTIONS

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In Chapter 51 the features and characteristics of interest-rate futures and options were explained. In this chapter, our focus is on how these derivative instruments can be used to control the interest-rate risk of a portfolio.

CONTROLLING INTEREST-RATE RISK WITH FUTURES

The price of an interest-rate futures contract moves in the opposite direction from the change in interest rates: when rates rise, the futures price will fall; when rates fall, the futures price will rise. By buying a futures contract, a portfolio's exposure to a rate increase is increased. That is, the portfolio's duration increases. By selling a futures contract, a portfolio's exposure to a rate increase is decreased. Equivalently, this means that the portfolio's duration is reduced. Consequently, buying and selling futures can be used to alter the duration of a portfolio.

While managers can alter the duration of their portfolios with cash-market instruments (buying or selling Treasury securities), using interest-rate futures

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instead of trading long-term Treasuries themselves has the following three advantages:

Advantage 1: Transaction costs for trading futures are lower than trading in the cash market.

Advantage 2: Margin requirements are lower for futures than for Treasury securities; using futures thus permits greater leverage.

Advantage 3: It is easier to sell short in the futures market than in the Treasury market.

Futures also can be used in constructing a portfolio with a longer duration than is available with cash-market securities. For example, suppose that in a certain interest-rate environment a pension fund manager must structure a portfolio to have a duration of 15 to accomplish a particular investment objective. Bonds with such a long duration may not be available. By buying the appropriate number and kind of interest-rate futures contracts, a pension fund manager can increase the portfolio's duration to the target level of 15.

General Principles of Interest-Rate Risk Control

The general principle in controlling interest-rate risk with futures is to combine the dollar exposure of the current portfolio and the dollar exposure of a futures position so that the total dollar exposure is equal to the target dollar exposure. This means that the manager must be able to accurately measure the dollar exposure of both the current portfolio and the futures contract employed to alter the exposure.

There are two commonly used measures for approximating the change in the dollar value of a bond or bond portfolio to changes in interest rates: price value of a basis point (PVBP) and duration. PVBP is the dollar price change resulting from a 1 basis point change in yield. Duration is the approximate percentage change in price for a 100 basis point change in rates. (Given the percentage price change, the dollar price change for a given change in interest rates can be computed.) There are two measures of duration: *modified* and *effective*. Effective duration is the appropriate measure that should be used for bonds with embedded options. In this chapter when we refer to duration, we mean effective duration. Moreover, since the manager is interested in dollar price exposure, it is the effective *dollar* duration that should be used. For a 1 basis point change in rates, PVBP is equal to the effective dollar duration for a 1 basis point change in rates.

To estimate the effective dollar duration, it is necessary to have a good valuation model. It is the valuation model that is used to determine what the new values for the bonds in the portfolio will be if rates change. The difference between the current values of the bonds in the portfolio and the new values estimated by the valuation model when rates are changed is the dollar price exposure. Consequently, the starting point in controlling interest-rate risk is the development of a reliable valuation model. A reliable valuation model also is needed to value the derivative contracts that the manager wants to use to control interest-rate exposure.

Suppose that a manager seeks a *target duration* for the portfolio based on either expectations of interest rates or client-specified exposure. Given the target duration, a target dollar duration for a small basis point change in interest rates can be obtained. For a 50 basis point change in interest rates, for example, the target dollar duration can be found by multiplying the dollar value of the portfolio by the target duration and then dividing by 200. For example, suppose that the manager of a $500 million portfolio wants a target duration of 6. This means that the manager seeks a 3% change in the value of the portfolio for a 50 basis point change in rates (assuming a parallel shift in rates of all maturities). Multiplying the target duration of 6 by $500 million and dividing by 200 gives a target dollar duration of $15 million.

The manager then must determine the dollar duration of the current portfolio. The current dollar duration for a 50 basis point change in interest rates is found by multiplying the current duration by the dollar value of the portfolio and dividing by 200. Thus, for our $500 million portfolio, suppose that the current duration is 4. The current dollar duration is then $10 million (4 times $500 million divided by 200).

The target dollar duration is then compared with the current dollar duration. The difference between the two dollar durations is the dollar exposure that must be provided by a position in the futures contract. If the target dollar duration exceeds the current dollar duration, a futures position must increase the dollar exposure by the difference. To increase the dollar exposure, an appropriate number of futures contracts must be purchased. If the target dollar duration is less than the current dollar duration, an appropriate number of futures contracts must be sold. That is,

$$\text{If target dollar duration} - \text{current dollar duration} > 0, \text{ buy futures}$$

$$\text{If target dollar duration} - \text{current dollar duration} < 0, \text{ sell futures}$$

Once a futures position is taken, the *portfolio's dollar duration* is equal to the *current dollar duration without futures* plus the *dollar duration of the futures position*. That is,

$$\begin{aligned}\text{Portfolio's dollar return} = {} & \text{current dollar duration without futures} \\ & + \text{dollar duration of futures position}\end{aligned}$$

The objective is to control the portfolio's interest-rate risk by establishing a futures position such that the portfolio's dollar duration is equal to the target dollar duration. Thus

$$\text{Portfolio's dollar duration} = \text{target dollar duration}$$

Or equivalently,

$$\begin{aligned}\text{Target dollar duration} = {} & \text{current dollar duration without futures} \\ & + \text{dollar duration of futures position}\end{aligned} \qquad (57\text{–}1)$$

Over time, the portfolio's dollar duration will move away from the target dollar duration. The manager can alter the futures position to adjust the portfolio's dollar duration to the target dollar duration.

Determining the Number of Contracts

Each futures contract calls for delivery of a specified amount of the underlying instrument. When interest rates change, the value of the underlying instrument changes, and therefore, the value of the futures contract changes. How much the futures dollar value will change when interest rates change must be estimated. This amount is called the *dollar duration per futures contract*. For example, suppose that the futures price of an interest-rate futures contract is 70 and that the underlying interest-rate instrument has a par value of $100,000. Thus the futures delivery price is $70,000 (0.70 times $100,000). Suppose that a change in interest rates of 50 basis points results in the futures price changing by about $0.03 per contract. Then the dollar duration per futures contract is $2,100 (0.03 times $70,000).

The dollar duration of a futures position is then the number of futures contracts multiplied by the dollar duration per futures contract. That is,

$$\begin{aligned}&\text{Dollar duration of futures position}\\&\quad = \text{number of futures contracts} \times \text{dollar duration per futures contract} \qquad (57\text{–}2)\end{aligned}$$

How many futures contracts are needed to obtain the target dollar duration? Substituting Eq. (57–2) into Eq. (57–1), we get

$$\begin{aligned}&\text{Number of futures contracts} \times \text{dollar duration per futures contract}\\&\quad = \text{target dollar duration} - \text{current dollar duration without futures} \qquad (57\text{–}3)\end{aligned}$$

Solving for the number of futures contracts, we have

$$\begin{aligned}&\text{Number of futures contracts}\\&\quad = \frac{\text{target dollar duration} - \text{current dollar duration without futures}}{\text{dollar duration per futures more contract}} \qquad (57\text{–}4)\end{aligned}$$

Equation (57–4) gives the approximate number of futures contracts that are necessary to adjust the portfolio's dollar duration to the target dollar duration. A positive number means that the futures contract must be purchased; a negative number means that the futures contract must be sold. Notice that if the target dollar duration is greater than the current dollar duration without futures, the numerator is positive, and therefore, futures contracts are purchased. If the target dollar duration is less than the current dollar duration without futures, the numerator is negative, and therefore, futures contracts are sold.

Dollar Duration for a Futures Position

Now we turn to how to measure the dollar duration of a bond futures position. Keep in mind what the goal is: it is to measure the sensitivity of a bond futures position to changes in rates.

The general methodology for computing the dollar duration of a futures position for a given change in interest rates is straightforward given a valuation model. The procedure is the same as for computing the dollar duration of any cash-market instrument—shock (change) interest rates up and down by the same number of basis points and determine the average dollar price change.

An adjustment is needed for the Treasury bond and note futures contracts. The pricing of the futures contract depends on the cheapest-to-deliver (CTD) issue.[1] Calculation of the dollar duration of a Treasury bond or note futures contract requires determining the impact of a change in interest rates will have on the price of a futures contract, which, in turn, affects how the futures price will change. The dollar duration of a Treasury bond and note futures contract is determined as follows:

$$\text{Dollar duration of futures contract} = \text{dollar duration of the CTD issue} \times \frac{\text{dollar duration of futures contract}}{\text{dollar duration of the CTD issue}}$$

There is a conversion factor for each issue that is acceptable for delivery for the futures contract. The conversion factor makes deliverable equitable to both the buyer and seller of the futures contract. For each deliverable issue, the product of the futures price and the conversion factor is the adjusted futures price for the issue. This adjusted price is called the *converted price*. Relating this to the preceding equation, the second ratio is approximately equal to the conversion factor of the cheapest-to-deliver issue. Thus we can write

$$\text{Dollar duration of futures contract} = \text{dollar duration of the CTD issue} \times \text{conversion factor for the CTD issue}$$

Why did we focus on dollar duration rather than duration? Recall that duration is the approximate percentage change in price. But what is the price of this leveraged instrument? The investor does not put up the full price of the position in order to acquire the position. Only the initial margin need be made in cash or a cash equivalent. Consequently, what is the base investment made by the investor? Rather than debate what should be used as the base investment in order to compute duration, let's simply ask why we are interested in calculating the exposure to changes in rates. As we have emphasized, it is to determine how a futures position will alter the exposure of a portfolio to changes in rates. Once we know how a futures position changes the dollar duration of a portfolio, we can determine for a portfolio its dollar duration. Given the funds invested by the investor in the portfolio, the portfolio's duration can be computed.

1. The cheapest-to-deliver issue is the one issue from among all those that are deliverable to satisfy a contract that has the highest return in a cash and carry trade. This return is called the *implied repo rate*.

Hedging with Interest-Rate Futures

Hedging with futures calls for taking a futures position as a temporary substitute for transactions to be made in the cash market at a later date. If cash and futures prices move together, any loss realized by the hedger from one position (whether cash or futures) will be offset by a profit on the other position. *Hedging is a special case of controlling interest-rate risk. In a hedge, the manager seeks a target duration or target dollar duration of zero.*

A *short hedge* (or *sell hedge*) is used to protect against a decline in the cash price of a bond. To execute a short hedge, futures contracts are sold. By establishing a short hedge, the manager has fixed the future cash price and transferred the price risk of ownership to the buyer of the futures contract. To understand why a short hedge might be executed, suppose that a pension fund manager knows that bonds must be liquidated in 40 days to make a $5 million payment to beneficiaries. If interest rates rise during the 40-day period, more bonds will have to be liquidated at a lower price than today to realize $5 million. To guard against this possibility, the manager can sell bonds in the futures market to lock in a selling price.

A *long hedge* (or *buy hedge*) is undertaken to protect against an increase in the cash price of a bond. In a long hedge, the manager buys a futures contract to lock in a purchase price. A pension fund manager might use a long hedge when substantial cash contributions are expected, and the manager is concerned that interest rates will fall. Also, a money manager who knows that bonds are maturing in the near future and expects that interest rates will fall can employ a long hedge to lock in a rate for the proceeds to be reinvested.

In bond portfolio management, typically the bond or portfolio to be hedged is not identical to the bond underlying the futures contract. This type of hedging is referred to as *cross-hedging*.

The hedging process can be broken down into four steps:

Step 1. Determining the appropriate hedging instrument

Step 2. Determining the target for the hedge

Step 3. Determining the position to be taken in the hedging instrument

Step 4. Monitoring and evaluating the hedge

We discuss each step below.

Determining the Appropriate Hedging Instrument

A primary factor in determining which futures contract will provide the best hedge is the degree of correlation between the rate on the futures contract and the interest rate that creates the underlying risk that the manager seeks to eliminate. For example, a long-term corporate bond portfolio can be better hedged with Treasury bond futures than with Treasury bill futures because long-term corporate bond rates are more highly correlated with Treasury bond futures than Treasury bill futures. Using the right delivery month is also important. A manager trying to lock in a rate or price for September will use September futures contracts because September futures contracts will give the highest degree of correlation.

Correlation is not, however, the only consideration if the hedging program is of significant size. If, for example, a manager wants to hedge $600 million of a cash position in a distant delivery month, liquidity becomes an important consideration. In such a case, it might be necessary for the manager to spread the hedge across two or more different contracts.

Determining the Target for the Hedge

Having determined the right contract and the right delivery months, the manager then should determine what is expected from the hedge—that is, what rate will, on average, be locked in by the hedge. This is the *target rate* or *target price.* If this target rate is too high (if hedging a future sale) or too low (if hedging a future purchase), hedging may not be the right strategy for dealing with the unwanted risk. Determining what is expected (calculating the target rate or price for a hedge) is not always simple. We'll see how a manager should approach this problem for both simple and complex hedges.

Risk and Expected Return in a Hedge. When a manager enters into a hedge, the objective is to "lock in" a rate for the sale or purchase of a security. However, there is much disagreement about what rate or price a manager should expect to lock in when futures are used to hedge. Here are the two views:

View 1. The manager can, on average, lock in the current spot rate for the security (i.e., current rate in the cash market).

View 2. The manager can, on average, lock in the rate at which the futures contracts are bought or sold.

The truth usually lies somewhere in between these two views. However, as the following cases illustrate, each view is entirely correct in certain situations.

The Target for Hedges Held to Delivery. Hedges that are held until the futures delivery date provide an example of a hedge that locks in the futures rate (i.e., the second view). The complication in the case of using Treasury bond futures and Treasury note futures to hedge the value of intermediate- and long-term bonds is that because of the delivery options the manager does not know for sure when delivery will take place or which bond will be delivered. This is because of the delivery options granted to the short.[2]

To illustrate how a Treasury bond futures held to the delivery date locks in the futures rate, assume for the sake of simplicity that the manager knows which Treasury bond will be delivered and that delivery will take place on the last day of the delivery month. Suppose that for delivery on the September 1999 futures

2. These delivery options are explained in Chapter 51.

contract, the conversion factor for a deliverable Treasury issue is 1.283, implying that the investor who delivers this issue would receive from the buyer 1.283 times the futures settlement price plus accrued interest. An important principle to remember is that at delivery, the spot price and the futures price times the conversion factor must converge. *Convergence* refers to the fact that at delivery there can be no discrepancy between the spot price and futures price for a given security. If convergence does not take place, arbitrageurs would buy at the lower price and sell at the higher price and earn risk-free profits. Accordingly, a manager could lock in a September 1999 sale price for this issue by selling Treasury bond futures contracts equal to 1.283 times the par value of the bonds. For example, $100 million face value of this issue would be hedged by selling $128.3 million face value of bond futures (1,283 contracts).

The sale price that the manager locks in would be 1.283 times the futures price. This is the converted price. Thus, if the futures price is 113 when the hedge is set, the manager locks in a sale price of 144.979 (113 times 1.283) for September 1999 delivery, regardless of where rates are in September 1999. Exhibit 57–1 shows the cash flows for a number of final prices for this issue and illustrates how cash flows on the futures contracts offset gains or losses relative to the target price of 144.979.

Let's look at all the columns in Exhibit 57–1 and explain the computations for one of the scenarios—that is, for one actual sale price for the $11^{1}/_{4}$% Treasury bond. Consider the first actual sale price of 140. By convergence, at the delivery date the final futures price shown in column (2) must equal the Treasury bond's actual sale price adjusted by the conversion factor. Specifically, the adjustment is as follows. We know that

$$\text{Converted price} = \text{Treasury bond's price} \times \text{conversion factor}$$

and by convergence

$$\text{Final futures price} = \text{converted price}$$

so that

$$\text{Final futures price} = \text{Treasury bond's actual sale price} \times \text{conversion factor}$$

Thus, to compute the final futures price in column (2) of Exhibit 57–1 given the Treasury bond's actual sale price in column (1), the following is computed:

$$\text{Final futures price} = \frac{\text{Treasury bonds actual sale price}}{\text{conversion factor}}$$

Since the conversion factor is 1.283 for the $11^{1}/_{4}$% Treasury issue, for the first actual sale price of 140, the final futures price is

$$\text{Final futures price} = \frac{140}{1.283} = 109.1193$$

Column (3) shows the market value of the Treasury bonds. This is found by multiplying the actual sale price in column (1) by 100 to obtain the actual sale

EXHIBIT 57–1

Treasury Issue Hedge Held to Delivery

Instrument to be hedged: \$100 million 11¼% Treasury Bonds of 2/15/15
Conversion factor for September 1999 = 1.283
Price of futures contract when sold = 113
Target price = (1.283 × 113) = 144.979
Par value hedged = \$100,000,000
Number of futures contracts = 1,283
Futures position = Target = \$144,979,000

(1)	(2)	(3)	(4)	(5)	(6)
Actual Price for 11.25% T-Bonds	Final Futures Price*	Market Value of Treasury Bonds	Value of Futures Position†	Gain or Loss from Futures Position†	Effective Sale Price‡
140	109.1192518	140,000,000	140,000,000	4,979,000	144,979,000
141	109.898675	141,000,000	141,000,000	3,979,000	144,979,000
142	110.6780982	142,000,000	142,000,000	2,979,000	144,979,000
143	111.4575214	143,000,000	143,000,000	1,979,000	144,979,000
144	112.2369447	144,000,000	144,000,000	979,000	144,979,000
145	113.0163679	145,000,000	145,000,000	–21,000	144,979,000
146	113.7957911	146,000,000	146,000,000	–1,021,000	144,979,000
147	114.5752143	147,000,000	147,000,000	–2,021,000	144,979,000
148	115.3546376	148,000,000	148,000,000	–3,021,000	144,979,000
149	116.1340608	149,000,000	149,000,000	–4,021,000	144,979,000
150	116.913484	150,000,000	150,000,000	–5,021,000	144,979,000
151	117.6929072	151,000,000	151,000,000	–6,021,000	144,979,000
152	118.4723305	152,000,000	152,000,000	–7,021,000	144,979,000
153	119.2517537	153,000,000	153,000,000	–8,021,000	144,979,000
154	120.0311769	154,000,000	154,000,000	–9,021,000	144,979,000
155	120.8106002	155,000,000	155,000,000	–10,021,000	144,979,000

*By convergence, must equal bond price divided by the conversion factor.
†Bond futures trade in even increments of 1/32. Accordingly, the futures prices and margin flows are only approximate.
‡Transaction costs and the financing of margin flows are ignored.

price per \$1 of par value and then multiplying by the \$100 million par value. That is,

$$\text{Market value of Treasury bonds} = (\text{actual sale price}/100) \times \$100{,}000{,}000$$

For the actual sale price of 140, the value in column (3) is

$$\begin{aligned}\text{Market value of Treasury bonds} &= (140/100) \times \$100{,}000{,}000\\ &= \$140{,}000{,}000\end{aligned}$$

Column (4) shows the value of the futures position at the delivery date. This value is computed by first dividing the futures price shown in column (2) by

100 to obtain the futures price per $1 of par value. Then this value is multiplied by the par value per contract of $100,000 and further multiplied by the number of futures contracts. That is,

$$\text{Value of futures position} \\ = (\text{final futures price}/100) \times \$100{,}0000 \times \text{number of futures contracts}$$

In our illustration, the number of futures contracts is 1,283. For the actual sale price of the bond of 140, the final futures price is 109.1193. Thus, the value shown in column (4) is

$$\text{Value of futures position} = (109.1193/100) \times \$100{,}000 \times 113 \\ = \$140{,}000{,}062$$

The value shown in column (4) is $140,000,000 because the final futures price of 109.1193 was rounded. Using more decimal places, the value would be $140,000,000.

Now let's look at the gain or loss from the futures position. This value is shown in column (5). Recall that the futures contract was shorted. The futures price at which the contracts were sold was 113. Thus, if the final futures price exceeds 113, this means that there is a loss on the futures position—that is, the futures contract is purchased at a price greater than for which it was sold. In contrast, if the futures price is less than 113, this means that there is a gain on the futures position—that is, the futures contract is purchased at a price less than for which it was sold. The gain or loss is determined by the following formula:

$$(113/100 - \text{final futures price}/100) \times \$100{,}000 \times \text{number of futures contracts}$$

In our illustration, for a final futures price of 109.1193 and 1,283 futures contracts, we have

$$(113/100 - 109.1193/100) \times \$100{,}000 \times 1{,}283 = \$4{,}978{,}938.1$$

The value shown in column (5) is $4,979,000 because that is the more precise value using more decimal places for the final futures price than shown in Exhibit 57–1. The value is positive which means that there is a gain in the futures position. Note that for all the final futures prices above 113 in Exhibit 57–1, there is a negative value, which means that there is a loss on the futures position.

Finally, column (6) shows the effective sale price for the Treasury bond. This value is found as follows:

$$\text{Effective sale price for Treasury bond} \\ = \text{actual sale price of Treasury bond} + \text{gain or loss on futures position}$$

For the actual sale price of $140 million, the gain is $4,979,000. Therefore, the effective sale price for the Treasury bond is

$$\$140{,}000{,}000 + \$4{,}979{,}000 = \$144{,}979{,}000$$

Note that this is the target price for the Treasury bond. In fact, it can be seen from column (6) of Exhibit 57–1 that the effective sale price for all the actual sale prices for the Treasury bond is the target price. However, the target price is determined by the futures price, so the target price may be higher or lower than the cash (spot) market price when the hedge is set.

When we admit the possibility that bonds other than the deliverable issue used in our illustration can be delivered and that it might be advantageous to deliver other issues, the situation becomes somewhat more involved. In this more realistic case, the manager may decide not to deliver this issue, but if she does decide to deliver it, the manager is still assured of receiving an effective sale price of approximately 144.979. If the manager does not deliver this issue, it would be because another issue can be delivered more cheaply, and thus the manager does better than the targeted price.

In summary, if a manager establishes a futures hedge that is held until delivery, the manager can be assured of receiving an effective price dictated by the futures rate (not the spot rate) on the day the hedge is set.

The Target for Hedges with Short Holding Periods. When a manager must lift (remove) a hedge prior to the delivery date, the effective rate that is obtained is much more likely to approximate the current spot rate than the futures rate the shorter the term of the hedge. The critical difference between this hedge and the hedge held to the delivery date is that convergence generally will not take place by the termination date of the hedge.

To illustrate why a manager should expect the hedge to lock in the spot rate rather than the futures rate for very short-lived hedges, let's return to the simplified example used earlier to illustrate a hedge to the delivery date. It is assumed that this issue is the only deliverable Treasury bond for the Treasury bond futures contract. Suppose that the hedge is set three months before the delivery date, and the manager plans to lift the hedge after one day. It is much more likely that the spot price of the bond will move parallel to the converted futures price (i.e., the futures price times the conversion factor) than that the spot price and the converted futures price will converge by the time the hedge is lifted.

A one-day hedge is, admittedly, an extreme example. Other than underwriters, dealers, and traders who reallocate assets very frequently, few money managers are interested in such a short horizon. The very short-term hedge does, however, illustrate a very important point: *when hedging, a manager should not expect to lock in the futures rate (or price) just because he is hedging with futures contracts*. The futures rate is locked in only if the hedge is held until delivery, at which point convergence must take place. If the hedge is held for only one day, the manager should expect to lock in the one-day forward rate,[3] which will very nearly equal the spot rate. Generally, hedges are held for more than one day but not necessarily to delivery.

3. Forward rates were covered in Chapters 7 and 8.

How the Basis Affects the Target Rate for a Hedge. The proper target for a hedge that is to be lifted prior to the delivery date depends on the basis. The *basis* is simply the difference between the spot (cash) price of a security and its futures price; that is:

Basis = spot price – futures price

In the bond market, a problem arises when trying to make practical use of the concept of the basis. The quoted futures price does not equal the price that one receives at delivery. For the Treasury bond and note futures contracts, the actual futures price equals the quoted futures price times the appropriate conversion factor. Consequently, to be useful, the basis in the bond market should be defined using actual futures delivery prices rather than quoted futures prices. Thus the price basis for bonds should be redefined as

Price basis = spot price – futures delivery price

For hedging purposes, it is also useful frequently to define the basis in terms of interest rates rather than prices. The *rate basis* is defined as

Rate basis = spot rate – futures rate

where spot rate refers to the current rate on the instrument to be hedged and the futures rate is the interest rate corresponding to the futures delivery price of the deliverable instrument.

The rate basis is helpful in explaining why the two views of hedges explained earlier are expected to lock in such different rates. To see this, we first define the *target rate basis*. This is defined as the expected rate basis on the day the hedge is lifted. A hedge lifted on the delivery date is expected to have, and by convergence will have, a zero rate basis when the hedge is lifted. Thus the target rate for the hedge should be the rate on the futures contract plus the expected rate basis of zero or, in other words, just the futures rate. When a hedge is lifted prior to the delivery date, one would not expect the basis to change very much in one day, so the target rate basis equals the futures rate plus the current difference between the spot rate and futures rate, that is, the current spot rate.

The manager can set the target rate for any hedge equal to the futures rate plus the target rate basis. That is,

Target rate for hedge = futures rate + target rate basis

If projecting the basis in terms of price rather than rate is more manageable (as is often the case for intermediate- and long-term futures), it is easier to work with the target price basis instead of the target rate basis. The *target price basis* is just the projected price basis for the day the hedge is to be lifted. For a deliverable security, the target for the hedge then becomes

Target price for hedge = futures delivery price + target price basis

The idea of a target price or rate basis explains why a hedge held until the delivery date locks in a price with certainty, and other hedges do not. The examples have shown that this is true. For the hedge held to delivery, there is no uncertainty surrounding the target basis; by convergence, the basis on the day the hedge is lifted is certain to be zero. For the short-lived hedge, the basis probably will approximate the current basis when the hedge is lifted, but its actual value is not known. For hedges longer than one day but ending prior to the futures delivery date, there can be considerable basis risk because the basis on the day the hedge is lifted can end up being anywhere within a wide range. Thus the uncertainty surrounding the outcome of a hedge is directly related to the uncertainty surrounding the basis on the day the hedge is lifted (i.e., the uncertainty surrounding the target basis).

The uncertainty about the value of the basis at the time the hedge is removed is called *basis risk*. For a given investment horizon, hedging substitutes basis risk for price risk. Thus one trades the uncertainty of the price of the hedged security for the uncertainty of the basis. Consequently, when hedges do not produce the desired results, it is customary to place the blame on basis risk. However, basis risk is the real culprit only if the target for the hedge is defined properly. Basis risk should refer only to the unexpected or unpredictable part of the relationship between cash and futures prices. The fact that this relationship changes over time does not in itself imply that there is basis risk.

Basis risk, properly defined, refers only to the uncertainty associated with the target rate basis or target price basis. Accordingly, it is imperative that the target basis be defined properly if one is to assess the risk and expected return in a hedge correctly.

Determining the Number of Futures Contracts

The final step that must be determined before the hedge is set is the number of futures contracts needed for the hedge. This is called the *hedge ratio*. Usually the hedge ratio is expressed in terms of relative par amounts. Accordingly, a hedge ratio of 1.20 means that for every $1 million par value of securities to be hedged, one needs $1.2 million par value of futures contracts to offset the risk. *In our discussion, the values are defined so that the hedge ratio is the number of futures contracts.*

Earlier we defined a cross-hedge in the futures market as a hedge in which the security to be hedged is not deliverable on the futures contract used in the hedge. For example, a manager who wants to hedge the sale price of long-term corporate bonds might hedge with the Treasury bond futures contract, but since non-Treasury bonds cannot be delivered in satisfaction of the contract, the hedge would be considered a cross-hedge. A manger also might want to hedge a rate that is of the same quality as the rate specified in one of the contracts but that has a different maturity. For example, it is necessary to cross-hedge a Treasury bond, note, or bill with a maturity that does not qualify for delivery on any futures contract. Thus, when the security to be hedged differs from the futures contract specification in terms of either quality or maturity, one is led to the cross-hedge.

Conceptually, cross-hedging is somewhat more complicated than hedging deliverable securities because it involves two relationships. First, there is the relationship between the cheapest-to-deliver (CTD) issue and the futures contract.

Second, there is the relationship between the security to be hedged and the CTD. Practical considerations at times may lead a manager to shortcut this two-step relationship and focus directly on the relationship between the security to be hedged and the futures contract, thus ignoring the CTD altogether. However, in so doing, a manager runs the risk of miscalculating the target rate and the risk in the hedge. Furthermore, if the hedge does not perform as expected, the shortcut makes it difficult to tell why the hedge did not work out as expected.

The key to minimizing risk in a cross-hedge is to choose the right number of futures contracts. This depends on the relative dollar duration of the bond to be hedged and the futures position. Equation (57–4) indicated the number of futures contracts to achieve a particular target dollar duration. The objective in hedging is to make the target dollar duration equal to zero. Substituting zero for target dollar duration in Eq. (57–4) we obtain

$$\text{Number of futures contracts} = -\frac{\text{current dollar duration without futures}}{\text{dollar duration per futures contract}} \qquad (57\text{–}5)$$

To calculate the dollar duration of a bond, the manager must know the precise point in time that the dollar duration is to be calculated (because volatility generally declines as a bond matures), as well as the price or yield at which to calculate dollar duration (because higher yields generally reduce dollar duration for a given yield change). The relevant point in the life of the bond for calculating volatility is the point at which the hedge will be lifted. Dollar duration at any other point is essentially irrelevant because the goal is to lock in a price or rate only on that particular day. Similarly, the relevant yield at which to calculate dollar duration initially is the target yield. Consequently, the numerator of Eq. (57–5) is the dollar duration on the date the hedge is expected to be delivered. The yield that is to be used on this date in order to determine the dollar duration is the forward rate.

Let's look at how we apply Eq. (57–5) when using the Treasury bond futures contract to hedge. The number of futures contracts will be affected by the dollar duration of the CTD issue. We can modify Eq. (57–5) as follows:

$$\begin{aligned}\text{Number of futures contracts} &= -\frac{\text{current dollar duration without futures}}{\text{dollar duration of the CTD issue}}\\ &\quad\times\frac{\text{dollar duration of the CTD issue}}{\text{dollar duration per futures contract}}\end{aligned} \qquad (57\text{–}6)$$

As noted earlier, the conversion ratio for the CTD issue is a good approximation of the second ratio. Thus Eq. (57–6) can be rewritten as

$$\begin{aligned}\text{Number of futures contracts} &= -\frac{\text{current dollar duration without futures}}{\text{dollar duration of the CTD issues}}\\ &\quad\times\text{conversion factor for the CTD issue}\end{aligned} \qquad (57\text{–}7)$$

An Illustration. An example for a single bond shows why dollar duration weighting leads to the correct number of contracts to use to hedge. The hedge illustrated is a cross-hedge. Suppose that on 6/24/99 a manager owned $10 million par value of a 6.25% Fannie Mae (FNMA) option-free bond maturing on 5/15/29 selling at 88.39 to yield 7.20%. The manager wants to sell September 1999 Treasury bond futures to hedge a future sale of the FNMA bond. At the time, the price of the September Treasury bond futures contract was at 113. The CTD issue was the 11.25% of 2/15/15 issue that was trading at the time at 146.19 to yield 6.50%. The conversion factor for the CTD issue was 1.283. To simplify, assume that the yield spread between the FNMA bond and the CTD issue remains at 0.70% (i.e., 70 basis points) and that the anticipated sale date is the last business day in September 1999.

The target price for hedging the CTD issue would be 144.979 (from 113 × 1.283), and the target yield would be 6.56% (the yield at a price of 144.979). Since the yield on the FNMA bond is assumed to stay at 0.70% above the yield on the CTD issue, the target yield for the FNMA bond would be 7.26%. The corresponding price for the FNMA bond for this target yield is 87.76. At these target levels, the dollar duration for a 50 basis point change in rates for the CTD issue and FNMA bond per $100 of par value is $6.255 and $5.453, respectively. As indicated earlier, all these calculations are made using a settlement date equal to the anticipated sale date, in this case the end of September 1999. The dollar duration for $10 million par value of the FNMA bond is then $545,300 ($10 million/100 times $5.453). Per $100,000 par value for the CTD issue, the dollar duration per futures contract is $6,255 ($100,000/100 times $6.255).

Thus we know

Current dollar duration without futures
= dollar duration of the FNMA bond
= $545,300

Dollar duration of the CTD issue = $6,255

Conversion factor for CTD issue = 1.283

Substituting these values into Eq. (57–7), we obtain

$$\text{Number of futures contracts} = \frac{\$545,300}{\$6,255} \times 1.283 = -112 \text{ contracts}$$

Consequently, to hedge the FNMA bond position, 112 Treasury bond futures contracts must be shorted.

Exhibit 57–2 uses scenario analysis to show the outcome of the hedge based on different prices for the FNMA bond at the delivery date of the futures contract. Let's go through each of the columns. Column (1) shows the assumed sale price for the FNMA bond, and column (2) shows the corresponding yield based on the actual sale price in column (1). This yield is found from the

EXHIBIT 57–2

Hedging a Nondeliverable Bond to a Delivery Date with Futures

Instrument to be hedged: $10 million FNMA 6.25% of 05/15/29
Price of FNMA as of hedge date (6/24/99) = 88.39
Conversion factor for September 1999 = 1.283
Price of futures contract when sold = 113
Target price for FNMA bonds = 87.76
Par value hedged = $10,000,000
Number of futures contracts = 112
Futures position = $12,656,000
Target market value for FNMA bonds = $8,776,000

(1) Actual Sale Price of FNMA Bonds	(2) Yield at Sale	(3) Yield of 11.25% Treasury Bond*	(4) Price of 11.25% Treasury Bond	(5) Futures Price†	(6) Value of Futures Position	(7) Gain or Loss on Futures Position	(8) Effective Sale Price‡
8,000,000	8.027	7.327	135.813	105.85581	11,855,850	800,150	8,800,150
8,100,000	7.922	7.222	137.031	106.80514	11,962,176	693,824	8,793,824
8,200,000	7.818	7.118	138.234	107.74279	12,067,193	588,807	8,778,807
8,300,000	7.717	7.017	139,422	108.66875	12,170,899	485,101	8,785,101
8,400,000	7.617	6.917	140.609	109.59392	12,274,519	381,481	8,781,481
8,500,000	7.520	6.820	141.781	110.50740	12,376,829	279,171	8,779,171
8,600,000	7.424	6.724	142.938	111.40920	12,477,830	178,170	8,778,170
8,700,000	7.330	6.630	144.094	112.31021	12,578,744	77,256	8,777,256
8,800,000	7.238	6.538	145.250	113.21122	12,679,657	–23,657	8,776,343
8,900,000	7.148	6.448	146.391	114.10055	12,779,261	–123,261	8,776,739
9,000,000	7.059	6.359	147.531	114.98909	12,878,778	–222,778	8,777,222
9,100,000	6.972	6.272	148.656	115.86594	12,976,985	–320,985	8,779,015
9,200,000	6.886	6.186	149.766	116.73110	13,073,883	–417,883	8,782,117
9,300,000	6.802	6.102	150.875	117.59548	13,170,694	–514,694	8,785,306
9,400,000	6.719	6.019	151.984	118.45986	13,267,504	–611,504	8,788,496
9,500,000	6.637	5.937	153.078	119.31255	13,363,005	–707,005	8,792,995

*By assumption, the yield on the cheapest-to-deliver issue is 70 basis points lower than the yield on the FNMA bond.
†By convergence, the futures price equals the price of the cheapest-to-deliver issue divided by 1.283 (the conversion factor).
‡Transaction costs and the financing of margin flows are ignored.

price/yield relationship. Given the assumed sale price for the FNMA bond, the corresponding yield can be determined. Column (3) shows the yield for the CTD issue. This yield is computed based on the assumption regarding the yield spread of 70 basis points between the FNMA bond and the CTD issue. Thus, by subtracting 70 basis points from the yield for the FNMA bond in column (2), the yield on the CTD issue (the 11.25% of 2/15/15) is obtained. Given the yield for the CTD issue in column (3), the price per $100 of par value of the CTD issue can be computed. This CTD price is shown in column (4).

Now we must move from the price of the CTD issue to the futures price. As explained in the description of the columns in Exhibit 57–1, by dividing the price for the CTD issue shown in column (4) by the conversion factor of the CTD issue (1.283), the futures price is obtained. This price is shown in column (5).

The value of the futures position is found in the same way as in Exhibit 57–1. First, the futures price per $1 of par value is computed by dividing the futures price by 100. Then this value is multiplied by $100,000 (the par value for the contract) and the number of futures contracts. That is,

$$\begin{aligned}&\text{Value of futures position}\\&\quad = (\text{futures price}/100) \times \$100{,}0000 \times \text{number of futures contracts}\end{aligned}$$

Since the number of futures contracts sold is 112,

$$\text{Value of futures position} = (\text{final futures price}/100) \times \$100{,}0000 \times 112$$

The values shown in column (6) use the preceding formula. Using the first assumed actual sale price for the FNMA of $8 million as an example, the corresponding futures price in column (5) is 105.85581. Therefore, the value of the futures position is

$$\begin{aligned}\text{Value of futures position} &= (105.85581/100) \times \$100{,}000 \times 112\\&= \$11{,}855{,}850\end{aligned}$$

Now let's calculate the gain or loss on the futures position shown in column (7). This is done in the same manner as explained for Exhibit 57–1. Since the futures price at which the contracts are sold at the inception of the hedge is 113, the gain or loss on the futures position is found as follows:

$$(113/100 - \text{final futures price}/100) \times \$100{,}000 \times \text{number of futures contracts}$$

For example, for the first scenario in Exhibit 57–2, the futures price is 105.85581, and 112 futures contract were sold. Therefore,

$$(113/100 - 105.85581/100) \times \$100{,}000 \times 112 = \$800{,}150$$

There is a gain from the futures position because the futures price is less than 113. Note that for all the final futures prices above 113 in Exhibit 57–2, there is a negative value, which means that there is a loss on the futures position. For all futures prices below 113, there is a loss.

Finally, column (8) shows the effective sale price for the FNMA bond. This value is found as follows:

$$\begin{aligned}&\text{Effective sale price for FNMA bond}\\&\quad = \text{actual sale price of FNMA bond} + \text{gain or loss on futures position}\end{aligned}$$

For the actual sale price of $8 million, the gain is $800,150. Therefore, the effective sale price for the FNMA bond is

$$\$8{,}000{,}000 + \$800{,}150 = \$8{,}800{,}150$$

Looking at column (8) of Exhibit 57–2, we see that if the simplifying assumptions hold, a futures hedge using the recommended number of futures contracts (112) very nearly locks in the target price for $10 million par value of the FNMA bonds.

Refining for Changing Yield Spread. Another refinement in the hedging strategy is usually necessary for hedging nondeliverable securities. This refinement concerns the assumption about the relative yield spread between the CTD issue and the bond to be hedged. In the prior discussion, we assumed that the yield spread was constant over time. Yield spreads, however, are not constant over time. They vary with the maturity of the instruments in question and the level of rates, as well as with many unpredictable and nonsystematic factors.

Regression analysis allows the manager to capture the relationship between yield levels and yield spreads and use it to advantage. For hedging purposes, the variables are the yield on the bond to be hedged and the yield on the CTD issue. The regression equation takes the form

$$\text{Yield on bond to be hedged} = a + b \times \text{yield on CTD issue} + \text{error} \qquad (57\text{–}8)$$

The regression procedure provides an estimate of b, which is the expected relative yield change in the two bonds. This parameter b is called the *yield beta*. Our example that used constant spreads implicitly assumes that the yield beta b equals 1.0 and a equals 0.70 (because 0.70 is the assumed spread).

For the two issues in question, that is, the FNMA bond and the CTD issue, suppose that the estimated yield beta was 1.05. Thus yields on the FNMA issue are expected to move 5% more than yields on the Treasury issue. To calculate the number of futures contracts correctly, this fact must be taken into account; thus the number of futures contracts derived in our earlier example is multiplied by the factor 1.05. Consequently, instead of shorting 112 Treasury bond futures contracts to hedge $10 million of the FNMA bond, the investor would short 118 (rounded up) contracts.

The formula for the number of futures contracts is revised as follows to incorporate the impact of the yield beta:

$$\begin{aligned}\text{Number of futures contracts} = -&\frac{\text{current dollar duration without futures}}{\text{dollar duration of the CTD issue}}\\ &\times \text{ conversion factor for the CTD issue}\\ &\times \text{ yield data} \qquad (57\text{–}9)\end{aligned}$$

where the yield beta is derived from the yield of the bond to be hedged regressed on the yield of the CTD issue (Eq. 57–8).

The effect of a change in the CTD issue and the yield spread can be assessed before the hedge is implemented. An exhibit similar to that of Exhibit 57–2 can be constructed under a wide range of assumptions. For example, at different yield levels at the date the hedge is to be lifted (the second column in Exhibit 57–2), a different yield spread may be appropriate and a different acceptable issue will be the CTD issue. The manager can determine what this will do to the outcome of the hedge.

Monitoring and Evaluating the Hedge

After a target is determined and a hedge is set, there are two remaining tasks. The hedge must be monitored during its life and evaluated after it is over. Most futures hedges require very little active monitoring during their life. In fact, overactive management poses more of a threat to most hedges than does inactive management. The reason for this is that the manager usually will not receive enough new information during the life of the hedge to justify a change in the hedging strategy. For example, it is not advisable to readjust the hedge ratio every day in response to a new data point and a possible corresponding change in the estimated value of the yield beta.

There are, however, exceptions to this general rule. As rates change, dollar duration changes. Consequently, the hedge ratio may change slightly. In other cases, there may be sound economic reasons to believe that the yield beta has changed. While there are exceptions, the best approach is usually to let a hedge run its course using the original hedge ratio with only slight adjustments.

A hedge normally can be evaluated only after it has been lifted. Evaluation involves, first, an assessment of how closely the hedge locked in the target rate—that is, how much error there was in the hedge. To provide a meaningful interpretation of the error, the manager should calculate how far from the target the sale (or purchase) would have been had there been no hedge at all. One good reason for evaluating a completed hedge is to ascertain the sources of error in the hedge in the hope that the manager will gain insights that can be used to advantage in subsequent hedges. A manager will find that there are three major sources of hedging errors:

1. The dollar duration for the hedged instrument was incorrect.
2. The projected value of the basis at the date the hedge is removed can be in error.
3. The parameters estimated from the regression (a and b) can be inaccurate.

Recall from the calculation of duration in Chapter 9 that interest rates are changed up and down by a small number of basis points and the security is revalued. The two recalculated values are used in the numerator of the duration formula. The first problem just listed recognizes that the instrument to be hedged may be a complex instrument (i.e., one with embedded options) and that the valuation model does not do a good job of valuing the security when interest rates change.

The second major source of errors in a hedge—an inaccurate projected value of the basis—is the more difficult problem. Unfortunately, there are no satisfactory simple models like regression that can be applied to the basis. Simple models of the basis violate certain equilibrium relationships for bonds that should not be violated. On the other hand, theoretically rigorous models are very unintuitive and usually soluble only by complex numerical methods. Modeling the basis is undoubtedly one of the most important and difficult problems that managers seeking to hedge face.

HEDGING WITH OPTIONS

Hedging strategies using options involve taking a position in an option and a position in the underlying bond in such a way that changes in the value of one position will offset any unfavorable price (interest rate) movement in the other position. We begin with the basic hedging strategies using options. Then we illustrate these basic strategies using futures options to hedge the FNMA bond for which a futures hedge was used earlier in this chapter. Using futures options in our illustration of hedging the bond is a worthwhile exercise because it shows how complicated hedging with futures options is and the key parameters involved in the process. We also compare the outcome of hedging with futures and hedging with futures options.

Basic Hedging Strategies

There are three popular hedging strategies: (1) a protective put-buying strategy, (2) a covered call-writing strategy, and (3) a collar strategy. We discuss each strategy below.

Protective Put-Buying Strategy

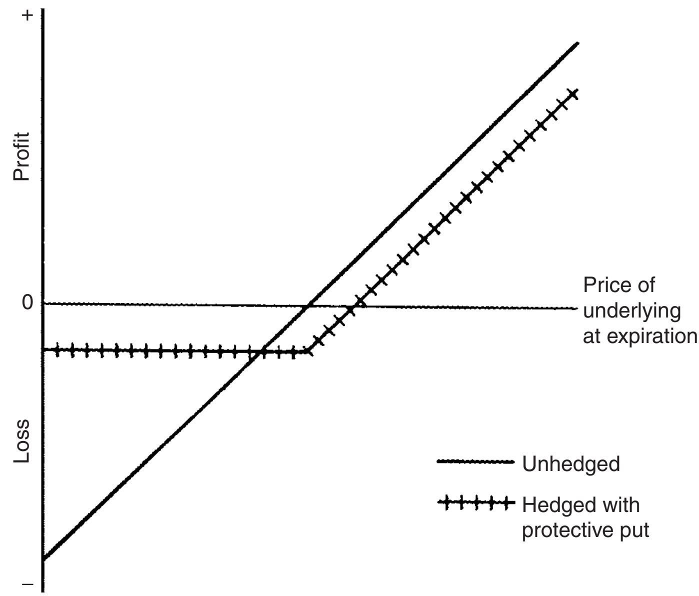
Consider a manager who has a bond and wants to hedge against rising interest rates. The most obvious options hedging strategy is to buy put options on bonds. This hedging strategy is referred to as a *protective put-buying strategy*. The puts are usually out-of-the-money puts and may be either puts on cash bonds or puts on interest-rate futures. If interest rates rise, the puts will increase in value (holding other factors constant), offsetting some or all of the loss on the bonds in the portfolio.

This strategy is a simple combination of a long put option with a long position in a cash bond. Such a position has limited downside risk, but large upside potential. However, if rates fall, the price appreciation on the bonds in the portfolio will be diminished by the amount paid to purchase the puts. Exhibit 57–3 compares the protective put-buying strategy to an unhedged position.

The protective put-buying strategy is very often compared with purchasing insurance. Like insurance, the premium paid for the protection is nonrefundable

EXHIBIT 57–3

Protective Put-Buying Strategy



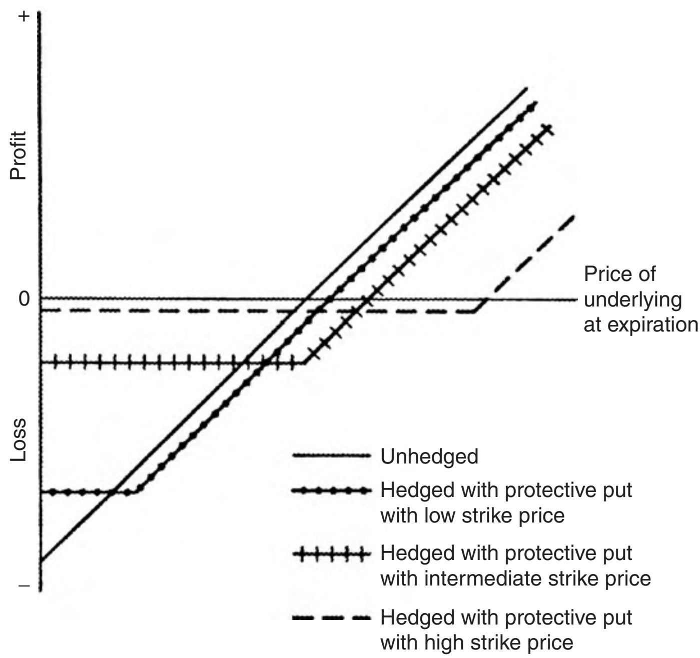
and is paid before the coverage begins. The degree to which a portfolio is protected depends on the strike price of the options; thus the strike price is often compared with the deductible on an insurance policy. The lower the deductible (i.e., the higher the strike price for the put), the greater is the level of protection, and the more the protection costs. Conversely, the higher the deductible (the lower the strike price on the put), the more the portfolio can lose in value, but the cost of the insurance is lower. Exhibit 57–4 compares an unhedged position with several protective put positions, each with a different strike price, or level of protection. As the exhibit shows, no one strategy dominates any other strategy, in the sense of performing better at all possible rate levels. Consequently, it is impossible to say that one strike price is necessarily the "best" strike price or even that buying protective puts is necessarily better than doing nothing at all.

Covered Call-Writing Strategy

Another options hedging strategy used by many portfolio managers is to sell calls against the bond portfolio. This hedging strategy is called a *covered call-writing strategy.* The calls that are sold are usually out-of-the-money calls and can be either calls on cash bonds or calls on interest-rate futures. Covered call writing is just an outright long position combined with a short call position. Obviously, this strategy entails much more downside risk than buying a put to protect the value

EXHIBIT 57–4

Protective Put-Buying Strategy with Different Strike Prices

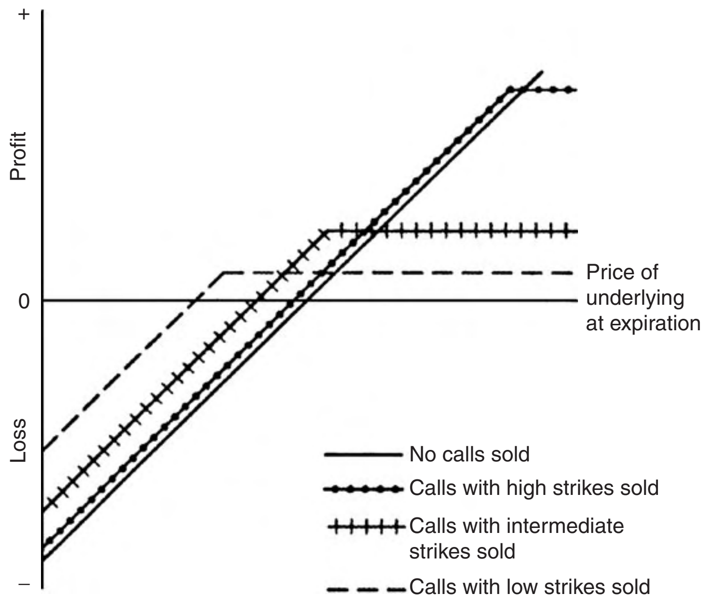


of the portfolio. In fact, many portfolio managers do not consider covered call writing a hedge.

Regardless of how it is classified, it is important to recognize that while covered call writing has substantial downside risk, it has less downside risk than an unhedged long position alone. On the downside, the difference between the long position alone and the covered call-writing strategy is the premium received for the calls that are sold. This premium acts as a cushion for downward movements in prices, reducing losses when rates rise. The cost of obtaining this cushion is that the manager gives up some of the potential on the upside. When rates decline, the call options become greater liabilities for the covered call writer. These incremental liabilities decrease the gains the manager would otherwise have realized on the portfolio in a declining rate environment. Thus the covered call writer gives up some (or all) of the upside potential of the portfolio in return for a cushion on the downside. The more upside potential that is forfeited (i.e., the lower the strike price on the calls), the more cushion there is on the downside. Exhibit 57–5 illustrates this point by comparing an unhedged position to several covered call-writing strategies, each with a different strike price. Like the protective put-buying strategy, there is no "right" strike price for the covered call writer.

EXHIBIT 57–5

Covered Call-Writing Strategy with Different Strike Prices



Collar Strategy

There are other hedging strategies employing options that are used frequently by managers. For example, many managers combine the protective put-buying strategy and the covered call-writing strategy. By combining a long position in an out-of-the-money put and a short position in an out-of-the-money call, the manager creates a long position in a *collar.* Consequently, this hedging strategy is called a *collar strategy*. The manager who uses the collar eliminates part of the portfolio's downside risk by giving up part of its upside potential. A long position hedged with a collar is shown in Exhibit 57–6.

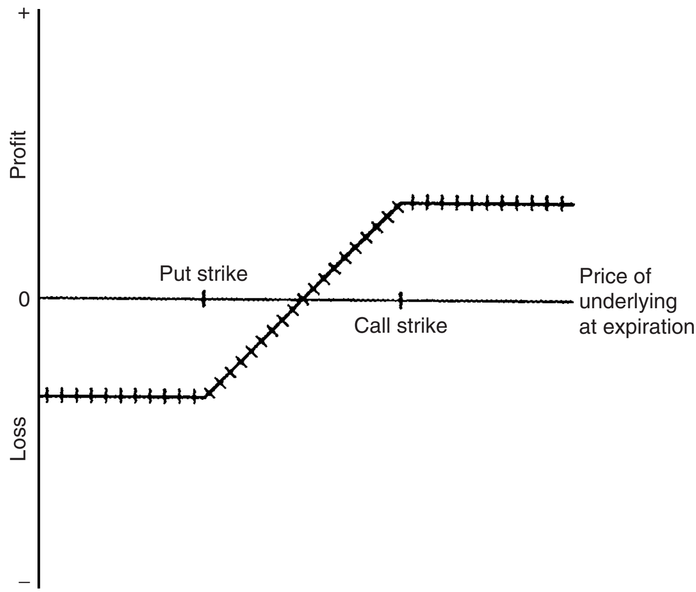
The collar in some ways resembles the protective put, in some ways resembles covered call writing, and in some ways resembles an unhedged position. The collar is like the protective put-buying strategy in that it limits the possible losses on the portfolio if interest rates go up. Like the covered call-writing strategy, the portfolio's upside potential is limited. Like an unhedged position, within the range defined by the strike prices, the value of the portfolio varies with interest rates.

Selecting the "Best" Strategy

Comparing the two basic strategies for hedging with options, one cannot say that the protective put-buying strategy or the covered call-writing strategy is necessarily

EXHIBIT 57–6

Long Position Hedged with a Collar



the better or more correct options hedge. The best strategy (and the best strike price) depends on the manager's view of the market. Purchasing a put and paying the required premium are appropriate if the manager is fundamentally bearish. If, instead, the manager is neutral to mildly bearish, it is better to receive the premium on the covered call-writing strategy. If the manager prefers to take no view on the market at all, and as little risk as possible, then the futures hedge is the most appropriate. If the manager is fundamentally bullish, then no hedge at all is probably the best strategy.

Steps in Options Hedging

Like hedging with futures, there are steps that managers should consider before setting their hedges. These steps include

Step 1. Determine the option contract that is the best hedging vehicle. The best option contract to use depends on several factors. These include option price, liquidity, and correlation with the bond(s) to be hedged. In price-inefficient markets, the option price is important because not all options will be priced in the same manner or with the same volatility assumption. Consequently, some options may be overpriced and some underpriced. Obviously, with other factors equal, it is better to use the underpriced options when buying and the overpriced options when selling.

Whenever there is a possibility that the option position may be closed out prior to expiration, liquidity is also an important consideration. If the particular option is illiquid, closing out a position may be prohibitively expensive, and the manager loses the flexibility of closing out positions early or rolling into other positions that may become more attractive. Correlation with the underlying bond(s) to be hedged is another factor in selecting the right contract. The higher the correlation, the more precisely the final profit and loss can be defined as a function of the final level of rates. Poor correlation leads to more uncertainty.

While most of the uncertainty in an options hedge usually comes from the uncertainty of interest rates themselves, the degree of correlation between the bonds to be hedged and the instruments underlying the options contracts add to that risk. The lower the correlation, the greater the risk.

Step 2. Find the appropriate strike price. For a cross-hedge, the manager will want to convert the strike price on the options that are actually bought or sold into an equivalent strike price for the actual bonds being hedged.

Step 3. Determine the number of contracts. The hedge ratio is the number of options to buy or sell.

Steps 2 and 3, determining the strike price and the number of contracts, can best be explained with examples using futures options.

Protective Put-Buying Strategy Using Futures Options

As explained earlier, managers who want to hedge their bond positions against a possible increase in interest rates will find that buying puts on futures is one of the easiest ways to purchase protection against rising rates. To illustrate a protective put-buying strategy, we can use the same FNMA bond that we used to demonstrate how to hedge with Treasury bond futures.[4] In that example, a manager held $10 million par value of a 6.25% FNMA bond maturing 5/15/29 and used September 1999 Treasury bond futures to lock in a sale price for those bonds on the futures delivery date. Now we want to show how the manager could use futures options instead of futures to protect against rising rates.

4. As explained in Chapter 52, futures options on Treasury bonds are used more commonly by institutional investors. The mechanics of futures options are as follows: If a put option is exercised, the option buyer receives a short position in the underlying futures contract and the option writer receives the corresponding long position. The futures price for both positions is the strike price for the put option. The exchange then marks the positions to market and the futures price for both positions is then the current futures price. If a call option is exercised, the option buyer receives a long position in the underlying futures contract and the option writer receives the corresponding short position. The futures price for both positions is the strike price for the call option. The exchange then marks the positions to market and the futures price for both positions is then the current futures price.

On 6/24/99, the FNMA bond was selling for 88.39 to yield 7.20%, and the CTD issue's yield was 6.50%. For simplicity, it is assumed that the yield spread between the FNMA bond and the CTD issue remains at 70 basis points.

Selecting the Strike Price

The manager must determine the minimum price that he wants to establish for the FNMA bonds. In our illustration, we will assume that the minimum price before the cost of the put options purchased is 84.453. This is equivalent to saying that the manager wants to establish a strike price for a put option on the hedged bonds of 84.453. But the manager is not buying a put option on the FNMA bond. He is buying a put option on a Treasury bond futures contract. Therefore, the manager must determine the strike price for a put option on a Treasury bond futures contract that is equivalent to a strike price of 84.453 for the FNMA bond.

This can be done with the help of Exhibit 57–7. We begin at the top left-hand box of the exhibit. Since the minimum price is 84.453 for the FNMA bond, this means that the manager is attempting to establish a maximum yield of 7.573%. This is found from the relationship between price and yield: given a price of 84.453 for the FNMA bond, this equates to a yield of 7.573%. (This gets us to the lower left-hand box in Exhibit 57–7.) From the assumption that the spread between the FNMA bond and the cheapest-to-deliver issue is a constant 70 basis points, setting a maximum yield of 7.573% for the FNMA bond is equivalent to setting a maximum yield of 6.873% for the cheapest-to-deliver issue. (Now we are at the lower box in the middle column of Exhibit 57–7.) Given the yield of 6.873% for the CTD issue, the minimum price before the cost of the puts purchased can be determined (the top box in the middle column of the

EXHIBIT 57–7

Calculating Equivalent Strike Prices and Yields for Hedging with Futures Options

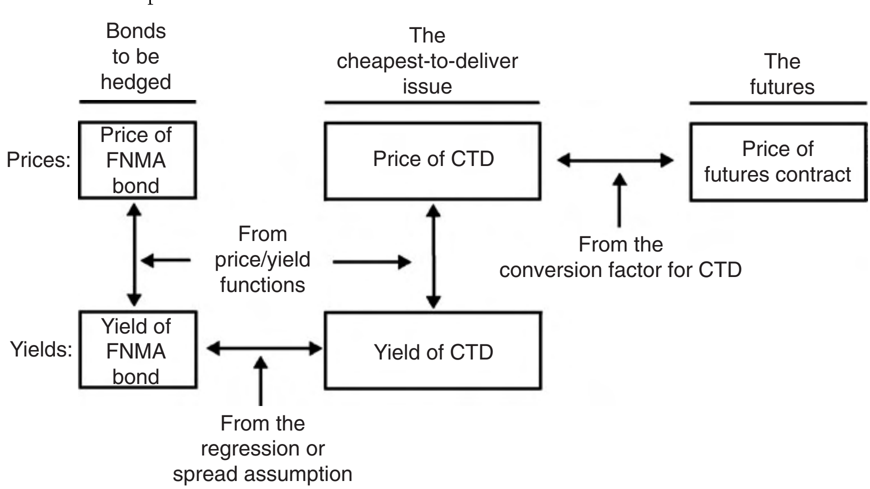


exhibit). A 6.873% yield for the CTD issue gives us a price of 141.136. (This is determined from the characteristics of the CTD issue.) The corresponding futures price is found by dividing the price of the CTD issue by the conversion factor. This gets us to the box in the right-hand column of Exhibit 57–7. Since the conversion factor is 1.283, the futures price is about 110 (141.136 divided by 1.283). This means that a strike price of 110 for a put option on a Treasury bond futures contract is roughly equivalent to a put option on our FNMA bond with a strike price of 84.453.

The foregoing steps are always necessary to obtain the appropriate strike price on a put futures option. The process is not complicated. It simply involves (1) the relationship between price and yield, (2) the assumed relationship between the yield spread between the bonds to be hedged and the cheapest-to-deliver issue, and (3) the conversion factor for the cheapest-to-deliver issue. As with hedging employing futures illustrated earlier in this chapter, the success of the hedging strategy will depend on (1) whether the cheapest-to-deliver issue changes and (2) the yield spread between the bonds to be hedged and the cheapest-to-deliver issue.

Calculating the Number of Options Contracts

The hedge ratio is determined using the following equation similar to Eq. (57–7) because we will assume a constant yield spread between the bond to be hedged and the cheapest-to-deliver issue:

$$\text{Number of options contracts} = \frac{\text{current dollar duration without options}}{\text{dollar duration of the CTD issue}} \times \text{conversion factor for CTD issue}$$

The dollar durations are as follows per 50 basis point change in rates:

Current dollar duration without options = \$512,320
Dollar duration of the CTD issue = \$6,021

Notice that the dollar durations are different from those used in calculating the number of futures contracts for the futures hedge. This is so because the dollar durations are calculated at prices corresponding to the strike price of the futures option (110) rather than the futures price (113). The number of futures options contracts is then

$$\text{Number of options contracts} = \frac{\$512{,}320}{\$6{,}021} \times 1.283 = 109 \text{ put options}$$

Thus, to hedge the FNMA bond position with put options on Treasury bond futures, 109 put options must be purchased.

Outcome of the Hedge

To create a table for the protective put hedge, we can use some of the numbers from Exhibit 57–2. Exhibit 57–8 shows the scenario analysis for the protective put

EXHIBIT 57–8

Hedging a Nondeliverable Bond to a Delivery Date with Puts on Futures

Instrument to be hedged: $10 million FNMA 6.25% of 05/15/29
Price of FNMA as of hedge date (6/24/99) = 88.39
Conversion factor for September 1999 = 1.283
Price of futures contract when sold = 113
Target price per bond for FNMA bonds = 84.453
Effective minimum sale price = 83.908
Par value hedged = $10,000,000
Strike price for put = 110
Number of puts on futures = 109
Price per contract = $500.00
Cost of put position = $54,500

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Actual Sale Price of FNMA Bonds	Yield at Sale	Yield of 11.25% Treasury Bond	Price of 11.25% Treasury Bond*	Futures Price	Value of Put Options†	Cost of Put Position	Effective Sale Price‡
8,000,000	8.027	7.327	135.813	105.85581	451,717	54,500	8,397,217
8,100,000	7.922	7.222	137.031	106.80514	348,239	54,500	8,393,739
8,200,000	7.818	7.118	138.234	107.74279	246,036	54,500	8,391,536
8,300,000	7.717	7.017	139.422	108.66875	145,107	54,500	8,390,607
8,400,000	7.617	6.917	140.609	109.59392	44,263	54,500	8,389,763
8,500,000	7.520	6.820	141.781	110.50740	0	54,500	8,445,500
8,600,000	7.424	6.724	142.938	111.40920	0	54,500	8,545,500
8,700,000	7.330	6.630	144.094	112.31021	0	54,500	8,645,500
8,800,000	7.238	6.538	145.250	113.21122	0	54,500	8,745,500
8,900,000	7.148	6.448	145.391	114.10055	0	54,500	8,845,500
9,000,000	7.059	6.359	147.531	114.98909	0	54,500	8,945,500
9,100,000	6.972	6.272	148.656	115.86594	0	54,500	9,045,500
9,200,000	6.886	6.186	149.766	116.73110	0	54,500	9,145,500
9,300,000	6.802	6.102	150.875	117.59548	0	54,500	9,245,500
9,400,000	6.719	6.019	151.984	118.45986	0	54,500	9,345,500
9,500,000	6.637	5.937	153.078	119.31255	0	54,500	9,445,500

*These numbers are approximate because futures trade in 32nds.
†From maximum of [(110/100 – futures price/100) × $100,000 × 109, 0].
‡Does not include transaction costs or the financing of the options position.

buying strategy. The first five columns are the same as in Exhibit 57–2. For the put option hedge, column (6) shows the value of the put option position at the expiration date. The value of the put option position at the expiration date will be equal to zero if the futures price is greater than or equal to the strike price of 110. If the futures price is below 110, then the options expire in the money, and the value of the put option position is

$$\text{Value of put option position} \\ = (110/100 - \text{futures price}/100) \times \$100{,}000 \times \text{number of put options}$$

For example, for the first scenario in Exhibit 57–8 of $8 million for the actual sale price of the FNMA bond, the corresponding futures price is 105.85581. The number of put options purchased is 109. Therefore

$$(110/100 - 105.85581/100) \times \$100{,}000 \times 109 = \$45{,}717$$

The effective sale price for the FNMA bonds is then equal to

$$\text{Effective sale price} = \text{actual sale price} + \text{value of put option position} \\ - \text{option cost}$$

Let's look at the option cost. Suppose that the price of the put option with a strike price of 110 is $500 per contract. With a total of 109 options, the cost of the protection is $54,500 (109 × $500, not including financing costs and commissions). This cost is shown in column (7) and is equivalent to 0.545 per $100 par value hedged.

The effective sale price for the FNMA bonds for each scenario is shown in the last column of Exhibit 57–8. This effective sale price is never less than 83.908. This equals the price of the FNMA bonds equivalent to the futures strike price of 110 (i.e., 84.453) minus the cost of the puts (i.e., 0.545 per $100 par value hedged). This minimum effective price is something that can be calculated before the hedge is ever initiated. (As prices decline, the effective sale price actually exceeds the target minimum sale price of 83.908 by a small amount. This is due only to rounding and the fact that the hedge ratio is left unaltered, although the relative dollar durations that go into the hedge ratio calculation change as yields change.) As prices increase, however, the effective sale price of the hedged bonds increases as well; unlike the futures hedge shown in Exhibit 57–2, the options hedge protects the investor if rates rise but allows the investor to profit if rates fall.

Covered Call-Writing Strategy with Futures Options

Unlike the protective put-buying strategy, covered call writing is not entered into with the sole purpose of protecting a portfolio against rising rates. The covered call writer, believing that the market will not trade much higher or much lower than its present level, sells out-of-the-money calls against an existing bond portfolio. The sale of the calls brings in premium income that provides partial protection in case rates increase. The premium received does not, of course, provide the kind of protection that a long put position provides, but it does provide some additional income that can be used to offset declining prices. If, instead, rates fall, portfolio appreciation is limited because the short call position constitutes a liability for the seller, and this liability increases as rates decline. Consequently, there is limited upside price potential for the covered call writer. Of course, this is not so bad if prices are essentially going nowhere; the added income from the sale of call options is obtained without sacrificing any gains.

To see how covered call writing with futures options works for the bond used in the protective put example, we construct a table much as we did before. With futures selling around 113 on the hedge initiation date, a sale of a 117 call option on futures might be appropriate. As before, it is assumed that the hedged bond will remain at a 70 basis point spread over the CTD issue. We also assume for simplicity that the price of the 117 calls is \$500 per contract. The number of options contracts sold will be the same, namely, 109 contracts for \$10 million face value of underlying bonds. Thus, the proceeds received from the sale of the 109 call options is \$54,500 (109 contracts × \$500) or 0.545 per \$100 par value hedged.

Exhibit 57–9 shows the outcomes of the covered call-writing strategy given these assumptions. The first five columns of the exhibit are the same as for Exhibit 57–8. In column (6), the liability resulting from the call option position is shown. The liability is zero if the futures price for the scenario is less than the strike price of 117. If the futures price for the scenario is greater than 117, the liability is calculated as follows:

$$(\text{Futures price}/100 - 117/100) \times \$100{,}000 \times \text{number of put options}$$

For example, consider the scenario in Exhibit 57–9, where the actual sale price of the FNMA bond is \$9.5 million. The corresponding futures price is 119.31255. The number of call options sold is 109. Therefore

$$(119.31255/100 - 117/100) \times \$100{,}000 \times 109 = \$252{,}068$$

That is,

$$\begin{aligned}\text{Effective sale price} = {} & \text{actual sale price} \\ & + \text{proceeds from sale of the call options} \\ & - \text{liability of call position}\end{aligned}$$

Since the proceeds from sale of the call options is \$54,500, then

$$\text{Effective sale price} = \text{actual sale price} + \$54{,}000 - \text{liability of call position}$$

The last column of Exhibit 57–9 shows the effective sale price for each scenario.

Just as the minimum effective sale price could be calculated beforehand for the protective put-buying strategy, the maximum effective sale price can be calculated beforehand for the covered call-writing strategy. The maximum effective sale price will be the price of the hedged bond corresponding to the strike price of the option sold plus the premium received. In this case, the strike price on the futures call option is 117. A futures price of 117 corresponds to a price of 150.111 (from 117 times the conversion factor of 1.283) and a corresponding yield of

EXHIBIT 57–9

Writing Calls on Futures against a Nondeliverable Bond

Instrument to be hedged: $10 million FNMA 6.25% of 05/15/29
Price of FNMA as of hedge date (6/24/99) = 88.39
Conversion factor for September 1999 = 1.283
Price of futures contract when sold = 113
Target maximum price for FNMA bonds per bond = 92.858
Par value hedged = $10,000,000
Strike price for call = 117
Number of calls on futures = 109
Price per contract = 500.00
Value of call position = 54,500
Target maximum value for FNMA bonds = $9,285,800

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Actual Sale Price of FNMA Bonds	**Yield at Sale**	**Yield of 11.25% Treasury Bond**	**Price of 11.25% Treasury Bond**	**Futures Price***	**Liability of Call Options†**	**Proceeds from Call Position**	**Effective Sale Price‡**
8,000,000	8.027	7.327	135.813	105.85581	0	54,500.00	8,054,500
8,100,000	7.922	7.222	137.031	106.80514	0	54,500.00	8,154,500
8,200,000	7.818	7.118	138.234	107.74279	0	54,500.00	8,254,500
8,300,000	7.717	7.017	139.422	108.66875	0	54,500.00	8,354,500
8,400,000	7.617	6.917	140.609	109.59392	0	54,500.00	8,454,500
8,500,000	7.520	6.820	141.781	110.50740	0	54,500.00	8,554,500
8,600,000	7.424	6.724	142.938	111.40920	0	54,500.00	8,654,500
8,700,000	7.330	6.630	144,094	112.31021	0	54,500.00	8,754,500
8,800,000	7.238	6.538	145.250	113.21122	0	54,500.00	8,854,500
8,900,000	7.148	6.448	146.391	114.10055	0	54,500.00	8,954,500
9,000,000	7.059	6.359	147.531	114.98909	0	54,500.00	9,054,500
9,100,000	6.972	6.272	148.656	115.86594	0	54,500.00	9,154,500
9,200,000	6.886	6.186	149.766	116.73110	0	54,500.00	9,254,500
9,300,000	6.802	6.102	150.875	117.59548	64,907	54,500.00	9,289,593
9,400,000	6.719	6.019	151.984	118.45986	159,125	54,500.00	9,295,375
9,500,000	6.637	5.937	153.078	119.31255	252,068	54,500.00	9,302,432

*These numbers are approximate because futures trade in 32nds.
†From maximum of [(Futures price/100 – 117/100) × $100,000 × 109, 0].
‡Does not include transaction costs or interest on the option premium received.

6.159% for the cheapest-to-deliver issue. The equivalent yield for the hedged bond is 70 basis points higher, or 6.859%, for a corresponding price of 92.313. Adding on the premium received of 0.545 per $100 par value hedged, the final maximum effective sale price will be about 92.858. As Exhibit 57–10 shows, if the hedged bond does trade at 70 basis points over the CTD issue as assumed, the

EXHIBIT 57–10

Comparison of Alternative Strategies

(1) Actual Sale Price of FNMA Bonds	(2) Effective Sale Price with Futures Hedge	(3) Effective Sale Price with Protective Puts	(4) Effective Sale Price with Covered Calls
8,000,000	8,800,150	8,397,217	8,054,500
8,100,000	8.793,824	8,393,739	8,154,500
8,200,000	8,788,807	8,391,536	8,254,500
8,300,000	8.785,101	8,390,607	8,354,500
8,400,000	8,781,481	8,389,763	8,454,500
8,500,000	8,779,171	8,445,500	8,554,500
8,600,000	8,778,170	8,545,500	8,654,500
8,700,000	8,777,256	8,645,500	8,754,500
8,800,000	8,776,343	8,745,500	8,854,500
8,900,000	8.776,739	8,845,500	9,954,500
9,000,000	8,777,222	8,945,500	9,054,500
9,100,000	8,779,015	9,045,500	9,154,500
9,200,000	8,782,117	9,145,500	9,254,500
9,300,000	8,785,306	9,245,500	9,289,593
9,400,000	8,788,496	9,345,500	9,295,375
9,500,000	8,792,995	9,445,500	9,302,432

maximum effective sale price for the hedged bond is, in fact, slightly over 92.858. The discrepancies shown in the exhibit are due to rounding and the fact that the position is not adjusted even though the relative dollar durations change as yields change.

Comparing Alternative Strategies

In this chapter we reviewed three basic strategies for hedging a bond position: (1) hedging with futures, (2) hedging with out-of-the-money puts, and (3) covered call writing with out-of-the-money calls. Similar but opposite strategies exist for managers who are concerned that rates will decrease. As might be expected, there is no "best" strategy. Each strategy has its advantages and its disadvantages, and we never get something for nothing. To get anything of value, something else of value must be forfeited.

To make a choice among strategies, it helps to lay the alternatives side by side. Using the futures example and the futures options examples, Exhibit 57–10 shows the final values of the portfolio for the various hedging alternatives. It is easy to see from Exhibit 57–10 that if one alternative is superior to another alternative at one level of rates, it will be inferior at some other level of rates.

Consequently, we cannot conclude that one strategy is the best strategy. The manager who makes the strategy decision makes a choice among probability distributions, not usually among specific outcomes. Except for the perfect hedge, there is always some range of possible final values of the portfolio. Of course, exactly what that range is, and the probabilities associated with each possible outcome, is a matter of opinion.

Hedging with Options on Cash Instruments

Hedging a position with options on cash bonds is relatively straightforward. Most strategies, including the purchase of protective puts, covered call writing, and buying collars, are essentially the same whether futures options or options on physicals are used. There are some mechanical differences in the way the two types of option contracts are traded, and there may be substantial differences in their liquidity. Nonetheless, the basic economics of the strategies are virtually identical.

Using options on physicals frequently relieves the manager of much of the basis risk associated with a futures options hedge. For example, a manager of Treasury bonds or notes usually can buy or sell options on the exact security held in the portfolio. Using options on futures, rather than options on Treasury bonds, is sure to introduce additional elements of uncertainty.

Given the illustration presented earlier, and given that the economics of options on physicals and options on futures are essentially identical, additional illustrations for options on physicals are unnecessary. The only important difference is the hedge ratio calculation and the calculation of the equivalent strike price. To derive the hedge ratio, we always resort to an expression of relative dollar durations. Thus, for options on physicals assuming a constant spread, the hedge ratio is

$$\frac{\text{Current dollar duration without options}}{\text{Dollar duration of underlying for option}}$$

If a relationship is estimated between the yield on the bonds to be hedged and the instrument underlying the option, the appropriate hedge ratio is

$$\frac{\text{Current dollar duration without options}}{\text{Dollar duration of underlying for option}} \times \text{yield beta}$$

Unlike futures options, there is only one deliverable, so there is no conversion factor. When cross-hedging with options on physicals, the procedure for finding the equivalent strike price on the bonds to be hedged is very similar. Given the strike price of the option, the strike yield is easily determined using the price/yield relationship for the instrument underlying the option. Then, given the projected relationship between the yield on the instrument underlying the option and the yield on the bonds to be hedged, an equivalent strike yield is derived for the bonds to be hedged. Finally, using the yield-to-price formula for the bonds to be hedged, the equivalent strike price for the bonds to be hedged can be found.

SUMMARY

Buying an interest-rate futures contract increases a portfolio's duration; selling an interest-rate futures contract decreases a portfolio's duration. The advantages of adjusting a portfolio's duration using futures rather than cash-market instruments are that transaction costs are lower, margin requirements are lower, and selling short in the futures market is easier.

The general principle in controlling interest-rate risk with futures is to combine the dollar exposure of the current portfolio and that of a futures position so that it is equal to the target dollar exposure. The number of futures contracts needed to achieve the target dollar duration depends on the current dollar duration of the portfolio without futures and the dollar duration per futures contract.

Hedging with futures calls for taking a futures position as a temporary substitute for transactions to be made in the cash market at a later date, with the expectation that any loss realized by the manager from one position (whether cash or futures) will be offset by a profit on the other position. Hedging is a special case of controlling interest-rate risk in which the target duration or target dollar duration is zero. Cross-hedging occurs when the bond to be hedged is not identical to the bond underlying the futures contract. A short or sell hedge is used to protect against a decline in the cash price of a bond; a long or buy hedge is employed to protect against an increase in the cash price of a bond.

The steps in hedging include (1) determining the appropriate hedging instrument, (2) determining the target for the hedge, (3) determining the position to be taken in the hedging instrument, and (4) monitoring and evaluating the hedge. The key factor to determine which futures contract will provide the best hedge is the degree of correlation between the rate on the futures contract and the interest rate that creates the underlying risk that the manager seeks to eliminate. The manager should determine the target rate or target price, which is what is expected from the hedge. The hedge ratio is the number of futures contracts needed for the hedge.

The basis is the difference between the spot price (or rate) and the futures price (or rate). In general, when hedging to the delivery date of the futures contract, a manager locks in the futures rate or price. Hedging with Treasury bond futures and Treasury note futures is complicated by the delivery options embedded in these contracts. When a hedge is lifted prior to the delivery date, the effective rate (or price) that is obtained is much more likely to approximate the current spot rate than the futures rate the shorter the term of the hedge.

The proper target for a hedge that is to be lifted prior to the delivery date depends on the basis. Basis risk refers only to the uncertainty associated with the target rate basis or target price basis. Hedging substitutes basis risk for price risk. Hedging non-Treasury securities with Treasury bond futures requires that the hedge ratio consider two relationships: (1) the cash price of the non-Treasury security and the cheapest-to-deliver issue and (2) the price of the cheapest-to-deliver issue and the futures price.

In computing the hedge ratio for nondeliverable securities, the yield beta should be considered; regression analysis is used to estimate the yield beta and captures the relationship between yield levels and yield spreads. After a target is determined and a hedge is set, the hedge must be monitored during its life and evaluated after it is over. It is important to ascertain the sources of error in a hedge in order to gain insights that can be used to advantage in subsequent hedges.

Three popular hedge strategies using options are the protective put-buying strategy, the covered call-writing strategy, and the collar strategy. A manager can use a protective put-buying strategy to hedge against rising interest rates. A protective put-buying strategy is a simple combination of a long put option with a long position in a cash bond. A covered call-writing strategy involves selling call options against the bond portfolio. A covered call-writing strategy entails much more downside risk than buying a put to protect the value of the portfolio, and many managers do not consider covered call writing a hedge. It is not possible to say that the protective put-buying strategy or the covered call-writing strategy is necessarily the better or more correct options hedge. The best strategy (and the best strike prices) depends on the manager's view of the market. A collar strategy is a combination of a protective put-buying strategy and a covered call-writing strategy. A manager who implements a collar strategy eliminates part of the portfolio's downside risk by giving up part of its upside potential.

The steps in options hedging include determining the option contract that is the best hedging vehicle, finding the appropriate strike price, and determining the number of options contracts. At the outset of options hedging, a minimum effective sale price can be calculated for a protective put-buying strategy and a maximum effective sale price can be computed for a covered call-writing strategy. The best options contract to use depends on the option price, liquidity, and correlation with the bond(s) to be hedged. For a cross-hedge, the manager will want to convert the strike price for the options that are actually bought or sold into an equivalent strike price for the actual bonds being hedged. When using Treasury bond futures options, the hedge ratio is based on the relative dollar duration of the current portfolio, the cheapest-to-deliver issue, and the futures contract at the option expiration date, as well as the conversion factor for the cheapest-to-deliver issue.

While there are some mechanical differences in the way options on physicals and options on futures are traded and there may be substantial differences in their liquidity, the basic economics of the hedging strategies are virtually identical for both contracts. Using options on physicals frequently relieves the manager of much of the basis risk associated with an options hedge.

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CHAPTER

FIFTY-EIGHT

INTRODUCTION TO CREDIT DERIVATIVES

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The credit derivatives market has grown rapidly over the past several years. Recent market surveys[1] estimate a total market notional of outstanding contracts of over $2 trillion. As a comparison, the total notional outstanding of global investment-grade corporate bond issuance currently stands at $3.1 trillion. This growth in the credit derivatives market has been driven by an increasing realization of the advantages credit derivatives possess over the cash alternative, plus the many new possibilities they present to both credit investors and hedgers. Those investors seeking yield pickup or new ways to hedge or assume an exposure to credit are increasingly turning toward the credit derivatives market.

The primary purpose of credit derivatives is to enable the efficient transfer and repackaging of credit risk. In their simplest form, credit derivatives provide a more efficient way to synthesize the credit risks that otherwise would exist in a standard cash instrument. Other credit derivatives such as default baskets and synthetic loss tranches introduce new exposures to default correlation that create a new way for the credit investor to leverage investment-grade credit risk. Through the bond and credit swaptions market, investors also can express a view on credit spread volatility.

The aim of this chapter is to set out the main credit derivatives types in terms of their mechanics, risks, and applications. These range from the plain-vanilla credit default swap, the simplest and most liquid credit derivative, to variations on the synthetic collateralized debt obligations (CDOs), a more complex, structured credit product. We begin with an overview of the market.

The author would like to acknowledge discussions with Georges Assi, Arthur Berd, Sunita Ganapati, Robert McAdie, Marco Naldi, Michal Oulik, Claus Pedersen, and Lutz Schloegl.

1. "*Risk Magazine* Credit Derivatives Survey," *Risk Magazine,* February 2003.

THE CREDIT DERIVATIVES MARKET

The credit derivatives market has changed substantially since its inception in the mid-1990s. Initially a small and highly esoteric market, it has evolved into a liquid market trading increasingly standardized products. While the founders were mainly banks using these new derivatives for the hedging needs of their loan books, the market has since broadened its base of users to include insurance companies, hedge funds, and asset managers.

The most recent snapshot of the credit derivatives market was provided in the 2003 "*Risk Magazine* Credit Derivatives Survey." This survey polled 12 banks at the end of 2002, composed of all the major players in the credit derivatives market. While the reported numbers cannot be considered as "hard," they can be used to draw fairly firm conclusions about the direction of the market, and we now summarize some of the main results.

According to the survey, the total market outstanding notional across all credit derivative products was calculated to be $2,306 billion, an increase of more than 50% on the previous year. A contract known as the *credit default swap* (CDS) remains the most used instrument in the credit derivative world, with 73% of market outstanding notional. The second most important product type is known as *correlation products*. These refer to synthetic loss tranches and default baskets. According to the survey, the total notional for all types of credit derivative portfolio/correlation products was $449.4 billion. Their share has kept pace with the growth of the credit derivative market at about 22%. This is not a surprise because there is strong link between these products and single-name CDS market caused by dealers hedging baskets and synthetic CDO tranches in the CDS market. The growth in the use of CDS has also been driven by hedge funds using credit derivatives as a way to exploit capital structure arbitrage opportunities and to go outright short the credit markets. It is worth noting that the percentage size of the options component of the credit derivative market is close to 1%. This is an area where we expect to see significant growth over the next few years.

The geographic origin of the credits traded in the credit derivative market also was examined by the *Risk Magazine* 2003 survey. The survey showed that 40.1% of all reference entities—the company to which a credit derivative contract is linked—are domiciled in Europe. This is similar to the 43.8% of North American–domiciled reference entities in credit derivatives contracts. This relatively equal weighting between the United States and Europe is in stark contrast to the global cash credit market, which has a significantly smaller size of European corporate bonds relative to North American corporate bonds. Asia and emerging markets make up the remainder of the credit derivatives market.

There is a broadening base of credit derivative end users. Banks still remain the largest users of credit derivatives, with nearly 50% share as end users. This is so mainly because of their substantial use of CDS as a hedging and diversification tool for their loan books and their active participation in synthetic securitizations. Insurance companies are also an important player. This has mainly been through their sourcing of triple-A-rated CDO tranches. The insurance share of credit derivative use is up to 13.6% from 8.8% the previous year. More recently, the growth in use of credit derivatives by hedge funds has had a marked impact on the overall credit derivative market itself, where their share has increased to 13% over the year. Hedge funds have been regular users of CDS, especially around many of the "fallen angel" credits, where they have been significant buyers of protection. Given their ability to leverage, they have substantially driven the volume and size of the CDS contracts traded, which in many cases has been disproportionate to their absolute size. We now discuss these various products in detail, starting with the credit default swap.

THE CREDIT DEFAULT SWAP

The credit default swap (CDS) is the most important product in the credit derivatives family in its own right and also as the building block of more exotic credit derivatives. Formally, a CDS is a bilateral contract to transfer the credit risk of a *reference entity* (a corporate or sovereign issuer) from one party to another. In a standard CDS contract, one party purchases credit protection from another party, to cover the loss of the face value of an asset following a *credit event*. Loosely speaking, a credit event can be thought of as default. However, we must take care to define this event precisely, and this is discussed below.

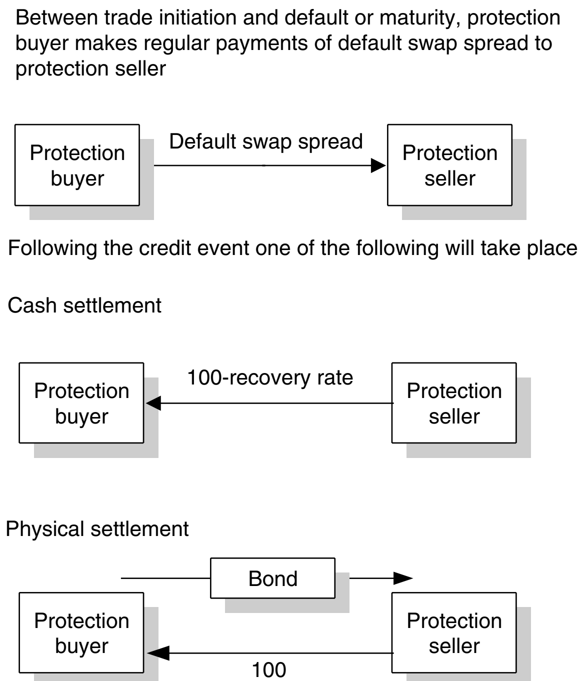
In the credit derivatives market, standard terminology refers to the two parties in a CDS as the *protection buyer* and the *protection seller*. Buying credit protection is economically equivalent to shorting the credit risk because a credit event results in a windfall gain. Equally, selling credit protection is economically equivalent to going long the credit risk because a credit event results in a loss.

The mechanics of a CDS are shown in Exhibit 58–1. The protection in a CDS contract lasts until some specified maturity date. To pay for this protection, the protection buyer makes regular payments to the protection seller on what is known as the *premium leg*. These payments last until a credit event occurs or the maturity date, whichever sooner, and are quoted in terms of an annual CDS spread. The actual payment amounts on the premium leg are adjusted for the frequency, usually quarterly, using a basis convention that is usually actual/360.

If a credit event occurs before the maturity date of the contract, there is a payment by the protection seller to the protection buyer. We call this leg of the CDS the *protection leg*. This payment equals the difference in value between par and the price of the cheapest deliverable asset of the reference entity calculated on the face value of the protection. It therefore compensates the protection buyer for the loss associated with holding the same face value of an asset of the same reference entity. The protection buyer also typically will pay the

EXHIBIT 58–1

Mechanics of a Credit Default Swap



portion of premium that has accrued since the previous payment date and the time of the credit event.

Settlement

Following the credit event, there are two ways to settle the payment of the protection leg, the choice being made at the initiation of the contract. They are shown in Exhibit 58–1, and are physical settlement and cash settlement.

Physical Settlement

This is the most widely used settlement procedure. It requires the protection buyer to deliver the notional amount of deliverable obligations of the reference entity to the protection seller in return for the notional amount paid in cash. In general, there is a choice of deliverable obligations from which the protection buyer can choose that satisfy a number of characteristics. Typically, they include restrictions on the maturity and the requirement that they be *pari passu*—most CDS are linked to senior unsecured debt. If the deliverable obligations trade with different prices following a credit event, which they are most likely to do if the credit event is a restructuring, the protection buyer can take advantage of this situation by buying and delivering the cheapest asset. The protection buyer therefore is long a *cheapest-to-deliver option.*

Cash Settlement

This is the alternative to physical settlement. While it is not the standard settlement method in CDS, it is the preferred alternative in default baskets and synthetic CDOs, which are discussed later. In cash settlement, a cash payment is made by the protection seller to the protection buyer equal to par minus the recovery price of the cheapest-to-deliver reference asset. The recovery rate is calculated by referencing dealer quotes or observable market prices over some period after the credit event has occurred. Economically, this should have the same value as physical settlement.

To make this clear, consider the following example. On April 22, 2004, an investor enters into a CDS contract to sell protection for five years at a contractual spread of 160 basis points on a face value of $10 million. The effective date, the date on which the credit protection begins is always $T + 1$ calendar. In this case, it is April 23, 2004 with a maturity date of April 23, 2009. Market convention for the cash flows is quarterly with an actual 360 basis. In this example, we assume that the default swaps experiences a credit event on the August 18, 2005. We also assume that the price of the delivered asset is $34 per $100 of face value. We show the resulting cash flows in Exhibit 58–2.

In terms of maturity, the most liquid contract traded is typically for five-year protection. However, a newly traded five-year contract will not generally mature exactly five years from the trade date. Instead, CDS contracts tend to have a maturity date that falls on one of four *roll* dates per year. These dates are the twentieth of March, June, September, and December. Consider for example, a five-year maturity CDS traded on the twelfth of April 2004. This will mature on the next roll

EXHIBIT 58–2

Cash Flows for Example CDS Trade Discussed in Text

Date	Cash Flow to Protection Seller
July 23, 2004	40,444.44
October 25, 2004	41,777.78
January 24, 2005	40,444.44
April 24, 2005	40,444.44
July 25, 2005	40,444.44
August 18, 2005	10,222.22 – 6,600,000 = –6,589,777.8

date after the twelfth of April 2009. This would be the twentieth of June 2009. However, a contract traded after the nineteenth of June 2004 will roll to the next maturity date on the twentieth of September 2009. Contracts to other maturity dates still can be traded, albeit with lower liquidity.

Uses of a CDS

The credit default swap is very versatile, and we list some of its main applications below:

- The CDS has revolutionized the credit markets by making it easy to short credit. This can be done for long periods without assuming any repo risk. This is very useful for those wishing to hedge current credit exposures or those wishing to take a bearish credit view.
- CDS are unfunded, so leverage is possible. This is also an advantage for those who have high funding costs because CDS implicitly lock in LIBOR funding to maturity.
- CDS are customizable in terms of maturity, seniority, and currency. However, deviation from the market standard may incur a liquidity cost.
- CDS can be used to take a spread view on a credit just as with a bond. Just as a bond can be sold to realize a gain or loss owing to spread movements, a CDS contract may be unwound in order to realize some mark-to-market gain or loss owing to changes in the CDS spread.
- Liquidity in the CDS market can be better than the cash market. For a start, a wider range of credits trade in the CDS market than in cash. We also see liquidity at fixed maturity points, the most liquid being the five-year contract, followed by the less liquid 3-year, 7-year, and 10-year points. The fact that a physical asset does not need to be sourced also means that it is generally easier to transact in large round sizes with CDS.
- Dislocations between the cash and CDS present new relative-value opportunities that can be exploited by traders. This is known as trading the *CDS basis*.

The CDS Documentation Framework

The CDS is a contract traded within the legal framework of the International Swaps and Derivatives Association (ISDA) master agreement. The definitions used by the market for defining credit events and other contractual details have been set out in the ISDA 1999 Definitions and recently amended and enhanced by the ISDA 2003 Credit Derivatives Definitions. The advantage of this standardization

EXHIBIT 58–3

ISDA Credit Events with a Description of Each

Credit Event	Description
Bankruptcy	Corporate becomes insolvent or is unable to pay its debts. The bankruptcy event is, of course, not relevant for sovereign issuers.
Failure to pay	Failure of the reference entity to make due payments, taking into account some grace period to prevent accidental triggering due to administrative error.
Restructuring	Changes in the debt obligations of the reference creditor but excluding those which are not associated with credit deterioration, such as a renegotiation of more favorable terms.
Obligation acceleration/ obligation default	Obligations have become due and payable earlier than they would have been due to default or similar condition. Obligations have become capable of being defined due and payable earlier than they would have been due to default or similar condition. This is the more encompassing definition and so is preferred by the protection buyer.
Repudiation/ moratorium	A reference entity or government authority rejects or challenges the validity of the obligations.

Source: ISDA and Lehman Brothers Fixed Income Research.

on a unique set of definitions is that it reduces legal risk, speeds up the confirmation process, and so enhances liquidity.

Of the eight possible credit events referred to in the 1999 ISDA Credit Derivative Definitions, the ones typically used within most contracts are listed in Exhibit 58–3. In terms of which are used, the market distinguishes between corporate- and sovereign-linked CDS. For corporate-linked CDS, the market standard is to use just three credit events—bankruptcy, failure to pay, and restructuring. For sovereign-linked CDS, obligation acceleration/default and repudiation/moratorium are also included.

Despite this standardization of definitions, the CDS market does not have a universal standard contract. Instead, the market has segmented into a United States, European, and Asian market standard, each differentiated by the way they handle the treatment of a restructuring credit event.

The Restructuring Clause

Restructuring is different from the other standard credit events of bankruptcy and failure to pay. Following a bankruptcy or failure to pay, *pari passu* assets of the company all should trade at the same recovery value. Bankruptcy and failure to pay therefore are known as "hard" credit events. However, following a restructuring, the debt of the reference entity continues to trade. Short-dated bonds may trade at higher prices than longer-dated bonds, and bonds with large coupons may trade at a higher price than bonds with low coupons. Loans, which typically are also deliverable, tend to trade at higher prices than bonds owing to their additional covenants.

This makes the delivery option owned by the protection buyer in a CDS potentially valuable. A protection buyer hedging a short-dated high-coupon asset may find that following a restructuring credit event it is trading at, say, $80, whereas another longer-dated deliverable may be trading at $65. By selling the $80 asset, purchasing the $65 asset, and delivering it into the CDS, the protection buyer may make a $15 windfall gain out of the delivery option. However, this gain is made at the expense of the protection seller.

This situation arose following the restructuring of debt of the U.S. Insurer Conseco in 2000. It was believed that protection buyers (mainly banks) had taken advantage of the delivery option to deliver lower priced bonds to the protection sellers than the loans they were protecting. Clearly, this left many of the protection sellers displeased and risked damaging the growing CDS market. This event spurred the credit derivatives market to act and in 2001, the U.S. market introduced a new restructuring definition called *modified restructuring mod-re*. The aim was to reduce the range of deliverable obligations following a restructuring event as a way to limit the value of the delivery option. It also attempted to ensure that a restructuring could only be triggered by a supermajority of the banks that had made the restructured loans. Owing to regulatory issues, Europe later adopted instead a similar but alternative version called *mod-mod-re* in 2003. This also set limits on which assets can be delivered following a restructuring credit event. A number of market participants, including some commercial banks and insurance companies, also have pushed the idea of a CDS contract without restructuring as a credit event. It remains to see whether this *no-re* contract will gain a significant following. A summary description of these different restructuring clauses is shown in Exhibit 58–4.

Where the same reference entity trades with different restructuring conventions, these different contract standards should be reflected in the quoted market spreads.[2] For example, modified-modified restructuring allows the protection buyer to have a broader range of deliverables than modified restructuring. This means that the value of the delivery option is greater for mod-mod-re than for mod-re, and so the protection should trade at a wider spread for the more valuable delivery option. The no-re contract should have the tightest spread, whereas contracts linked to the old-re, that is, the old restructuring definitions, should have the widest spread.

2. See Dominic O'Kane, Claus Pedersen, and Stuart Turnbull, "Valuing the Restructuring Clause in CDS," Lehman Brothers Fixed Income Research, New York, June 2003.

EXHIBIT 58–4

The Different Restructuring Standards Provided by the ISDA 2003 Definitions

Type	Description
Old restructuring	This is the original standard for deliverables in CDS in which the maximum maturity deliverable is 30 years.
Modified restructuring	This is the current standard in the U.S. market. An exact description of the allowed deliverables is beyond the scope of this chapter. Roughly speaking, it limits the maturity of deliverable obligations to the maximum of the remaining maturity of the CDS contract and 30 months.
Modified-modified-restructuring	This is the new standard for the European market. It limits the maturity of deliverable obligations to the maximum of the remaining maturity of the CDS contract and 60 months. It also allows the delivery of conditionally transferable obligations rather than only fully transferable obligations. This should widen the range of bonds/loans that can be delivered.
No restructuring	This contract removes restructuring as a credit event.

Source: ISDA and Lehman Brothers Fixed Income Research.

Credit Default Swap Formats

Credit derivatives, including CDS, can be traded in a number of formats. The standard, known as *swap format,* has been discussed already. This format is also termed *unfunded format* because the investors makes no initial payment that has to be funded. Subsequent payments are simply payments of premia. Losses require payments to be made from the protection seller to the protection buyer, and this has counterparty-risk implications.

The other format is to trade the risk in the form of a *credit-linked note*. This is essentially a synthesized bond. This format is known as *funded* because the investor has to fund the purchase price, typically par. This par is used by the issuer to purchase high-quality collateral chosen to satisfy the note buyer. At the same time, the issuer sells protection on the reference asset, passing the spread payments through to the note buyer. As a result, the investor receives the coupon on the collateral, which may be floating rate, plus the CDS spread of the reference credit. At maturity, if no credit event has occurred, the collateral matures, and the investor is returned the initial investment of par. Any credit event before maturity results in the collateral being sold, the issuer covering the loss on the CDS, and the investor receiving the remaining proceeds. In this scenario, the issuer is exposed to the default risk of the collateral rather than the counterparty.

Determining the CDS Spread

What should a protection buyer receive on the premium leg in order to compensate her for the risk of a credit event? It is possible to answer this question using no-arbitrage arguments involving cash bonds. This involves setting up a portfolio in which the cash flows of the CDS are exactly offset by those of the other cash instruments in the portfolio in all possible scenarios. Since the combined position has no net cash flow, pricing the CDS is then a matter of determining what CDS spread makes the net present value of the cash flows equal to zero.

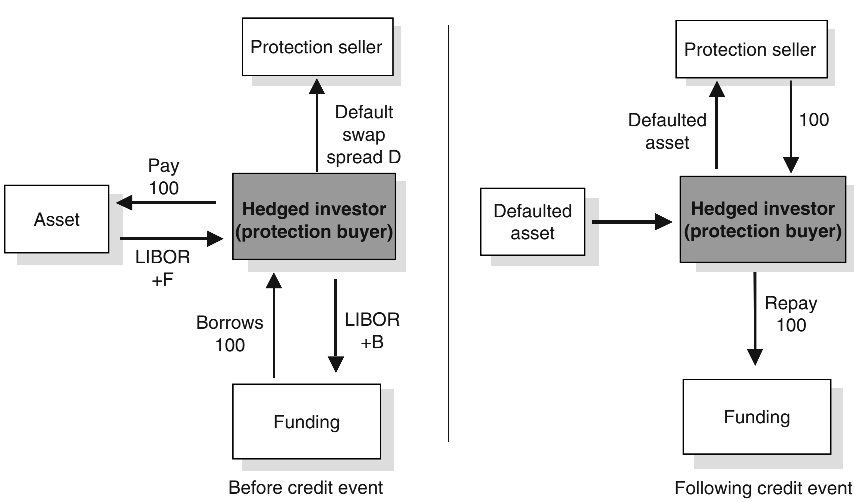
Consider the trade shown in Exhibit 58–5, where we present a "hedged investor"—a market participant who has purchased a credit-risky par floater and hedged this risk by buying protection in CDS format linked to the issuer of the par floater and with the same maturity as the par floater. Suppose that this par floater (or asset swap) pays a coupon of LIBOR plus F basis points.

The purchase of this asset for par is funded on the investor's balance sheet at a rate that depends on the borrowing cost. Alternately, the asset may be funded on repo. Suppose that the funding cost of the asset is LIBOR plus B, paid on the same dates as the CDS spread D. Suppose also that the repo rate is fixed until to the term of the CDS. Consider what happens:

Before credit event. On (annual) payment dates, the hedged investor receives $+F - D - B$ on the trade notional. At maturity, if no credit event has occurred, the protection buyer receives the par redemption from the asset and uses it to repay the borrowed par amount.

EXHIBIT 58–5

Scenarios for a Hedged Investor Showing before a Credit Event and following a Credit Event



Following credit event. The protection buyer delivers the defaulted asset to the protection seller in return for par and then repays the funding loan with this principal, which we assume costs par. The position is closed out with no net cost.

Since this whole strategy had no initial cost and is net flat following a credit event, the break-even value for the default swap spread (or what the protection buyer can afford to pay for protection) has to be such that the net flows before the credit event equal zero. For this to be true, we require that $D = F - B$. For example, suppose that the par floater pays LIBOR plus 25 basis points, and the asset can be funded at LIBOR plus 5 basis points (i.e., $B = 5$ basis points). The protection buyer is then able to pay the break-even default swap spread equal to 25 basis points − 5 basis points = 20 basis points.

Using such a no-arbitrage strategy to price CDS is not exact because it ignores effects such as accrued interest and coupon recovery. It is also not totally realistic because other effects such as availability of the cash, liquidity, supply and demand, and counterparty risk also play a role in the determination of the default swap spread. We explain these effects in more detail in the next section on the default swap basis. However, this should not detract from the main point here, which is that knowing the asset swap spread or par floater spread of the cash bond and the spread at which it can be funded provides a good reference for where the default swap will trade. Indeed, if this relationship breaks down significantly, arbitrage opportunities will arise that will be acted on and which will have the effect of reestablishing this relationship.

The Default Swap Basis

We have shown that a CDS can be viewed by a credit investor as an unfunded proxy for a cash bond. However, this relationship is not exact, and this is reflected in the market, where we observe that divergences can occur between CDS and cash spreads. We call this spread divergence the *CDS basis* and define it as follows:

$$\text{Default swap basis} = \text{CDS spread} - \text{cash LIBOR spread}$$

A *positive basis* occurs when the cash bond spread trades inside the CDS spread. A negative basis occurs when the CDS spread trades inside the cash LIBOR spread. Hence a trade that involves purchase of the cash bond and purchase of protection is termed a *negative-basis trade* or *short-basis trade* because the income to the investor is the cash LIBOR spread minus the CDS spread, which is the negative of the CDS basis, as defined earlier.

The reasons for the divergence between the cash and CDS spread can be broken down into two categories, which we shall call *fundamental* factors and *market* factors. We have examined all these factors in greater detail elsewhere[3]

3. See Dominic O'Kane and Robert McAdie, "Explaining the Basis: Cash versus Default Swaps," Lehman Brothers Fixed Income Research, New York, March 2001.

and so only summarize them below. Fundamental factors relate to the precise specification of a CDS contract.

Funding

For those credit investors who need to borrow cash in order to purchase a bond, typically banks and leveraged funds, there is an issue of funding. If their credit quality is high and so their funding is sub-LIBOR, then it may be better to buy the bond than to sell protection in CDS format. If their funding level is above LIBOR, then the reverse may be true. If the average funding level of market participants is different from LIBOR, this can drive apart the bond and CDS spread levels, resulting in a basis.

The Delivery Option

If a credit event occurs, the protection buyer in a CDS specified with physical settlement has the option to choose which asset to deliver subject to the constraints of the particular contract. Since this is a potentially valuable feature, it makes a long protection position more valuable than a short cash position and so has the effect of widening the CDS spread and so increasing the basis.

A Default Swap Protects Par

A default swap is a par asset—it compensates the protection buyer against the loss on a par value of the asset. Fixed-rate assets that typically can trade significantly above (or below) par owing to a large (small) coupon expose the investor to a greater (lower) credit risk than the same-face-value CDS. As a result, the credit spread of these assets should reflect the different credit risks. Bonds trading below par should pay a lower spread than CDS, whereas bonds trading above par should pay a larger spread than default swaps.

Counterparty Risk

A CDS is a bilateral over-the-counter (OTC) derivative transaction linked to the issuer as reference entity that is entered into with a counterparty. This adds the new dimension of counterparty credit risk to the CDS. Protection buyers therefore will tend to pay a lower spread as compensation against the risk of counterparty default. This reduces the default swap basis. However, collateral posting may be used to reduce the effective counterparty risk.

Market factors relate to the nature of the market in which the cash and default swap contracts are traded. They include technical short, convertible issuance, and demand for protection. We discuss these below.

Technical Short

The hedging of newly issued synthetic loss tranches (described later) by dealers requires a significant amount of dealer hedging by selling protection in the single-name CDS market. This has the effect of driving CDS spreads tighter, thereby reducing the basis.

Convertibles Issuance

Equity convertible funds use CDS to hedge the credit risk embedded within convertible bonds. The net effect of this is to drive default swap spreads wider, especially if there are few outstanding bonds to short on asset swap. However, the spread widening is often not sustained because, after the hedging abates, default swap spreads tend to normalized levels.

Demand for Protection

A negative view around a credit can be expressed in two ways—either the bond can be sold short or protection can be bought in default swap form, widening both cash and default swap spreads in the process. For those looking to go outright short a credit, in many cases it is much easier to buy protection in default swap format than to short the cash bond. This has the effect of driving out the default swap spread relative to the cash. Typically, we observe that any negative sentiment in the market usually is observed first in the CDS market, with the cash market lagging behind.

As more investors use the default swap as a proxy for going long the credit risk or as a new way to short credit risk, an understanding of the dynamics of the default swap basis becomes more necessary. Furthermore, the default swap basis can present new opportunities to relative-value investors.

Valuation of a Credit Default Swap Position

A CDS contract costs nothing to enter into. As a result, at trade inception, its value is zero. Thereafter, its value may change, driven mainly by changes in the market CDS spread. This value, known as the *mark to market* (MTM) is defined as the amount the market would pay us to unwind the CDS position before maturity. This MTM may be negative or positive. The purpose of this section is to describe how to calculate this value which, as we shall explain, requires a model.

The starting point is to recognize that the owner of a short protection CDS contract is long the premium leg, and short the protection leg. The premium leg is the series of contractual payments of spread until maturity or a credit event, whichever sooner. The protection leg is the contingent payment of par minus recovery following a credit event. Both premium and protection legs of a CDS each have a financial value, and that this value can change over time as the CDS spread changes.

However, at initiation of the CDS contract, the CDS spread has been set by the market so that both legs must have equal value. As a result, at contract inception

Expected present value of the protection leg
= Expected present value of the premium leg

By expected present value, we mean that all future cash flows have been discounted back to today in a way which takes into account the credit risk of the cash flows consistent with the pricing of CDS contracts. More formally, we are taking a risk-neutral expectation on the probability of a credit event.

However, once a CDS position has been established, changes in the current market CDS spread will mean that the MTM begins to deviate from zero, and this equation no longer holds. Consider the following example: An investor sells five-year protection on a reference entity at a CDS spread of 250 basis points. One year later the credit quality of the reference entity has improved, and the corresponding CDS spread has tightened so that four-year CDS protection trades at 100 basis points. What is the value of the CDS position?

To begin with, the MTM value of the contract to the investor is given by the difference between what the investor is expecting to receive minus what she is contractually liable to pay. As a result, we can write

MTM = expected present value of premium leg of 250 basis points
– expected present value of protection for four years

We also can write that the current four-year market spread of 100 basis points is the current break-even spread. By definition, the current value of a new four-year contract is zero, so we can write

Expected present value of premium leg of 100 basis points
= expected present value of protection for four years

Substituting we, write

MTM = expected present value of premium leg of 250 basis points
– expected present value of premium payments at 100 basis points

As both premium legs are paid on the same schedule and are subject to the same contingent credit event, they can simply be netted as

MTM = expected present value of premium leg of 150 basis points

To go any further, we have to compute the discounted present value of these 150 basis points payments. However, these payments are only made until the maturity of the CDS or *to the time of a credit event,* whichever is sooner. To compute the MTM, we need to weight each premium payment by the probability that there is no credit event until that payment date. We therefore write

$$\text{MTM} = 150 \text{ basis points} \times \text{RPV01}$$

The RPV01 is the "risky" PV01, equal to the expected present value of 1 basis point paid on the premium leg of the CDS, until maturity or credit event, whichever is sooner. However, calculating the risky PV01 of a CDS requires a model which uses the market spreads of CDS to determine the market implied (or risk-neutral) probability of default of the reference credit. Investors can find an implementation of the market standard model on Bloomberg under the CDSW function or can implement their own version. A full description of the model can be found elsewhere.[4]

4. See Dominic O'Kane and Stuart Turnbull, "Valuation of Credit Default Swaps," *Lehman Brothers Quantitative Credit Research Quarterly,* 2003-Q1/Q2.

Unwinding a Credit Default Swap

A CDS is an over-the-counter (OTC) derivative contract. Since almost all CDS are traded within the framework of the ISDA Master Agreement, there is widespread standardization of the documentation of CDS, and many counterparties are happy to trade these bilateral contracts in what is effectively a secondary market. To unwind a CDS before its maturity date, an investor may choose one of following three courses of action.

1. Negotiate a cash unwind price with the original counterparty. The price should be the same as the MTM value. In practice, a bid-offer spread will have to be crossed. Part of this negotiation may involve some exchange of information as to the recovery-rate assumptions used by both counterparties because this is one of the inputs to the pricing model.
2. If the investor is shown a better unwind price by a counterparty different from the one with whom the initial trade was executed, he can ask to have the contract reassigned to this other counterparty and then close it out for a cash unwind value.
3. Finally, the investor may choose to enter into an offsetting position. For example, an investor who has sold protection for five years may decide a year later to close out the contract by selling protection for four years. The value of this combined position should exactly equal the model market to market.

Which one of these choices is made is usually determined by which is showing the best price. Note that choice 3 is different from choices 1 and 2 because it does not result in the investor receiving a cash amount, realizing any gain or loss, and terminating the trade. Instead, the mark-to-market is unrealized and must be realized over the remaining life of the contracts. If the mark-to-market is positive, there is a risk that a credit event occurs, all remaining spread income is lost, and the gain is not realized. On the other hand, if no credit event occurs, the received income will be worth more than that received through the cash unwind.

Upfront Credit Default Swaps

If the reference credit in a CDS becomes distressed, new CDS contracts linked to that name begin to trade in what is known as *upfront* format. In these contracts, the protection buyer pays for the protection to some specified maturity date in a single upfront payment. No further payments of premium are required. The protection or contingent leg of the default swap is exactly the same as in a standard default swap. To distinguish the two formats, the standard contract may be termed a *running* CDS as the premium is paid as a spread on the face value of the protection on payment dates *running* throughout the life of the contract.

The reason why dealers prefer to quote distressed credits in upfront format is that it reduces the variance in the outcomes. If the protection seller quotes too low a running spread, he can lose significantly if there is an early credit event. If the protection buyer quotes too high a spread, then he can lose significantly if there is no credit event. Upfront CDS therefore have enabled the CDS contract to adapt to the situation of highly distressed credits. In addition, they have provided market participants with a new type of relative-value-basis trading opportunity.[5]

CDS PORTFOLIO PRODUCTS

CDS portfolio products enable an investor to go long or short the credit risk associated with a portfolio of CDS in one transaction. They are effectively equivalent to the investor buying or selling, in CDS format, all the underlying credits in the portfolio.

Since 2002, the credit derivatives market has witnessed the dramatic growth of CDS portfolio products. These are the Dow Jones (DJ) CDX index products in the United States and the DJ iTraxx products in Europe.

Both are families of indexes referencing a portfolio of the most liquidly traded 125 CDS names in the United States and Europe, respectively. An Asian set of indexes with fewer names also exists. Currently, these indexes are issued once or twice a year, in March and September, with a 5- and 10-year maturity. They trade in the form of an unfunded swap format similar to a standard CDS, with the difference being that the contractual spread is fixed at issuance. As a result, entering into an index at a later date involves an up-front payment of the mark to market of the index. It is also possible to embed these indexes into a credit-linked note format. These are generally issued at par.

Consider the DJ iTraxx Europe Series 2 Main index which was issued with a contractual spread of 35 basis points and matures on the March 20, 2010. The value of the contract is embedded within the quoted index spread observed in the market. If this is trading at a spread of 36.50/37.0 basis points, then to enter a long protection position on this index, the protection buyer has to trade at 37.0 basis points. On a notional of €10 million, to enter this would cost €8,936 (including accrued interest) which is paid on trade date plus 3 days. This price is calculated using a simple extension of the model used for the pricing of standard CDS.

If one of the names in the index experiences a credit event before maturity, the protection seller is required to physically take delivery of 1/125th of €10 million = €80,000 of face value of the defaulted asset in return for a payment of €80,000 in cash. The notional, on which the contractual spread of 35 basis points is paid, reduces from €10 million to €9.92 million.

5. See Dominic O'Kane and Saurav Sen, "Up-front Credit Default Swaps," *Lehman Brothers Quantitative Credit Research Quarterly,* 2003-Q3.

These indexes are a very efficient way to assume or hedge a macro credit position in U.S. or European markets. As a result, they are traded by a wide range of users including hedge funds, asset managers, insurance companies, correlation trading desks, and corporate treasuries. It is also possible to trade sub-sectors of these indexes such as Financials, Telecom, Tech (TMT), Industrials, Energy, Autos, and Consumer sectors separately, making it much easier to implement cross-sector trading strategies. It is also worth noting that the indexes can trade rich or cheap to their intrinsic value (i.e., the spread implied by the individual spreads of all constituent credit default swaps). This may reflect a market demand to buy or sell portfolio-wide credit risk rather than single-name credit risk.

Both the DJ CDX and DJ iTraxx products have gained significant liquidity, frequently trading with sub basis point bid-offer spreads. This makes frequent trading cheap and viable and so has resulted in the creation of more complex derivative structures linked to these indexes. These include synthetic tranches and options which are discussed later.

For investors looking to benchmark the performance of their CDS portfolios, a different type of index is required. Lehman Brothers has produced a family of global investment-grade CDS indexes. There is a 250-credit U.S. index, a 150-credit European index, and a 40-credit Japanese index. Note that a benchmark index is not the same as a traded CDS portfolio product such as DJ iTraxx because a benchmark index must price at its intrinsic value, should be completely transparent in terms of rules of inclusion and rebalancing, and should be as representative of the whole regional credit market as possible.

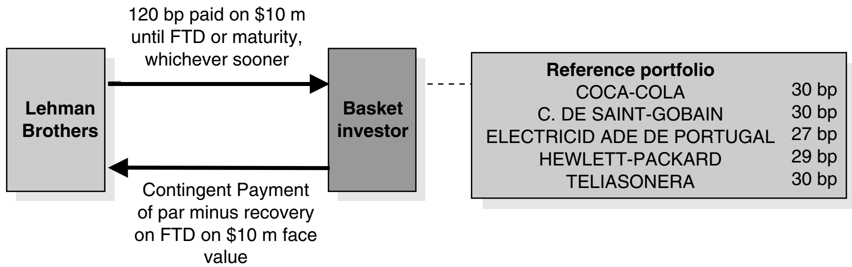
BASKET DEFAULT SWAPS

Baskets default swaps, or *default baskets*, are the simplest synthetic credit correlation product. Synthetic credit correlation products are based on redistributing the credit risk of a portfolio of CDS. The underlying portfolio may be as small as five credits or as large as 200. The redistribution mechanism is based on the idea of assigning losses on the credit portfolio to the different securities in a specified order. The riskiest securities take the first losses on the underlying portfolio, whereas the safer securities take later losses. This mechanism exposes the investor to the tendency of assets in the portfolio to default together, that is, default correlation.

A basket default swap is similar to a CDS with the difference that the trigger is the nth credit event in a specified basket of reference entities. In the particular case of a first-to-default (FTD) basket, $n = 1$, and it is the first credit event in a basket of reference credits that triggers a payment to the protection buyer. As with a CDS, the contingent payment typically involves physical delivery of the defaulted asset in return for a payment of the par amount in cash. In return for assuming the n-to-default risk, the protection seller receives a spread paid on the notional of the position as a series of regular cash flows until maturity or the nth credit event, whichever is sooner.

EXHIBIT 58–6

Mechanics of a First-to-Default (FTD) Basket on Five Credits



The advantage of a FTD basket is that it enables an investor to leverage their risk *without* increasing the notional at risk. This can be done while still being exposed to well-known investment-grade credits. What is leveraged in a FTD basket is not the size of the exposure but the probability of a triggering event, since the risk of one or more asset in a portfolio defaulting is greater than the probability of any one asset defaulting. Because of this, the basket spread paid can be a multiple of the spread paid by the individual assets. This is shown in Exhibit 58–6 where we have basket of five investment-grade credits paying an average spread of about 29 basis points, but the FTD basket pays 120 basis points.

More risk-averse investors can use default baskets to construct lower-risk assets. Second-to-default (STD) baskets, where $n = 2$, trigger after two or more assets have undergone credit events. For a typical basket of five assets, the likelihood of two or more assets defaulting is significantly smaller than the probability of any one asset in the portfolio defaulting. The spread paid therefore is low. For certain investors, an STD basket may be viewed as a better risk-return investment than buying a single, very-high-quality asset.

A default basket, irrespective of whether it is FTD or STD, cannot be replicated using existing single-name instruments. Valuation requires a pricing model. We list below the main inputs to such a model and their effect on the basket spread:

Value of n. An FTD ($n = 1$) is riskier than an STD ($n = 2$) and so commands a higher spread.

Number of credits. The greater the number of credits in the basket, the greater is the likelihood of one or more credit events, and so the higher the spread.

Credit quality. The lower the credit quality of the credits in the basket, which can be measured in terms of spread or rating, the higher is the spread.

Maturity. The effect of maturity depends on the shape of the individual credit curves and the correlation term structure.

Recovery rate. Following a default, the investor will prefer a higher realized recovery rate because this results in a smaller loss. From a valuation perspective, the recovery-rate sensitivity is lowered by the fact that the implied default probability must increase if the assumed recovery rate increases, assuming a fixed spread.[6]

Default correlation. Increasing default correlation increases the likelihood of more assets defaulting and surviving together. We now discuss this is more detail.

Baskets and Default Correlation

The default basket spread depends on the tendency of the reference assets in the basket to default together. It is reasonable to assume that assets issued by companies within the same country and industrial sector should have a higher default correlation than those within different industrial sectors. After all, they share the same market and the same interest rates and are exposed to the same costs. At a global level, all companies are affected by the performance of the world economy. We believe that systemic risks tend to outweigh idiosyncratic effects, so we expect that default correlation is, on average, positive.

Increasing default correlation has two effects on a portfolio of credits—it makes the credits more likely to *survive together* and to *default together*. There are two correlation limits in which an FTD basket can be priced without resorting to a model: (1) when all the assets are independent and (2) when the assets have maximum correlation. We consider these in turn.

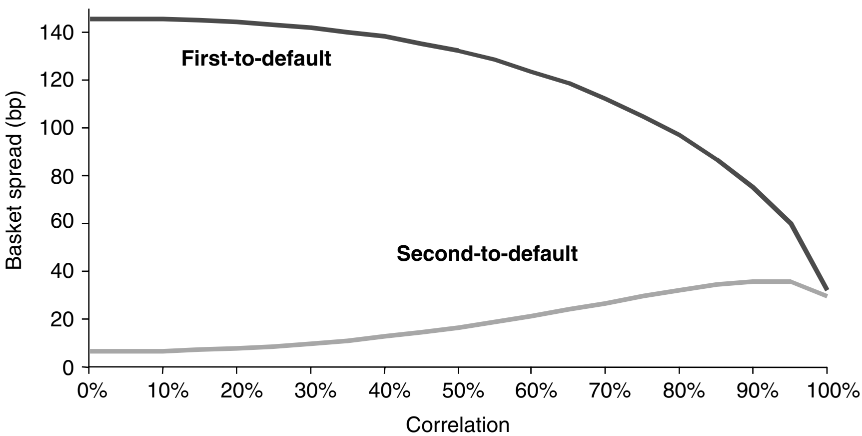
Independence

Consider a five-credit FTD basket where all the underlying credits have flat credit curves. If the credits are all independent and never become correlated during the life of the trade, the natural hedge is for the FTD basket investor to buy CDS protection on each of the individual names to the full notional. If a credit event occurs, one of the CDS hedges covers the first loss on the basket, and all the other CDS hedges can be unwound at no cost, assuming that they have (on average) simply rolled down their flat credit curves. This is due to the independence assumption which means that they have not widened after the first credit event. This implies that the initial basket spread for independent assets with flat credit curves should be equal to the sum of the spreads of the names in the basket.

6. It is possible to show that the CDS spread S is related to the annualized default probability P and the recovery rate R via the approximate relationship $S = P(1 - R)$. To hold the spread constant, an increase in the recovery rate requires that the probability of default also must increase.

EXHIBIT 58–7

Correlation Dependence of Spread for an FTD and STD Basket on Five Names



Maximum Correlation

Consider the same FTD basket, but this time where the default correlation is at its maximum. In practice, this means that when any asset defaults, the asset with the widest spread always will default too. As a result, the probability of the basket being triggered has to be the same as the probability of the widest spread asset defaulting, and the FTD basket spread should be that of the widest spread credits in the basket.

Between these two limits we require a full model of the dependency structure of default to calculate the fair-value basket spread. Using a gaussian copula[7] model, we have plotted in Exhibit 58–7 the correlation dependence of the FTD and STD spread for the five-credit basket shown in Exhibit 58–6. At 0% correlation, the credits in the portfolio are independent, and the FTD spread is close to 146 basis points, the sum of the spreads. At 100% correlation, the basket has the risk of the widest spread asset, equal to 30 basis points. The STD spread is lowest at zero correlation because the probability of two assets defaulting is low if the assets are independent. At maximum correlation, the STD spread tends to the spread of the second-widest asset in the basket, also equal to 30 basis points.

Many investors require a credit rating on the basket. Rating agencies have developed their own models for rating default baskets. Using a model calibrated to historical default statistics and that takes into account the default correlation

7. For a description of CDO valuation models, see Dominic O'Kane, Marco Naldi, Sunita Ganapati, Claus Pedersen, Arthur Berd, and Roy Mashal, *The Lehman Brothers Guide to Exotic Credit Derivatives* (New York: Lehman Brothers Fixed Income Research, 2003).

between the assets, Moody's determines the expected loss on the basket and uses this output to determine the appropriate rating. S&P has its own model, which attempts to capture the same effects. S&P uses the probability of loss rather than the expected loss to determine the credit rating.

Uses of Default Baskets

Default baskets have a range of applications, which we list.

- Investors can use default baskets to leverage their credit exposure and so earn a higher yield without increasing their notional at risk.
- The reference entities typically are investment grade and hence familiar to credit analysts and so require little extra analysis.
- The basket can be customized to the investors' exact view regarding notional, maturity, number of credits, the credit selection, and the order of protection, that is, FTD or STD.
- Default baskets can be used to hedge a portfolio of credits more cheaply than buying protection on each of the individual credits.
- Default baskets can be used to express a view on default correlation.

SYNTHETIC CDOs

Synthetic CDOs, also known as *synthetic loss tranches,* were conceived in 1997 as a flexible and low-cost mechanism for transferring credit risk off bank balance sheets. The primary motivation was to use them as a way to reduce regulatory capital. However, over the past few years, investors have begun to view synthetic CDOs as an asset class that enables them to create portfolio credit risks that match their risk appetite. This has been assisted by the new correlation trading paradigm, discussed below, that has enabled dealers to issue customized synthetic loss tranches.

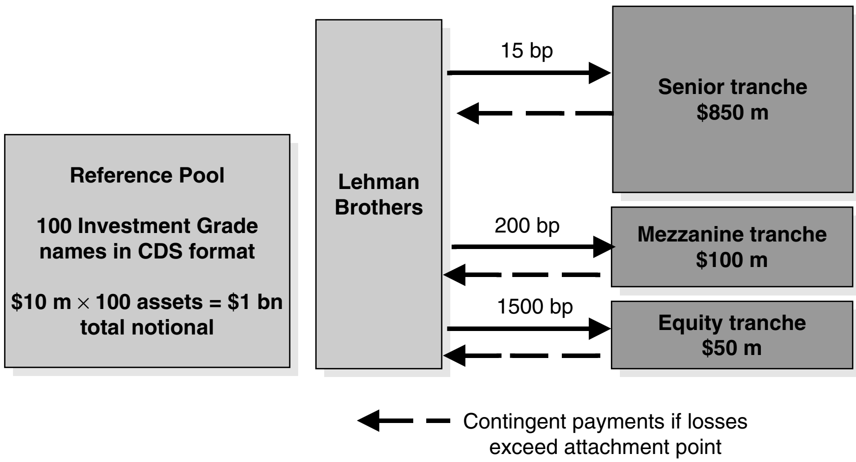
Mechanics of a Synthetic CDO

The performance of a synthetic CDO is linked to the incidence of credit events in a reference synthetic portfolio of CDS. As with a default basket, the CDO redistributes this risk by allowing different tranches to take these default losses in a specific order. As with baskets, this ordering of losses introduces an exposure to default correlation.

Consider the synthetic CDO shown in Exhibit 58–8. In this example, there is a reference pool of 100 CDS, each with a €10 million notional. This risk is redistributed into three tranches: a $50 million equity tranche, a $100 million

EXHIBIT 58–8

The Mechanics of a Synthetic CDO



mezzanine tranche, and an $850 million senior tranche. These tranches can be traded in unfunded swap format just as with CDS, and the investor is simply paid a coupon commonly referred to as a *spread*. If traded in a funded format, the investor pays par to buy the credit-linked note and receives LIBOR plus this spread. Consider an unfunded CDO. The investor in the equity tranche receives a spread of 1500 basis points, the investor in the mezzanine tranche receives a spread of 200 basis points, and the senior investor receives a spread of 15 basis points.

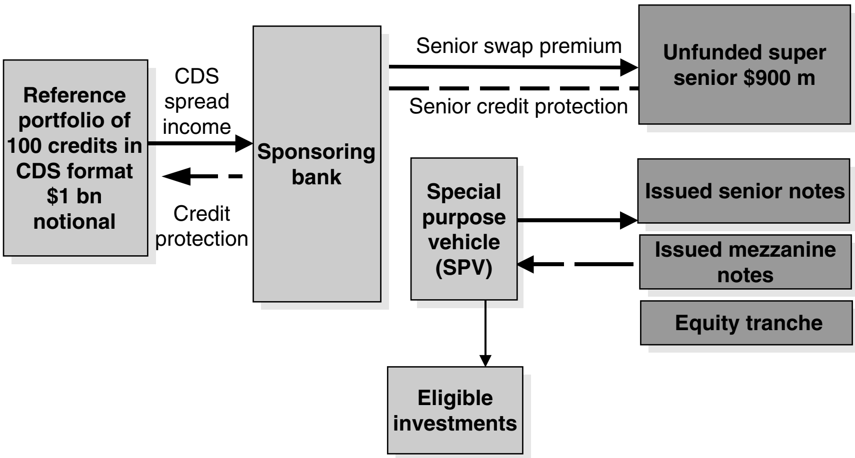
When nothing defaults in the reference portfolio of the CDO, the investor simply receives the spread until maturity. However, consider what happens if one of the reference entities in the reference portfolio undergoes the first credit event with a 30% recovery causing a $7 million loss.

- The equity investor takes the first loss of $7 million, which is immediately paid to the originator.
- The "equity" tranche notional falls from $50 million to $43 million, and the equity coupons, set at 1500 basis points, is now paid on this smaller notional. These therefore fall from $7,500,000 to 15% × $43,000,000 = $6,450,000.
- If traded in a funded format, the $3 million recovery is either reinvested in the portfolio or used to reduce the exposure of the senior-most tranche (similar to early amortization of senior tranches in cash-flow CDOs).

This process repeats following each credit event. If the losses exceed $50 million, then the mezzanine investor must bear the subsequent losses with the corresponding reduction in the mezzanine notional. If the losses exceed $150 million, then it is the senior investor who takes the principal losses.

EXHIBIT 58–9

The Structure of a Full Capital Structure Synthetic CDO



Full Capital Structure Synthetics

There are two ways of issuing a synthetic CDO. The first is as a full capital structure synthetic, and the second is as a customised tranche. In the typical full capital structure synthetic CDO structured using securitization technology, the sponsoring institution, typically a bank, enters into a portfolio default swap with a special purpose vehicle (SPV). The SPV typically provides credit protection for 10% or less of the losses on the reference portfolio. The SPV, in turn, issues notes in the capital markets to cash collateralize the portfolio default swap with the originating entity. The notes issued can include a nonrated "equity" piece, mezzanine debt, and senior debt, creating cash liabilities. The remainder of the risk, 90% or more, generally is distributed via a senior default swap to a highly rated counterparty in an unfunded format, as shown in Exhibit 58–9.

Reinsurers, who typically have AAA/AA ratings, traditionally have had a healthy appetite for this type of senior risk and are the largest participants in this part of the capital structure—often referred to *as super senior AAAs* or *super senior swaps*.

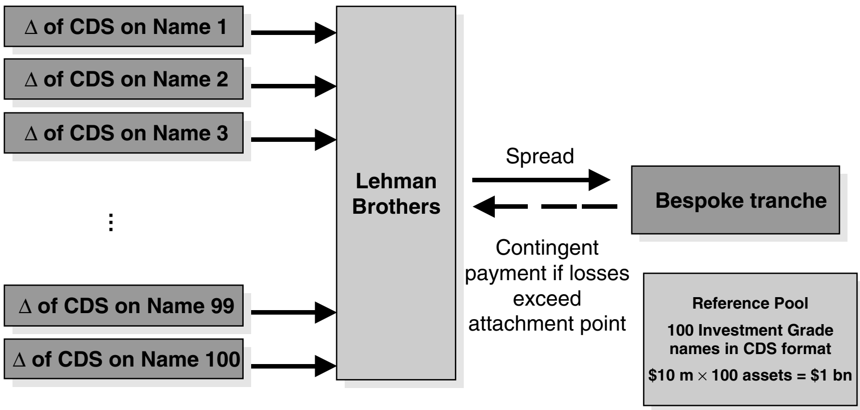
If an obligor in the reference pool defaults, the trust liquidates investments in the trust and makes payments to the originating entity to cover default losses. This payment is offset by a successive reduction in the equity tranche and then in tranches in order of subordination (BBs, BBBs, As, AAs, AAAs), and finally, the superseniors are called to make up losses.

Bespoke Synthetic CDO Tranches

Unlike full capital structure synthetics that issue the whole capital structure, bespoke synthetics may issue only one tranche on a given reference portfolio of

EXHIBIT 58–10

Dealer Hedging of a Bespoke Synthetic CDO Tranche



CDS. The advantage of bespoke tranches is that they can be designed to match exactly the risk appetite and credit expertise of the investor. The investor can choose the credits in the collateral, the trade maturity, the attachment point, the tranche width, the rating, the rating agency, and the format (funded or unfunded). Execution of the trade can take days rather than the months that full capital structure CDOs require.

What makes this possible is the use by dealers of derivative technology to dynamically hedge the first-order risks of a synthetic tranche using CDS and to use a trading-book approach to hedge the higher-order correlation and other risks.

For example, consider an investor who buys a bespoke mezzanine tranche from Lehman Brothers. We will then hedge it by selling protection on a "delta" amount of each credit in the portfolio via the CDS market. This is shown in Exhibit 58–10. The delta is the amount of protection to be sold in order to immunize the portfolio against small changes in the CDS spreads for that credit. Higher-order correlation risks then are managed as part of a large correlation trading book that will contain risk-offsetting trades.

Standard Synthetic CDO Tranches

Since late 2003, the CDO market has seen a considerable growth in the liquidity of synthetic CDO tranches with the standard DJ CDX and DJ iTraxx indexes as the reference portfolio. We are now able to observe daily pricing on a range of CDO tranches linked to U.S., European, and Japanese investment-grade and high-yield CDS indexes.

EXHIBIT 58–11

Indicative Pricing for the Standard DJ CDX and DJ iTraxx Europe Tranches for October 13, 2004*

	5Y CDX Investment Grade North America Series 3		5Y iTraxx Europe Series 2	
Tranche	**Lower-Upper Strike**	**Upfront/ Running Spread (bp)**	**Lower-Upper Strike**	**Upfront/Running Spread (bp)**
Equity	0–3%	37.125% + 500	0–3%	24.25% + 500
Junior Mezzanine	3–7%	259.5	3–6%	137.5
Senior Mezzanine	7–10%	101.0	6–9%	47.5
Senior	10–15%	38.5	9–12%	34.5
Super Senior	15–30%	11.5	12–22%	15.5

*Note that the convention for quoting prices is different for equity tranches. We can see that an investor who goes long the credit risk of the 0–3% equity tranche receives an upfront payment of 37.125 points plus a running annual spread of 500 bp. An investor who buys the 3–6% tranche receives an annualized spread of 259.5 bp (paid in quarterly installments).

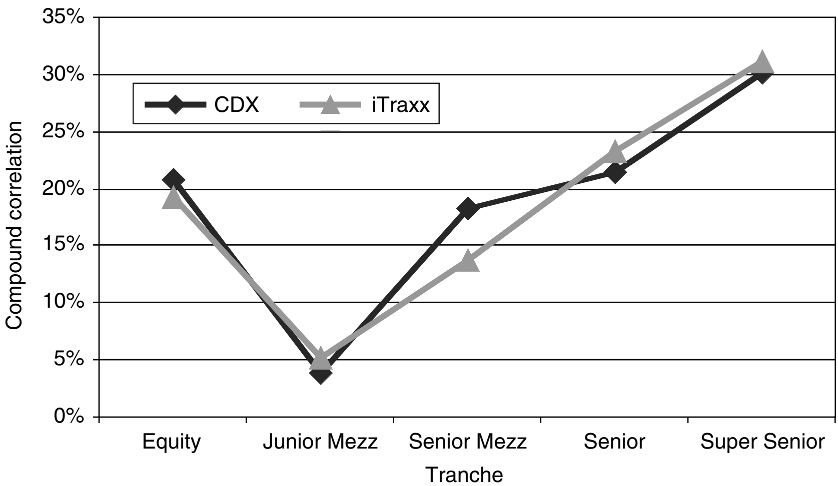
Each standard tranche is denoted by its subordination and its upper limit expressed as a percentage of the size of the underlying reference portfolio. For the U.S. DJ CDX index, the standard tranches are an equity 0–3%, followed by a junior mezzanine 3–7%, a 7–10% senior mezzanine, a 10–15% senior, and a 15–30% super senior tranche. No tranches trade with a subordination greater than 15% as this is considered to be essentially risk free. The European DJ iTraxx tranches have slightly lower subordinations: 0–3%, 3–6%, 6–9%, 9–12%, and 12–22%. This reflects the tighter CDS spreads observed in the investment grade credit European market.

An example of tranche pricing observed on the October 13, 2004, for tranches on these indexes is shown in Exhibit 58–11. Note that the equity tranche trades as a combination of an upfront payment plus a running spread. So an investor who purchases $10 million of a 0–3% tranche on the 5-year CDX index will receive an initial payment of $3.7125 million plus a running spread of 500 basis points per annum, paid on the outstanding tranche notional for the remaining five years. We also see that an investor in the 5-year maturity 3–7% junior mezzanine tranche on the CDX investment grade portfolio will receive an initial coupon of about 260 basis points per annum.

As discussed in the previous section, the investor in a 3–7% tranche will only incur principal losses if there are a sufficient number of defaults for the losses to

EXHIBIT 58–12

Compound Correlation Curve for DJ CDX and DJ iTraxx Europe for October 13, 2004



exceed the subordination of 3%. How many credit events over five years would be needed to cause this to occur? Given that there are 125 names in the reference index, and assuming a recovery rate of 40%, this implies that it would take seven credit events out of a total of 125 investment credits for this tranche to begin to incur losses.

The price of a CDO tranche is a function of the default correlation between the assets in the reference portfolio.[8] An equity tranche investor can be shown to be long the default correlation between the credits in the underlying CDS index while a senior tranche investor is short this default correlation. Hence an equity tranche will increase in value and a senior tranche will fall in value if the default correlation of the underlying CDS index increases.

By observing the market prices of synthetic CDO tranches, we can begin to extract information about market-implied rather than historical default correlation. To do so requires the invocation of a particular model and the market standard has become the Large Homogeneous Portfolio model.[9] This has led to the observation of an implied correlation smile, shown in Exhibit 58–12, in which different tranche prices are seen to exhibit different correlation assumptions. This can be viewed as analogous to the volatility skew observed in the equity options market.

8. A See O'Kane, Naldi et al. [2003] for a discussion.
9. See Base Correlation Explained, O'Kane and Livesey, Lehman Brothers Fixed Income Quantitative Research, December 2004.

This "smile" shape is interesting and can be explained. It is first worth emphasizing that it is driven by market prices—prices at which buyers and sellers of tranche protection are willing to trade. It is also present in both the DJ CDX tranches and the DJ iTraxx tranches and has persisted through time for both 5-year investment-grade indexes. We believe that this smile shape reflects a mixture of effects including concerns about systemic versus idiosyncratic credit risk, fear of principal versus mark-to-market losses, liquidity effects, and supply and demand for certain tranches. It can be argued that this shape is driven by the fall in implied correlation for the junior mezzanine tranches which is due to the significant demand in the market for this tranche rather than the others. After all, this is the first investment-grade tranche as you ascend the capital structure of the CDO. Demand for this tranche causes the spread of the junior mezzanine tranche to tighten. As this tranche is short correlation, this then results in a lower implied correlation.

There have been a number of extensions to the standard synthetic CDO structure. These have included the incorporation of reserve accounts and coupon step-ups and the introduction of substitution rights for credits in the reference portfolio. One very recent extension of the CDO paradigm has been the CDO of CDOs, also known as *CDO squared*. Typically, this is a mezzanine super tranche CDO in which the collateral is made up of either mezzanine tranches of synthetic CDOs or a mixture of asset-backed securities and mezzanine tranches of synthetic CDOs. Principal losses are incurred if the sum of the principal losses on the underlying portfolio of synthetic tranches exceeds the attachment point of the super tranche. This structure enables the investor to further leverage the credit risk embedded within the underlying single-name credits while maintaining a buffer of subordination against small numbers of defaults.

Valuation of a Synthetic CDO

The synthetic CDO spread over LIBOR depends on a number of factors. We list the main ones and describe their effect on the tranche spread.

Attachment point. This is the amount of subordination below the tranche. The higher the attachment point, the more defaults are required to cause tranche principal losses, and the lower is the tranche spread.

Tranche width. The wider the tranche for a fixed attachment point, the more losses to which the tranche is exposed. However, since the spread is expressed as a percentage of the tranche notional, it is not always clear if the spread should increase or decrease. This requires a model that takes into account the tranche and collateral details.

Portfolio credit quality. The lower the quality of the asset portfolio, measured by spread or rating, the greater is the risk of all tranches owing to the higher default probability, and the higher is the spread.

Portfolio recovery rates. Lower recovery rates imply larger losses on default.

Maturity. This depends on the shapes of the CDS credit curves for the reference portfolio and the term structure of correlation.

Default correlation. If default correlation is high, assets tend to default together, and this makes senior tranches more risky. Assets also tend to survive together, making the equity safer. Senior investors therefore are short correlation, and equity investors are long correlation. Mezzanine investors can be either long or short correlation. Determining this very much depends on the details of the tranche and the collateral and usually requires a model.

There is a fundamental difference between the nature of the credit exposure to equity and senior tranches. Equity tranches are idiosyncratic credit plays because they incur a principal loss as soon as one asset in the collateral defaults. This implies that equity investors should focus less on the overall properties of the collateral and more on trying to choose assets that they believe will not default. As a result, we would expect equity tranche buyers to be skilled credit investors, able to pick the right credits for the portfolio or at least able to hedge the credits they do not like. On the other hand, the senior investor has a significant cushion of subordination to insulate her from principal losses until maybe 20 or more of the assets in the collateral have defaulted. As a consequence, the *senior investor is truly taking a portfolio view* and so should be more concerned about the average properties of the collateral than the quality of any specific asset. The senior tranche is really a deleveraged macro credit trade. Mezzanine tranche investors are somewhere in between these two limits.

As with basket default swaps, rating agencies have their own models for rating CDO tranches. All of them attempt to capture the risks of CDOs in terms of asset quality, recovery rates, default correlation, and structural features. Moody's standard rating model for CDO tranches is a multinomial extension of the binomial expansion technique (BET) model that captures default correlation by taking into account the number of assets across different industries. After calibrating to historical default data, the model is able to generate an expected loss for a tranche that takes into account the subordination and default correlation. This expected loss is then mapped to a rating category. In S&P's ratings methodology, a Monte Carlo simulation is used to model the losses on the tranche. This model is calibrated using historical rating default statistics, and correlation assumptions are made regarding the distribution of assets across different industry sectors. Unlike Moody's, who rate on the basis of expected loss, Standard & Poor's rates on the probability of a tranche loss.

CREDIT DERIVATIVE OPTIONS

While the credit derivatives market has evolved from trading single-name default risk in CDS format to trading portfolio default correlation risk in CDOs, there has been little increased activity in credit volatility dimension, as noted earlier in this chapter—the options component of the credit derivatives market accounts for only

1% of market outstanding notional. However, this has started to change, and we are starting to see a growing market in both bond options and options on default swaps.

Bond Options

Traditionally, the market in credit volatility has been linked to corporate bonds. Puts and call options on corporate bonds have traded, albeit with fairly low liquidity, for many years. There also has been a lot of stripping of embedded options from corporate bonds. This is now changing because we have seen a significant increase in the trading of short-dated corporate bond options over the past year. The most liquid corporate bond options typically have been European-style options with the strike specified in price terms. The option maturities have been between three and six months.

One popular strategy among investors has been selling covered calls. This involves buying a corporate bond and selling a call option struck at a slightly higher price. The option premium can be seen as a way to reduce the purchase price of the bond. If the bond price does not rise too much, the option expires out of the money, and the investor enhances his yield on the strategy beyond what he would have received by buying just the bond. Another strategy is the naked put, in which the investor sells a put on a bond. If the bond price falls below the strike price, the investor receives the bond and holds onto the option premium. However, if the price remains above the strike, then the investor just keeps the premium.

Default Swaptions

We also have seen the birth of a new market in synthetic credit options with the advent of options on CDS known as *default swaptions*. This growth has been driven by credit investors using options as a way to enhance yield or to take a view on credit spread volatility. Some also has been driven by hedge funds using options as a component of capital structure arbitrage trades.

Instead of the terms *call* and *put,* credit derivative market convention describes options to buy protection as *payer default swaptions*—the investor will pay the spread if the option is exercised. Options to sell protection are known as *receiver default swaptions*—the investor will receive the spread if the option is exercised. This mirrors the terminology used in the interest-rate swap market when discussing options on interest-rate swaps. Another variation is the *cancellable default swap,* in which a protection buyer can cancel her protection at no cost. This is often useful for bank loan portfolio managers hedging loans that can be prepaid.

Most default swaptions are European-style; that is, they can only be exercised at expiry. They are usually short-dated, with expiries of less than a year on a five-year CDS underlying. As with CDS, the expiry date is usually aligned with the twentieth of June, September, December, or March.

EXHIBIT 58–13

Default Swaption Types

Product	Payer Default Swaption	Receiver Default Swaption
Credit option equivalent	Put	Call
Description	Option to buy protection forward	Option to sell protection forward
Exercised if	CDS spread at expiry > strike spread	CDS spread at expiry < strike spread
Credit view	Short credit forward	Long credit forward
Knockout	May trade with or without	Not relevant

In a payer default swaption, the option buyer pays a premium to the option seller for the right but not the obligation to buy default protection on a reference entity at a predetermined spread on a future date. The standard payer default swaption knocks out at no cost if there is a credit event between trade date and expiry date. In some cases this may be removed such that the option holder could exercise into a payment of protection.

In the case of a receiver default swaption, the option buyer pays a premium to the option seller for the right but not the obligation to sell CDS protection on a reference entity at a predetermined spread on a future date. This spread is the option strike. There is no need to consider what happens if the reference entity experiences a credit event between trade date and expiry date because the receiver option holder would never exercise in this case. As a result, there is no need for a knockout feature for receiver default swaptions. The different types as summarized in Exhibit 58–13.

Since the pricing of a default swap is driven almost exclusively by the default swap spread, options on default swaps are also almost pure plays on credit spread and volatility. Currently, the standard pricing model for these instruments is based on extensions to Black's model for pricing interest-rate swaptions.[10] Most options are also traded at or close to the money, so there is as yet no observable volatility skew.

Default swaption products therefore are a useful tool for investors to take a view on pure credit spread volatility on a single name. They make possible to credit investors a wide range of option strategies, including directional strategies

10. See Philipp Schonbucher, "A Note on Survival Measures and the Pricing of Options on Credit Default Dwaps," working paper, May 2003.

such as bull spreads and bear spreads and market-neutral strategies including strangles and straddles.

Portfolio Swaptions

We are also seeing rapid growth in options on the DJ iTraxx and DJ CDX portfolios products of CDS. The advantage of these is that they reduce the investor's exposure to idiosyncratic risk, allowing investors to take an asymmetric view on macro credit spread movements. Portfolio swaptions also enable the investor to express a view on macro credit volatility. By trading options on subindexes of these products, investors also can trade sector volatilities. For hedgers, these options can be used as a cheaper way to hedge a portfolio credit exposure. The pricing of these products is more involved than single-name default swaptions.[11] However, this is a product that has seen a huge increase in liquidity over the past few months.

CONCLUSIONS

The credit derivative market has revolutionized the credit markets by creating an alternative to trading cash that also can enable market participants to go short credit risk more efficiently. Furthermore, the credit derivative market also has been extended to create exposures to default correlation and spread volatility. These have presented new and flexible ways for investors to tailor risk profiles to their precise risk appetite and credit view.

Credit derivatives have also enabled the redistribution of credit risk from the traditional holders of credit (i.e., banks with their loan books), to the capital markets and so to non-traditional credit holders such as insurance companies and hedge funds. Banks have also been able to diversify their concentration of credit risk exposure to particular credits by buying protection on one name and selling protection on another. It can be argued that this has helped to reduce the systemic credit risk in the banking sector.

The credit derivatives market has been driven by the twin processes of innovation and standardization. Innovation is driven by the need to find new products which package and redistribute credit risk more efficiently. However innovation is only made possible by the process of standardization which generates the products with the liquidity and simplicity necessary to hedge these new innovative products. We expect these two processes to continue.

11. See Claus Pedersen,"Valuation of Portfolio Credit Default Swaptions," Lehman Brothers Fixed Income Research, *Quantitative Credit Research Quarterly,* 2003–Q4.

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PART

EIGHT

CONVERTIBLE SECURITIES

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CHAPTER
FIFTY-NINE

CONVERTIBLE SECURITIES AND THEIR INVESTMENT CHARACTERISTICS

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Convertible securities are fixed income securities that permit the holder the right to exchange that security for the common stock of the issuing corporation under prespecified conditions. The terms at which the debt security can be exchanged for the issuer's common stock are set forth in the security's indenture. The option to convert is solely at the discretion of the debt holder and will only be exercised if the holder finds such an exchange desirable. Mandatory convertible securities are an exception; conversion to equity is required.

Convertible securities typically contain other embedded options. The most common is an option providing the issuer the right to call the issue at its discretion in accordance with the terms set forth in the indenture. Many convertible securities also contain "put" provisions, which enable the holder to redeem the bond prior to maturity. Because of the multiple embedded options in a convertible security, the valuation of these securities is not a simple task. Valuation methods for convertible securities have advanced significantly in recent years with the development of option pricing theory for both equity options and interest-rate options and with the tremendous advances in computer technology. Even so, the valuation of convertible securities remains very complex.

In this chapter the fundamental characteristics of convertible securities, the convertible universe, risk and return characteristics, and the basic principles of how convertibles can be valued are described.

The authors wish to thank Yuri Garbuzov of PIMCO and Sandra Harris for considerable technical assistance.

GENERAL CHARACTERISTICS OF CONVERTIBLES

Convertible bonds are often subordinated debentures. Conceptually, this means that the claims of "senior" creditors must be settled in full before any payment will be made to holders of subordinated debentures in the event of insolvency or bankruptcy. Senior creditors typically include holders of all other long-term debt issues and bank loans. Subordinated debentures have a priority over preferred and common stock. Structurally, a convertible bond is very similar to a straight corporate bond with an attached warrant. Exhibit 59–1 details the similarity. Convertible preferred stocks are equity type securities which offer a priority to dividend payments over common stock as well as higher payments and that offer the opportunity to share in corporate growth, albeit at a slower rate than the common.

The value of a convertible security is related to many variables, including changes in the price of the underlying stock and changes in interest rates, credit quality, and the volatility of both the stock and the interest rates. The ideal convertible bond renders a bondlike return if the return on the underlying issuer's stock is minimal or negative and an equity-like return if the underlying stock's return is quite positive. Naturally, a bondlike return, if held to maturity, is determined by the coupon payments, the earnings on the reinvested coupons, and the return of principal. Thus the convertible provides the investor with the "better of" return profile. (See Exhibit 59–2.)

EXHIBIT 59–1

Factors Affecting a Convertible's Valuation

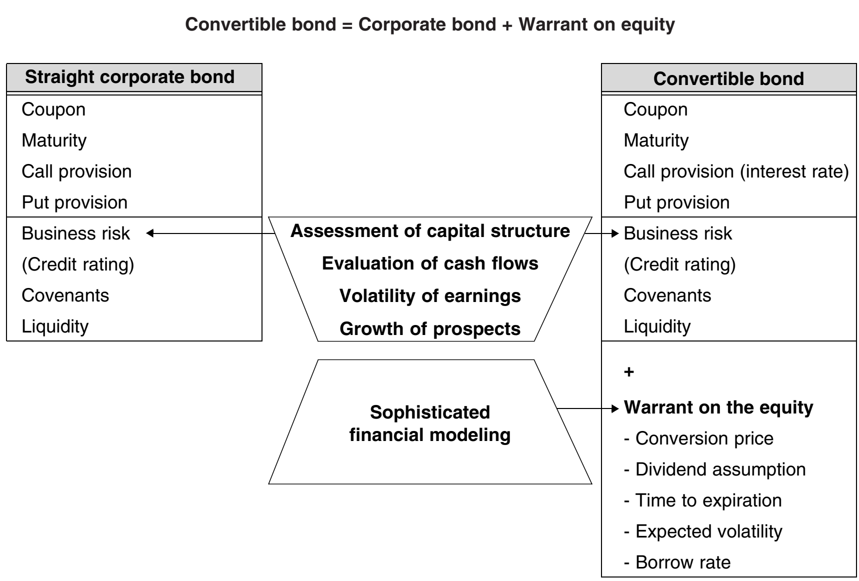
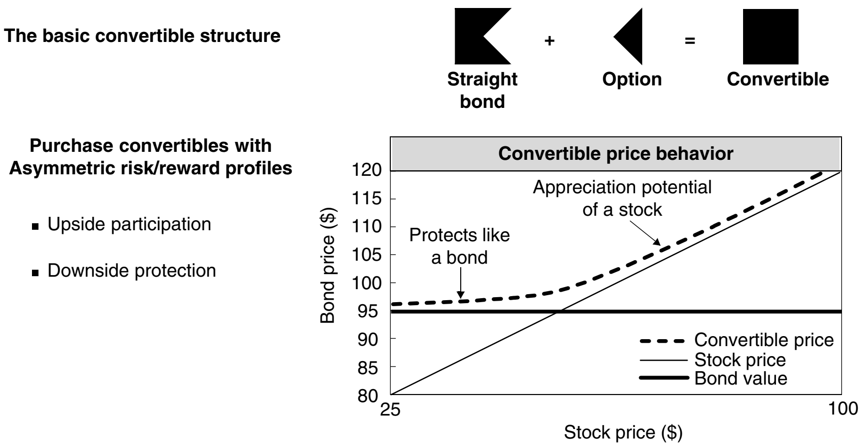


EXHIBIT 59–2

Convertible Securities: The Best of Two Worlds



The yield at issuance on convertible bonds is lower than the yield on the more senior debt of the same issuer. The cumulative yield sacrificed represents a payment for the conversion privilege. Normally, the convertible bond yield will exceed the dividend yield of the stock. However, the cost of the stock, when purchased through the conversion rights, will exceed the price at which the common stock could have been purchased by the premium paid. The premium will vary on issuance but will approximate 25% for a well-balanced convertible bond.

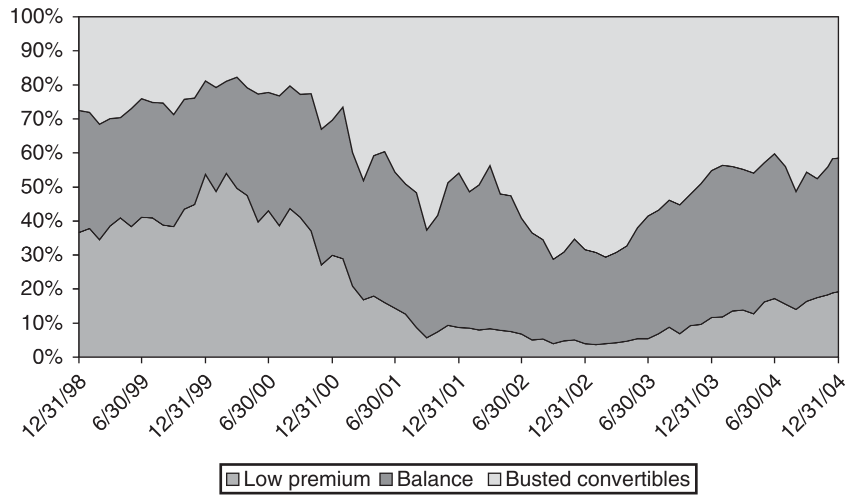
The final maturity of convertible bonds may vary. Historically, most convertibles were issued with maturities of 25 to 30 years. More recently, convertible bonds have been issued with intermediate type maturities of 5 to 10 years. This change implies that the investment value, or bond floor, of the convertible bond universe is currently more stable than in the past, all other factors constant. However, it also implies that the option period is much shorter. In addition, most bonds issued have issuer call provisions which serve to further truncate the option period, to the investor's detriment.

There are many varieties of convertible securities in the market. The main factor distinguishing the various types of securities is the degree of equity-like association. Exhibit 59–3 briefly describes some of the issue types in the market and their relative bond/equity exposure. The analytical convention of this chapter is primarily directed to traditional convertible bonds.

Convertible bonds are issued in many countries and denominated in many currencies. Rather than dwell on detail, we will generalize by region to approximate the size of the respective markets. Exhibit 59–4 summarizes the historical issuance of domestic convertible bonds, as well as the present distribution of convertible bonds in the three foreign primary markets.

EXHIBIT 59–3

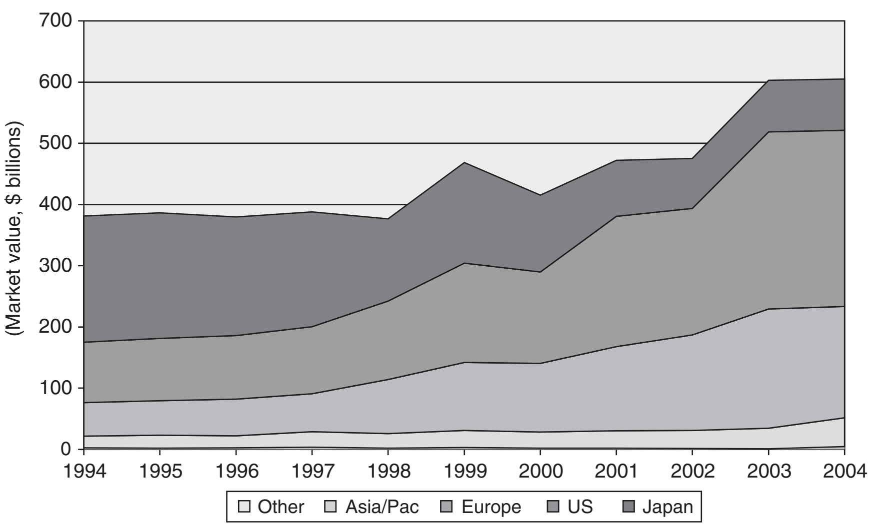
Convertibles Market Breakdown



Source: Merrill Lynch.

EXHIBIT 59–4

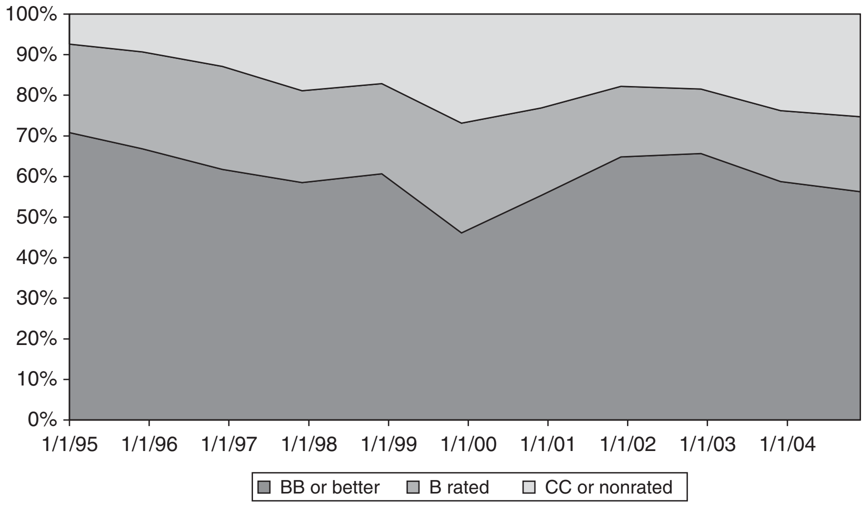
Aggregate Global Convertible Debt Outstanding



Source: Merrill Lynch.

EXHIBIT 59–5

Convertibles Market Breakdown
(By Credit Quality as % of Market Value)



Because a bond is issued in a particular country does not mean that the bond is necessarily issued in the local currency. In fact, many foreign bonds are dollar denominated. With the introduction of the euro, a number of Asian corporations have issued euro-denominated bonds.

Convertible bonds have been issued by companies engaged in a variety of businesses along a broad range of credit worthiness. Exhibit 59–5 provides a glimpse of the change in profile of the universe with respect to quality, and time.

ADVANTAGES AND DISADVANTAGES TO ISSUING FIRMS

Convertible issues offer two basic potential advantages to the issuer. The issuance of convertible bonds offers the advantage of lower interest cost and less restrictive covenants relative to a nonconvertible bond issue. In other words, the investor pays for the right to participate in future favorable price changes in the underlying common stock by accepting a lower yield and a less restrictive debt agreement.

The required yield to sell a convertible relative to that of a nonconvertible issue varies over time and with the particular deal structure and credit quality. A nonconvertible issue will require a yield-to-maturity that is higher than that offered by a convertible issue. This is true in spite of the fact that convertibles typically are subordinated debt issues. The rating agencies usually have rated convertible issues one class below that of a straight debenture issue. Absent covenants to the contrary, the convertible debt holder is exposed to the risk of expropriation that comes with the issuance of additional new debt. The interest-cost-savings to a firm will be highly related to market uncertainty for the issuer and its common stock. Paradoxically, to some extent the greater the uncertainty, the lower are the interest costs. This happens because the increased uncertainty results in an increase in the option value.

The issuer of a convertible bond is confronted with capital structure uncertainty. Normally, the firm will choose between debt and equity capital. The decision to issue a convertible bond is a hybrid uncertain capital structure decision. At the outset, the issue is a debt issue. The issuer thus can expense interest costs. In contrast, dividend payments cannot be expensed. However the firm does incur greater interest costs relative to revenues, increasing the riskiness of the firm. In fact, in the extreme, the issuer is faced with the worst of two worlds. If the firm's business prospects sour, the choice of a convertible bond rather than equity will have proven to be a bad one because bankruptcy risk will have increased considerably. If, on the other hand, the business booms and the common stock price accelerates substantially, the firm's convertible bonds will be converted to equity and existing shareholders' share of the growth is diluted. Obviously, the issuance of a straight debt issue would have been preferred in this case. The choice of a convertible bond is a bet by the firm that its business is more stable than that implied by the market's assessment of firm-specific volatility. The firm incurs lower marginal financing costs and fewer restrictions while accepting the possibility of having to "pay up" in common stock in the future. It is generally easier to issue a large amount of convertible bonds than it is to issue a like amount of stock.

The following example illustrates the complexity of capital structure decisions. Assume that a high-quality (AA rated) company knows that its business is slowing. Management believes that earnings will fall. A convertible bond issue will not materially affect the company's rating. Management decides to issue the convertible because it does so at an implied premium to its stock price and at reduced interest costs. Price/earnings multiples need to expand considerably for dilution to occur. The cost of capital is reduced because of the convertible bond issuance.

Naturally, corporate finance decisions are made at time of issue and are not plain and simple. The firm's ability to access the capital market, the float in its stock, and its specific tax situation are among many considerations that complicate the financial structure decisions. The bottom line is that the company usually knows more about its particular financial attributes than the market. Thus, corporate financing decisions may provide important signals to the market.

ADVANTAGES TO THE INVESTOR

An investor purchasing a convertible security receives the advantages of a more senior security: the safety of principal (prior claim to assets over equity security holders) and relative income stability at a known interest rate. Furthermore, if the common stock of the issuer rises in price, the convertible instrument usually also will rise to reflect the increased value of the underlying common stock. Upside potential can be realized through sale in the secondary market of the convertible bond without conversion into the stock. In contrast, if the price of the underlying common stock declines in the market, the bond can be expected to decline no lower in price than where it yields a satisfactory return on its value as a straight bond. A convertible offers the downside protection that bonds can offer during bad economic times, while allowing one to share in the upside potential for the common stock of a growing firm. As we will see later in this chapter, the empirical price of the Rite Aid 5.25 9/15/02 behaved precisely as convertible theory would predict for quite a while and then not at all. Hewlett-Packard bonds, of very high quality, have performed as predicted throughout their tenure.

Convertible bonds typically offer higher current yield than do common stocks. If the dividend yield on the underlying common stock surpassed the current yield on the convertible bond, conversion would tend to become more attractive. All else equal, increases in the dividend yield are detrimental to the value of the convertible bond.

Convertible bonds may be a particularly attractive asset class for investors whose ability to take equity risk is constrained. Many investors face discrete equity market risk allocation constraints. Because convertible bonds are in fact bonds, they may be an ideal asset for a constrained investor who desires more equity risk. They offer downside protection afforded by the bond and the upside potential of the equity risk. This investor may construct a bond portfolio with an "equity kicker" component through the use of convertible securities.

The investor may wish to speculate on the implied volatility of the equity of the issuer for issues where publicly traded put and call options are nonexistent. The fully developed credit default swap market enables investors a medium with which a reasonably well hedged volatility position can be established by combining a convertible bond, a credit default swap, and a short equity position.

DISADVANTAGES TO THE INVESTOR

The investor pays a premium to bond value for the conversion privilege by accepting a significantly lower yield than that offered by nonconvertible bonds of equivalent quality. If anticipated corporate growth is not realized, the purchaser will have sacrificed current yield and may well see the market value of the convertible instrument fall below the price paid to acquire it. A substantial rise in the price of the underlying common stock is usually necessary to offset the yield sacrifice. Convertible bonds offer an insurance policy to the investor at a relatively cheap price. However, if the price of the stock is very stable, then there is little use for the insurance, and the price of the option may be too much.

The investor must be cognizant of the potential inverse association between the convertible bond's yield spread and the issuer's stock price. The fact that the yield spread may widen as the stock price falls and contract as the stock price increases renders an elasticity to the bond that is independent of interest rates and the attached warrant. For some convertible bonds this means that the bond's price may fall as much or more than the stock falls (excepting the limit case). As with all bonds, a strict fundamental credit analysis is a prerequisite to the purchase of convertible bonds.

EXHIBIT 59–6

Convertible Structure	Distinctive Characteristics
High coupon	Premium greater Income greater More bondlike Sacrificing equity participation
Puttable securities	Reduces credit risk Shortens bond life Sacrifice yield
Callable securities	Force conversion Reduce effective option period due to *either* changes in interest rates or changes in the stock price
Exchangeable securities	Bond of an issuing company exchangeable into the equity of another company Permits exchange of credit risk with equity risk
Zero coupon	Greater credit risk More interest rate exposure per maturity Lower premium Lower bond floor
Premium redemption price	Advertised yield-to-maturity realized only if bond held to maturity

ALTERNATIVE FORMS OF CONVERTIBLE FINANCING

Exhibit 59–6 lists six convertible types and notes how each differs from a traditional convertible. The wide variety of convertibles issued increases investor alternatives, meeting a variety of portfolio objectives.

TYPES OF CONVERTIBLE INVESTORS

The following are brief descriptions of some of the types of convertible investors typically found in the market.

Defensive equity managers. Some managers of common stock portfolios may wish to be defensive at times. Convertible securities offer the possibility of being defensive through their downside protection, while still pursuing the growth potential associated with common stock investment.

Equity managers seeking income. Some portfolio managers may desire a higher level of income than currently being provided by common stocks, while maintaining the potential of sharing in the growth of the firm through the embedded warrant on the underlying equity. Some growth potential is sacrificed because convertibles typically sell at a premium to the underlying equity value.

Convertible specialists. There are investment mangers who specialize in the management of convertible securities.

Bond portfolio managers. Some bond portfolio managers are willing to sacrifice income to obtain a limited exposure to the growth potential and risks associated with an option on the underlying common stock.

Arbitrageurs and hedgers. These investors are "hedged" (i.e., they short common stock against their long convertible bond position and credit default swap positions, hoping to profit from changes in valuation and volatility). These investors tend to participate in the in-the-money part of the universe.

Insurance companies. Insurance companies are required to reserve capital as a function of portfolio risk. Because stocks are riskier than bonds, the capital requirements are greater. Often, insurance companies will invest in convertible bonds to achieve a greater exposure to the equity market without increasing capital requirements. Insurance companies tend to participate in the at-the-money part of the universe.

ANALYSIS OF CONVERTIBLE SECURITIES

The following factors must be considered when evaluating convertible securities:

1. The appreciation in price of the common stock that is required before conversion could become attractive as measured by the *conversion premium*
2. The prospects for growth in the price of the underlying stock
3. The downside price risk in the event that the conversion privilege proves valueless. The ultimate credit quality of the issuer. This analysis helps define the stability of the bond floor
4. The probability of greater than anticipated volatility in the price of the underlying common stock
5. Special provisions and covenants

AN ILLUSTRATIVE ANALYSIS

We will illustrate how to analyze convertibles using three convertible issues. Information about each issue is provided in Exhibit 59–7.

A few basic definitions are in order before explaining the analysis. The convertible security contract will state either a *conversion ratio* or a *conversion price.*

EXHIBIT 59–7

	Rite Aid	Hewlett-Packard	Winstar Communications
Issue Information			
Conversion ratio	27.672	5.43	1.0079
Coupon/dividend	5.25%	0%	7%
Maturity	09/15/02	10/14/17	03/15/10
First call date	09/15/00	10/14/00	03/20/01
First call price	102.10	59.03	51.75
First put date	—	10/14/00	—
First put price	—	59.03	—
Provisional call hurdle	—	—	—
Redemption value	100	100	50
Issue price	100	53.785	50
Issue size, par	$650,000,000	$2,000,000,000	$200,000,000
Conversion restrictions	None	None	None
Market Information			
Bond price (bid/ask)	100.00/100.50	63.375/63.625	59.125/59.875
Stock price	$25.438	$100.50	$51.75
Spread	135 bp	80 bp	550 bp
Implied volatility for long-term stock options	40%	38%	65%
Credit rating (Moody's/S&P)	Baa2/BBB–	Aa3/AA	NA/CCC–
Last-quarter stock dividend	$0.115	$.16	—
Short rebate rate for stock borrowing	0.30%	0.30%	1.60%
Valuation Results			
Fair bond value	101.95	63.69	61.17
Parity	70.39	54.57	52.16
Percent premium to bid	42%	16%	13%
Delta	37%	58%	81%
Bond floor	94.45	54.75	37.25
Break-even time	12.20 years	—	1.91 years
Yield-to-maturity	5.25%	2.51%	4.86%
Yield-to-call	6.97%	–5.52%	–1.27%
Yield-to-put	—	–5.52%	—
Effective duration	1.5	0.6	0.8

A conversion ratio directly specifies the number of shares of the issuing firm's common stock that can be obtained by surrendering the convertible security. Alternatively, the conversion ratio may be expressed in terms of a conversion price—the price paid per share to acquire the underlying common stock through conversion. The conversion ratio may then be determined by dividing the stated conversion price into the par value of the security. For example, if the conversion price were $20, a holder of such a bond would receive 50 shares of common stock in conversion, assuming a typical par value of $1,000 for the bond.

In some cases, the security contract may provide for changes in the conversion price over time. For example, a conversion price of $20 might be specified for the first five years, $25 for the next five years, $30 for the next five years, and so on. This means that a holder of the instrument will be able to obtain fewer shares through conversion each time the conversion price increases. For example, 50 shares can be obtained when the conversion price is $20, but only 40 shares when the conversion price rises to $25. Such a provision forces investors to emphasize early conversion if they intend to convert, and the provision would be reasonable if corporate growth generally leads to a rising value for the common stock over time.

One of the issues analyzed is a zero-coupon bond (the Hewlett-Packard bonds). In general, zero-coupon convertible bonds have 20 years to maturity, they are issued at a fraction of par value, and redemption at 100% of par provides yield. Most of these bonds have three to five years of call protection and offer an option to put the bond back to the issuer at the first call date and a couple of dates after. Call and put strike prices for the same dates are matched at accreted values. Zero-coupon bonds do not have any yield advantage over underlying equities and their premium is determined by the value of the embedded equity put option with a sliding up strike price (at the first put date the strike is lower than that at maturity).

Conversion Premium

The market conversion price of a convertible instrument represents the cost per share of the common stock if obtained through the convertible instrument. For example, the market conversion price of $38.66 calculated for the Rite Aid 51/4% convertible bond is obtained by dividing the market price of the convertible bond (1,019.50) by the number of common shares that could be obtained by converting that bond (27.672 shares). Because the market conversion price is higher than the current market price of a common share, the bond is selling at a conversion premium, represented by the excess cost per share to obtain the common stock through conversion.

The *conversion premium ratio* shows the percentage increase necessary to reach a parity price relationship between the underlying common stock and the convertible instrument. *Conversion parity* is that price relationship between the convertible instrument and the common stock at which neither a profit nor a loss would be realized by purchasing the convertible, converting it, and selling the common shares that were received in conversion, ignoring commissions.

When the price of the common stock exceeds its conversion parity price, one could feel certain that the convertible security would fluctuate directly with changes in the market price of the underlying common stock. In other words, gains in value of the underlying common stock then should be able to be realized by the sale of the convertible instrument rather than by conversion and sale of the stock itself. The market conversion price, incidentally, is the parity price for a share of common stock obtainable through the convertible instrument.

There is usually, although not always, some conversion premium present on convertible instruments, which reflects the anticipation of a possible increase in the price of the underlying common stock beyond the parity price. Professional arbitrageurs are constantly looking for situations in which the stock can be obtained more cheaply by buying the convertible instrument than through direct purchase in the market. For example, assume that a bond is convertible into 20 shares and can be purchased for $1,000. If the common stock was currently selling at $55 a share, an arbitrageur would buy the convertible and simultaneously short sell the common stock. The arbitrageur would realize a gross profit (before transaction costs) of $100 calculated as follows:

Short sale of $20 shares at $55/share	$1,100
Less purchase cost of bond	1,000
	$ 100

The demand by arbitrageurs for the convertible would continue until the resultant rise in the price of the convertible no longer made such actions profitable.

Yield Sacrifice

At the time of this analysis, nonconvertible bonds of equivalent quality to the convertible issued by Rite Aid offered a yield-to-maturity of 7.20%, or 195 basis points higher than the yield-to-maturity offered by the convertible. The yield sacrifice suggested by this would have to be overcome by an equivalent rise in the price of the underlying common stock, assuming the bond was held to maturity, or the investor would have been better advised to purchase the nonconvertible instrument. This differential is possibly misleading in this case, as the sacrifice relative to the current yield is significantly less. The current yield would seem more significant if the rise in the common stock were realized well before maturity.

In the final analysis, it is the price appreciation potential for the underlying common stock and the quality of the bond floor that are most important.

Downside Risk Potential

The floor price for a convertible is estimated as that value at which the instrument would sell in the market to offer the yield of an equivalent nonconvertible instrument. Rite Aid bonds were rated BBB by Standard & Poor's Corporation in June 1999, and the yield paid by BBB bonds was used as the basis for estimating the required market yield for present value calculations for the nonconvertible bond.

The floor price of the Rite Aid bonds is the sum of the present values of the cash flows (discounting at 7.21%) that would be generated by a nonconvertible $5^1/_4$% bond maturing in three years and three months. The floor price is $94.45 for Rite Aid bonds. A similar calculation for the Hewlett-Packard bonds renders a bond floor of $54.75. The investor put option for this issue, effective in 16 months on 10/14/00, provides for a high, stable bond floor despite the long maturity.

The analysis suggests a 5.45% (5.55/101.95) downside risk for the Rite Aid bonds and a 13.54% (8.625/63.69) downside risk for the Hewlett-Packard bonds.

The bond floor, representing the insurance inherent to a convertible bond, is very important. However, one should not place too much emphasis on the estimated floor prices. The calculations assume that current yield levels will continue, and this may well not be correct. If instead, if market yields rise to higher levels and the conversion privilege proves worthless, the price of the bonds could fall below the estimated floor price. On the other hand, if market yield levels fall, the loss would not be as great as suggested. In fact, if interest rates fall enough, the bond may actually be called independent of any movement on the price of the stock. More importantly, normally an investor should not be purchasing convertibles (remember the yield sacrifice) unless an investor believes the probability is relatively high that the market price of the underlying common stock will be more volatile than implied by the bond and that the price will rise and eventually exceed the parity price for that common stock.

Break-Even Time

Break-even time represents the number of years it will take for the favorable income differential over the common stock offered by the convertible instrument to equal the total dollar conversion premium paid to acquire the convertible instrument on a per share basis. For example, the break-even time for the Rite Aid convertible bonds is 12.2 years, calculated as follows:

Interest paid on each $1,000 bond at	5.25%
Stock dividend yield	
4 × 0.115/25.438	1.81%
Favorable bond differential	3.44%
Percent premium [(100 – 70.39)/70.39])	42%
Break-even time equals percent premium	
Divided by bond yield advantage (42%/3.44)	12.2 years

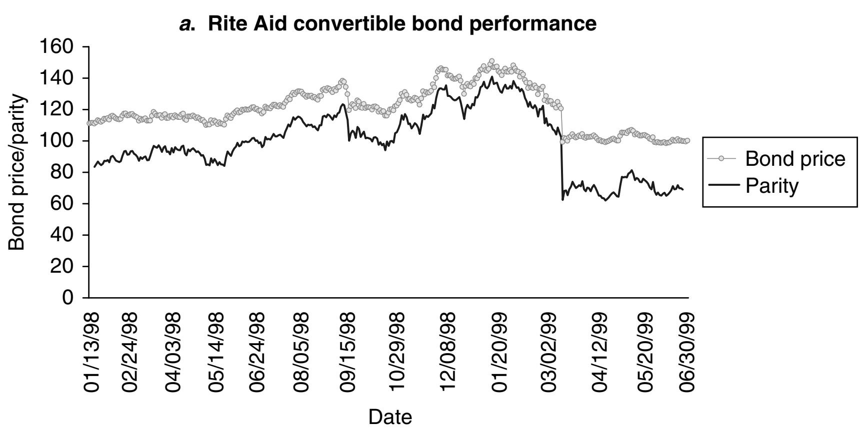
Break-even time is a crude method for measuring the value of a convertible security. It is a measure of the amount of time it takes to pay for the option premium but ignores the actual value of the equity option. All else equal, we expect that the more volatile the underlying stock, the greater the premium and break-even time.

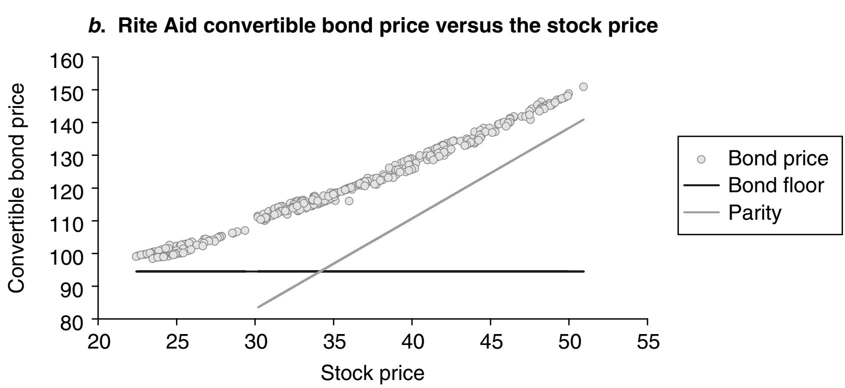
The deficiency of "break-even time" as a valuation variable is readily gleaned from Exhibit 59–7. By most conventional rules of thumb, a 12.2 year break-even time for the Rite Aid bonds would render it unattractive. (Historically, five years or less until break-even was required for consideration in the "attractive" category.) However, we see that the RAD bonds are theoretically valued at 101.95 yet are offered at only 100.50. The investor should consider many things when evaluating convertible securities, including a dynamic scenario analysis and the quality of the inputs into a theoretical model. Scenario analysis of these securities is presented in Exhibit 59–7. The inputs of the valuation theoretic are designated in dashed boxes in Exhibit 59–7.

Scenario Analysis

The theoretical scenario analysis in Exhibit 59–8 illustrates many of the convertible's attributes discussed earlier in this chapter. The analysis is "dynamic" in the sense that the yield spread of the bond and the volatility of the stock are

EXHIBIT 59–8





Source: PIMCO Analytics.

both integrally related to the movement of the stock. Price movements of the stock are assumed independent of the market interest rate charges. For example, we can see that the return of the bond varies over the annual period and is varying in the same direction of the stock. Conceptually, the RAD bonds epitomize a classic convertible bond. The investment value (bond floor) is extremely stable and the bond participated in the portion of the upside of the equity movement. The participation is somewhat muted because the price of the stock has rendered the option component slightly out of the money.

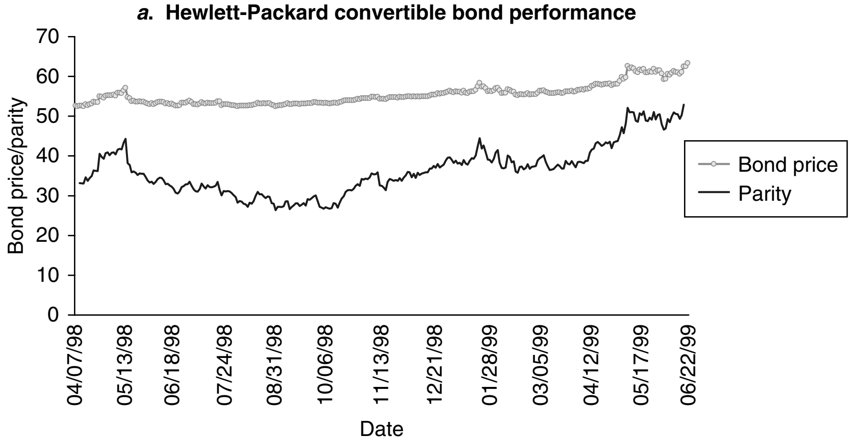
In Exhibit 59–8, we observe actual historical price behavior of the RAD bond and stock for the period through June 1999. In panel *a* we see the historical point premium between the bond and its parity. We note that there is always a positive premium (will always be positive unless the bond is not immediately convertible). Moreover, as expected, the premium narrows as parity increases and expands as parity decreases.

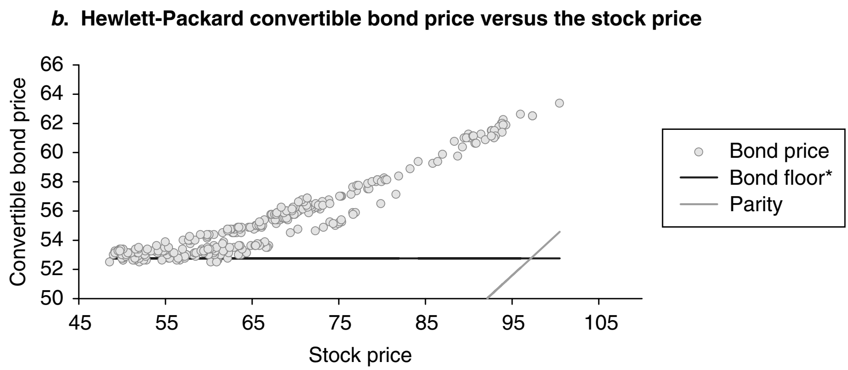
The empirical information in panel *b* portrays the theoretically perfect convertible. The price of the bond travels with the stock as stock prices increase and falls at a slower and slower rate as the stock falls. Finally, it hits its bond value and stops falling even though the stock continues to fall. The Hewlett-Packard bonds exhibit a very similar historical pattern (see Exhibit 59–9). The HWP bonds are conceptually nice because of the high credit quality and because the put option period is near which serves to create a strong, stable bond floor. It should be noted, however, the HWP bonds are trading to the call/put date.

The scenario analysis for the HWP zero is interesting because, contrary to the RAD bond, it is slightly in the money. As a consequence, the bond floor is further away. The HWP's local performance (within a 25% move of the stock) is symmetric. However, given a substantial move in the stock price of greater than 25%, a strong asymmetry between stock and bond performance is to be expected. Most convertible bonds should outperform the delta adjusted underlying equity when large price changes (high volatility) occur because the value of the option exceeds the premium paid. There are instances when a convertible security may fare poorly when the stock falls sharply. Empirically,Winstar Communications 7% Preferred is such a security.

Winstar Communications 7% Preferred is a low quality, long-term security in a very volatile competitive industry. Convertible securities issued by speculative companies can, as noted above, be very valuable but can also perform very poorly at times. The Winstar convertible preferred is one such security. During the fall of 1998, the bond was issued at $50 in a very volatile market at a credit spread of 9% which implied a 23.45 bond floor. The collapse in the market value of Winstar Communications common stock from 40 in March 1998 (time of issue of the preferred) to 15 in October 1998 implied a change in the total firm value from $2 billion to $750 million. This abrupt valuation change caused the perception of the credit risk of the preferred to increase dramatically. The implied credit spread of 15% has subsequently declined to 6% as the stock price has recovered to 50 (August 1999). The extreme volatility in the credit spread

EXHIBIT 59–9





*Bond floor here is calculated for the beginning of the period shown and is lower than its current level. See discussion on the bond in the text.
Source: PIMCO Analytics.

implies a very unstable investment value. Given the security's long maturity and the improved credit perception, the investment value has increased from 23.45 to 37.25. We can see the extremely poor convertible dynamics in both the theoretical construct as well as in the empirical data. Despite this poor set of dynamics, there may be other compelling investment merits of the Winstar preferred. The investor must, however, be able to predict, *a priori,* the probable value of the convertible given a particular scenario for the common stock.

The importance of credit quality and credit analysis to convertible bond portfolio management cannot be overstated. Rite Aid 5¼ of 2002, our model convertible bond, experienced a substantial change in its investment value.

The company started experiencing financial problems in fall 1999. There were fraud allegations and management changes accompanying poor financial results. The credit spread gapped wider while simultaneously the equity value tumbled. The convertible bond price fell from 100 in March 1999 to 50 in June 2000. As investors viewed the credit to be distressed and highly speculative, the meaning of a "bond floor" was called into question.

Separate Asset Class

We noted earlier that, on issuance, the convertible is neither a stock nor a bond. Most likely, it is more bondlike. This generalized opinion is true for the issuer and the investor alike. Neither buyer nor seller know. It is only after the fact that one can conclude about its ultimate character. Because this is true and because not all stocks go up together (nor do they change at a constant rate), the correlation of the performance of the convertible bond universe to bonds and stocks varies considerably but predictably; neither stock nor bond. Convertible securities should be considered a separate asset class. Exhibit 59–10 provides such statistical data. In Exhibit 59–11, a modest 20% allocation of convertibles to a portfolio containing a mix of the S&P 500 and the Lehman Brothers Aggregate Bond Index is shown to exert a substantial improvement in the efficient frontier.

The investor in a convertible bond has a great advantage over the holder of a nonconvertible corporate bond of the same issuer. Management of many

EXHIBIT 59–10

Risk Reward Statistics
Convertibles have produced attractive risk-adjusted returns
Performance summary of Broad Market Indexes for the Period January 1988 through June 1999*

	Annualized Return	Standard Deviation	Sharpe Ratio†
Merrill Lynch All U.S. Convertible Index	13.95%	9.46%	0.89
S&P 500	19.28%	13.06%	1.05
Russell 2000	14.13%	16.43%	0.52
Merrill Lynch Government and Corporate Bond Master Index	8.57%	4.45%	0.69
Lehman Brothers Aggregate Bond Index	8.59%	4.17%	0.74

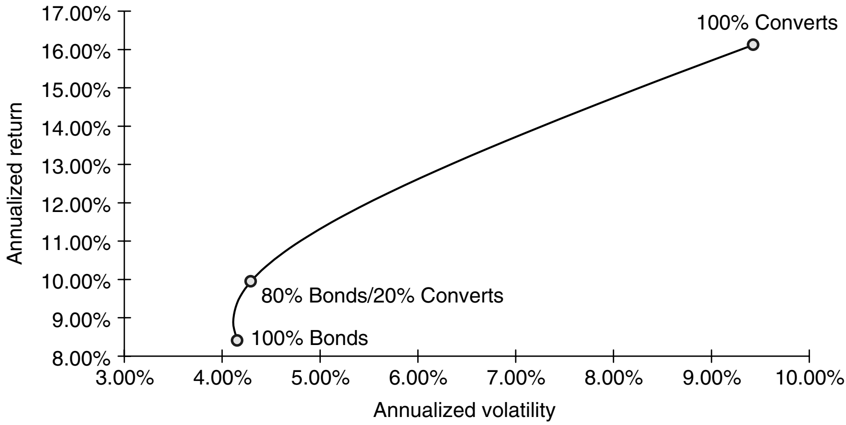
*Merrill Lynch All US Converts Index return data are available from January 1988.

†Sharpe ratio = (total return – risk-free rate)/standard deviation, where we used average return on three-month T-bills for the reporting period (5.52%).

Source: PIMCO.

EXHIBIT 59–11

Efficient Frontier for Lehman Aggregate and Merrill Lynch All Converts Portfolio, January 1988–June 1999



Addition of corporate bonds to fixed income portfolio can benefit an investor for the following reasons:

- Convertibles allow investors to get exposure to companies which often do not have straight-debt issues
- Upside potential, or in general, return profiles on fixed income and convertible instruments issued by the same company, are quite different
- Provide investors mechanism to purchase cheap equity market insurance

Due to these three factors, a portfolio with an allocation to convertibles (1) benefits from diversification (correlation between components less than 1), and (2) allows for better use of portfolio managers's security-selection skills.

Source: PIMCO

companies have engaged in leveraged stock-buyback programs at the expense of the debt holders and to the benefit of stockholders and option holders (like management itself). Similarly, although not likely, capital structure changes initiated by management that reduce leverage tend to help bond holders. Convertible bonds tend to increase in value as the issuer's credit quality improves, all else equal. Because convertible bondholders participate in both bond and stock movements, the investors cannot be a target of management. Ultimately, the effect of a change in capital structure on the value of the convertible will depend on the success of the initiative and the relative changes in the price of the equities, the quality of the bonds, and the "state" of the convertible at the time of the initiative.

Call Risk

In June 1999, the RAD was callable in one year on 9/15/00 at a call price in excess of the market price of the convertible. The call risk was not high. However, the call will limit the potential gain on the convertible if the stock moves substantially to the upside. In June 2000, with the call out of the money and the yield high on the bond, the probability of call is about zero.

The convertible of HWP offered call protection through 10/14/00. The low premium, and the put provision are attractive elements of this convertible. However, because of the probable call, the price of the common, and the zero coupon, there is a negative yield on the bond. This convertible is in the money and trading to its call date. As such, there is on a modest amount of premium and the bond will trade to stock closely on the upside.

Putable Convertibles

Some convertibles offer a put option, adding a possible further attractive feature to the instrument. For example, the Hewlett-Packard convertibles are putable to the corporation on October 14, 2000 at 59.03, offering downside protection. However, the yield to the 2000 put is –5.52%.

Dilution of the Conversion Privilege

A large common stock split or stock dividend could markedly dilute the value of the conversion privilege, unless adjustment of the number of shares received in conversion is made. For example, assume that a bond is convertible into 20 shares and that the company undergoes a 2-for-1 stock split. Recognizing this, the conversion privilege is typically protected by terms in the bond indenture providing for a pro rata adjustment of the conversion price and/or the conversion ratio so that the exchange ratio would increase to 40 shares after the stock split.

DURATION MANAGEMENT

Duration is a measure of the sensitivity of the price of a bond to changes in interest rates. Embedded options complicate the calculation of duration, particularly when there are multiple embedded options as is the case with convertible bonds.

The importance of duration to convertible bond management varies as a function of the price of the equity relative to the conversion price. The greater this ratio, the less is the importance of duration management. At low ratios, convertible bonds approach straight corporate bond status and duration management is most important. Effective duration calculation, which accounts for the effect of the embedded options, is the important bond management metric for duration management.

VALUATION OF CONVERTIBLES

An investor in a convertible security effectively owns a nonconvertible fixed income security and a call option on the issuer's common stock. The value of a convertible security is therefore the sum of these two values, disregarding any other options that may be embedded in the convertible security (e.g., the issuer's right to call the issue).

The value of a convertible bond disregarding the conversion feature is called its *straight value*. This is found by discounting the cash flow for the bond at a yield equal to the yield to maturity of an equivalent nonconvertible bond.

The value of a convertible bond, if it is converted immediately into the common stock of the issuer, is called its *conversion value*. This value is found by multiplying the conversion ratio by the current market price of the common stock. The conversion value for RAD is 70.39 (27.672 × 25.458) and 54.57 for HWP.

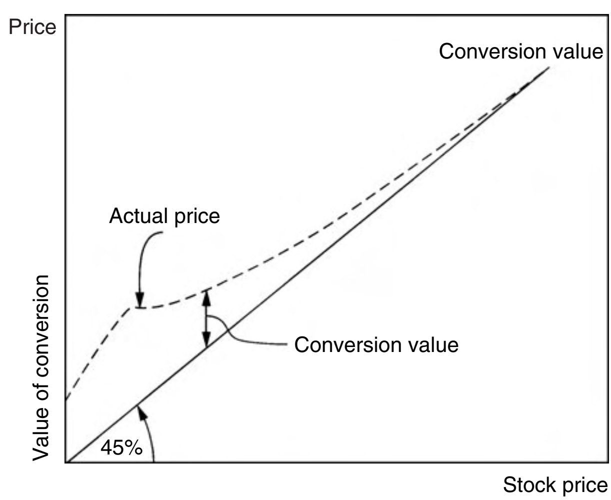
The minimum value of a convertible bond is the *greater* of its straight value and conversion value. Arbitrage ensures that this will occur. For example, suppose that the straight value of the Rite Aid issue is 94.45 when its conversion value is 100 and that the issue is trading at 94.45. Investors would buy the issue for 94.45 and convert it for 27.67 shares worth 35.14 each, resulting in a riskless arbitrage profit of 5.55. Suppose, instead, the straight value is 94.45 at the time of the conversion value is 70.39 but the issue is trading at 70.39. In this case, investors would be buying a bond offering a higher-than-market yield with a "free" equity option.

A convertible bond will trade at a premium above the minimum value just described because of the value of the option the security holder has. It is usually very difficult to infer precise values because the convertible bonds are generally subordinate to the senior debt and the covenants in the indenture are different. The option component always has a value even if it is way out-of-the-money.

Exhibit 59–12 shows the typical price response of a convertible bond at different stock price levels. The solid line in the exhibit shows the conversion value. The dashed curve is the actual price of the convertible bond. At any common

EXHIBIT 59–12

Convertible Bond Price versus Stock Price

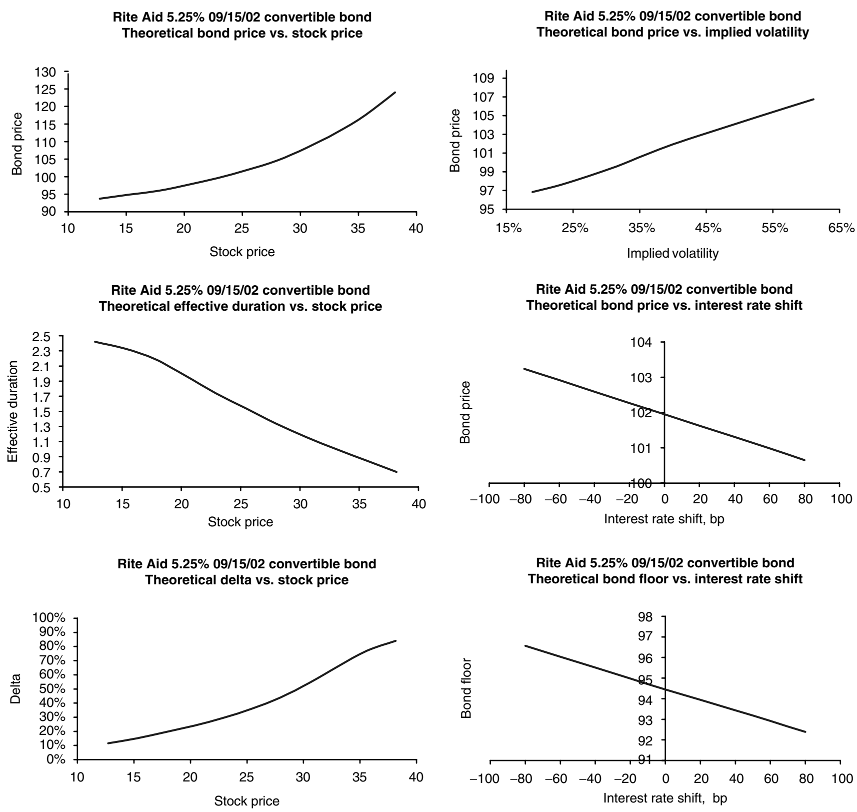


stock price, the difference between the actual price and the minimum price is the value of the option.

Determining the worth of the option to buy the common stock embedded in a convertible bond is complicated. Here is where equity option pricing models typically are used. The Black-Scholes option pricing model might be used for a quick approximation of the value of the equity option. A more comprehensive model that takes into consideration the many nuances embedded within a convertible bond was utilized to derive the matrix of theoretical valuations shown in Exhibit 59–13 for its RAD bonds. This exhibit includes many of the important valuation measures and portfolio management variables that were discussed in this chapter and are quite important to convertible bonds. The information contained in Exhibit 59–13 is the result of an advanced, comprehensive analysis of

EXHIBIT 59–13

Rite Aid 5$^1/_4$ 9/15/02



Dated 9/15/99

Source: PIMCO Analytics.

convertible bonds and is a necessary information set for convertible bond management.

SUMMARY

Some fixed income securities are convertible into common stock, offering the basic advantages of a senior security (bond or preferred stock), while allowing the holder to participate in potential corporate growth. The investor pays for the conversion privilege by accepting a significantly lower yield than could be obtained by purchasing nonconvertible bonds or preferred stocks. A convertible, moreover, usually sells at a premium over the value of the underlying common stock. If the anticipated growth in the value of the common stock is not realized, the purchaser will have sacrificed yield and, in some instances, may well see the value of the convertible instrument fall sharply.

There are three distinct areas of analysis that should be undertaken when evaluating a convertible security:

1. The quality of the security should be assessed in the same way as for other nonconvertible senior securities. This requires assessing the ability of the issuing company to meet the fixed charges mandated by the issue under reasonably conceived adverse economic circumstances.
2. The growth potential for the underlying common stock must be evaluated, because that growth potential offers the basis for generating the added yield necessary to offset the yield sacrifice incurred at the time of purchase and provides a return that makes purchase attractive.
3. A rigorous quantitative and scenario analysis of the convertible security must be performed to insure expectational consistency of the security to portfolio objectives.

CHAPTER
SIXTY

CONVERTIBLE SECURITIES AND THEIR VALUATION

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Managing Director
Quellos Capital Management

Convertible debentures and convertible preferred shares or, more generally, equity-linked securities span the space from common stock on the one hand to nonconvertible (straight) debt on the other. While the majority of newly issued convertible securities combines a balance of the common stock and straight debt attributes, some are close proxies for common stock, and others are skewed toward straight debt. Some new issues may have maturity of as short as three years, as in the case of convertible notes and mandatorily convertible securities, whereas traditional convertible preferred shares are perpetual; that is, the issuer is not ever required to repay the par or the principal amount of the security. Over time, a convertible security that may have started out as very close to straight debt may become very much like common stock owing to price appreciation in the common stock into which it is convertible, called the *underlying stock*. The reverse is also true as the price of the underlying common stock declines.

Convertible securities have evolved significantly along with the market's sophistication in analytics, trading, and attention to risk. This chapter will examine the products that comprise the asset class, the size of the market and its evolution, motivations for their issuance and purchase, and their structural aspects. A substantial part of the chapter will focus on valuing and hedging these securities colloquially known as *convertibles* or *converts*. Passing reference will be made to convertible markets in Europe and Japan.

The essential features of convertible products and notable exceptions thereto are as follows:

- A convertible security may be converted, generally at any time until its maturity date, into the underlying common stock. Exceptions: Some converts may have an initial nonconversion period of up to 6 to 12 months.

In the earlier editions of this *Handbook,* this topic had been coauthored with Yu Zhu. I remain grateful for his comments and insight.

A very significant number of recent U.S. convertible issues have a *contingent conversion* clause whereby the conversion right of the holder only commences if the underlying stock price exceeds a threshold price, usually higher than the conversion price, for a prespecified number of days. These convertibles with such *knock-in* conversion rights are popularly known as "CoCos" and are discussed in detail below.

- The vast majority of convertibles is convertible into the shares of the issuer. The rest are convertible into shares of another publicly traded entity. These latter securities are called *exchangeables*.
- The conversion right rests with the holder. Exceptions: In some mandatorily convertible securities, investors are not given a conversion option. They receive the applicable shares mandatorily at maturity. Some nonmandatorily convertibles may have a knock-in automatic conversion subject to the underlying stock price exceeding a threshold price for a prespecified number of days.
- Almost all converts have a redemption feature that allows the issuer to redeem them prior to maturity. Exceptions: Some traditional convertibles and most mandatorily convertibles are nonredeemable.
- Although convertible at any time, their holders are likely to exercise the conversion right only in response to a redemption notice by the issuer—also known as the *issuer call* or, simply, the *call*. In other words, virtually all conversions occur only when forced by the issuer. Exceptions: (1) When the underlying stock pays a high dividend and is also illiquid, for example, real estate investment trust stocks, (2) in the presence of material market friction such as restrictions on conversion or when it is costly to borrow the underlying stock to sell it short as a hedge, and (3) when the underlying stock price is above the *critical stock price,* discussed in further detail below.
- On conversion, the issuer usually will satisfy its obligation by transferring to the holder the specified number of shares of the underlying stock per convertible. This is called a *physical settle*. Exceptions: Sometimes the issuer may have the right, specified in the prospectus for the convertible, to satisfy its obligation by paying the holder the cash value of the underlying securities. This is known as the *cash settle option*. Depending on the liquidity of the underlying stock, a cash-settled convert may fetch a slightly lower price than would a physically settled convert owing to the cost incurred by arbitrage and hedge fund investors in covering their stock short position. With some exceptions for deep-out-of-the-money convertibles, hedge funds short the underlying stock against a long position in the convert. In some instances, conversion is specified into a combination of the underlying stock and cash or a specified combination of stocks or a choice among specified

multiple stocks. The last case is called a *rainbow conversion option,* wherein the holder has the option of converting into any stock among the choices provided that results in the highest value on conversion.

- A convertible's current yield or yield-to-maturity or yield-to-first-put usually exceeds the dividend yield of the underlying stock.
- The price of a convertible is at least equal to the value of the shares into which it is convertible, that is, its *conversion value*. In other words, a convertible should trade at a nonnegative premium to its conversion value. Exceptions may occur under the following conditions: (1) when there are restrictions on the holders' conversion right, (2) when the underlying stock is illiquid and the cost of borrowing the stock is high, (3) in anticipation of forced conversion leading to a loss of the accrued coupon—this feature is colloquially known as the *screw clause*—a currently redeemable, deep-in-the-money convertible may trade at a discount to its conversion value, and (4) cash-settled convertibles due to the additional transaction costs for arbitrage and hedge fund investors.
- Convertible debentures are issued most commonly as subordinated debentures, although senior subordinated and senior unsubordinated debentures are increasingly more frequent. In Europe, most convertibles are unsubordinated debentures. When issued as either subordinated convertible debentures or convertible preferred, they are accompanied with few restrictive covenants.
- Convertibles have a prespecified maturity. Exceptions include (1) a handful of mandatorily convertibles whose maturities may be extended by a year at the option of the issuer and (2) the "PHONES" convertible product (described below), where maturity may be extended by as long as 30 years.
- Convertibles have a prespecified number of shares per convertible, that is, a fixed *conversion ratio*. Exceptions: (1) The number of shares received upon conversion of a mandatorily convertible security is not fixed but is a function of the underlying share price on the settlement date. However, the number of shares to be received is bounded by prespecified maximum and minimum limits. (2) Some Japanese and non-Japan Asian converts have a *reset* or *refix* clause whereby the conversion ratio is adjusted upward, and the conversion price is adjusted downward, if the underlying stock price does not exceed prespecified trigger prices.

Evolving sophistication of convertible issuers, investment bankers, and holders has changed the convertible market in several key ways. Higher interest-rate volatility has highlighted *duration risk* and *convexity* inherent in any security with a fixed income component, including converts. The increased volatility of corporate spreads (over Treasury or LIBOR or other interest-rate benchmarks) as a consequence of recent high corporate default rates and defaults by countries—the *sovereign defaults*—has heightened investor sensitivity to default risk and the reliability of the *fixed income floor* or *bond value* of the convert. An active *credit default swap* (CDS) market has developed as a consequence. A CDS transfers the default risk of the underlying *reference debt security* from a holder of the reference debt who buys the CDS to the CDS seller. The buyer makes a stipulated series of quarterly or semiannual premium payments to the CDS seller as consideration. These payments continue until the maturity of the CDS unless terminated earlier on the occurrence of a default event. The CDS seller, usually a financial institution that wants to assume the credit exposure, agrees to pay a stipulated percent of the notional amount of the reference debt (usually par minus recovery value) in the event of default and on receipt of a *deliverable* security or CDS contract from the CDS buyer. CDS trading has very quickly become an integral part of convertible valuation and arbitrage.

Convertibles have equity and interest-rate options and, occasionally, currency options embedded in them. The value of these options is a function of, among others, (1) equity volatility, (2) interest-rate volatility, (3) spread volatility, (4) default probability, and (5) recovery value in the event of default. Except in some simple situations where options embedded in a convertible are separable and therefore can be valued using simple models in an additive mode, in the vast majority of cases the options interact with each other and are not separable. Investors therefore, should be aware of the inherent danger of attempting to value the embedded options as if they were separable options.

We will employ the contingent claims approach to the valuation of convertible securities. After reviewing the evolution of convertible markets in the past decade and describing the products and recent innovations, we will discuss the general attributes of a convertible and the traditional valuation method. We will then outline a simple contingent claim approach valuation model and discuss the impact of the various inputs to the model. Finally, we will discuss the applications of the model and decisions faced by issuers and investors.

EVOLUTION IN THE CONVERTIBLE MARKETS

The convertible market was viewed until relatively recently as a source of funds for firms of marginal credit quality and often unable to access public debt markets. Convertibles have now evolved into an asset class in which the largest single issue raised €5.0 billion for an Aaa-rated issuer.[1] Several large firms have raised more than $1 billion each, some through overnight transactions with

1. KfW Bank's €5.0 billion (US$ 5.66 billion) 0.75% exchangeable debt maturing on 8/8/2008 issued in July 2003. Among the largest U.S. convertible issues to date are the $5 billion convertible trust preferred issued by Ford Motors in 2002 and the $4.3 billion convertible preferred issued by General Motors issued in 2003.

very little marketing effort, a fact that attests to the maturity of the asset class. To understand this evolution and its future direction, it will be useful to segment this asset class into its distinct distribution channels.

Convertible Market Segments

The first, and by far the largest, segment consists of the publicly issued convertibles. It includes convertible securities issued either as registered under the Securities Act of 1933 (*SEC registered*) or under Rule 144A institutional private placement (*144A issue*). Gross proceeds at issue in this segment are generally of least $50 million each. Smaller issues may not attract institutional buying interest and as a result are usually illiquid with wide bid-offer spreads.[2] This chapter therefore will focus on the publicly traded convertibles, although the economic and valuation logic applies to the other segments as well.

The second segment of the convertible market consists of convertibles issued by "small cap" and "micro cap" issuers with *equity market capitalization,* that is, the number of shares outstanding multiplied by the price per share, less than $250 million. Typically, convertible issues range in size from $10 million to $45 million, underwritten and distributed by the smaller investment banks. These issues may be either SEC registered or issued under Rule 144A. Although they are structured so as to permit secondary trading, and they do trade, albeit infrequently, these issues are distinct from those in the next segment, called the *Rule 144* or *Regulation D* issues.

This third segment of the convertible market consists of highly structured and individually negotiated transactions, wherein the issuer and a single investor or handful of investors draw up the terms and conditions of the investment and the structure of the convertible security purchased. This "private investment" is not available to investors at large. The specific one-off nonmarket features and covenants of privately placed issues may include (1) a very high conversion premium in exchange for a high coupon or preferred dividend, (2) an extended period of nonconversion, (3) conversion into restricted stock that cannot be monetized immediately on conversion, (4) a resetting of the conversion premium and/or coupon or preferred dividend based on balance sheet/income statement/cash-flow target ratios for specific time periods, (5) debt covenant restrictions, (6) seniority in the event of bankruptcy, merger, or acquisition, and (7) provisions for voting and control issues. Typical investors are leveraged buyout funds, private equity funds, hedge funds, and occasionally, mutual funds. These buyers provide strategic capital

2. Although convertible bonds may be listed on the New York Stock Exchange (NYSE) or the American Stock Exchange (AMEX), they are traded most frequently in the over-the-counter (OTC) markets. As a result, the price levels reported in the press may not be representative of the current market price indications. SEC-registered convertible preferreds usually trade on the NYSE and AMEX. Rule 144A convertible preferreds trade on the OTC market until they are registered or are "seasoned," at which time they are listed and trade on the NYSE or AMEX.

infusion to distressed firms, firms needing added capital to restructure or to grow through acquisitions, and firms not otherwise ready for, or unwilling to pursue, public market transactions. This set of investors tends to have long holding period horizons and bullish projections about the future stock market performance of the firm and/or hedge themselves. Secondary market liquidity of the structured convertible therefore, is of less concern to them. In the "post-Internet bubble crash," several Regulation D privately placed convertibles have been criticized and often referred to as "death spiral" or "toxic" convertibles. However, at the time of issuance during the Internet bubble period, issuers often either did not realize the extreme dilutive impact of clause (4) and the continuing pressure on the stock price due to shorting by the holders to hedge their exposure to the stock or did not consider it material, given their then expectations of stock price growth. This segment of the convertible market is materially diminished and more rationalized with a greater awareness of the pros and cons of the structures.

Privately placed equity-linked products are also used to transfer risk from holders of restricted or illiquid stocks to equity derivative departments of investment banks, insurance companies, and other financial institutions. Restricted stock situations include equity stakes by officers or directors of a firm, holdings by affiliates, and stakes received as a part of a merger or acquisition by an individual or a corporate entity. Typical structures employed are zero cost collars and trust-backed convertibles (see below). Owners of the stock are forwarded up to approximately 80% of the value of the shares, depending on the specific structure. The equity derivative seller then hedges and trades a portfolio of such positions for its own account.

Convertible Product Range

Convertible products[3] may be divided into three categories based on their seniority in the balance sheet and the tax treatment of the preferred dividend. These categories are (1) convertible debt products, (2) convertible preferred products of the mandatory and the nonmandatory type, and (3) hybrid products, which are preferred shares from a financial reporting perspective but are structured so as to be tax-deductible and thus to reduce the net cost to the issuer.

Convertible Debt Products

Convertible debt products' interest payment obligation can be in the form of cash coupons or interest accrual or both or neither. The "neither" case occurs when the value of the equity option embedded in the convertible offsets the value of coupon payments of an otherwise identical nonconvertible debt of the same issuer. In the

3. For the balance of this chapter, unless otherwise noted, we will use the term *convertible* for exchangeables as well. As may be expected, exchangeables are used to monetize stakes that an entity, be it a firm or an individual, owns in the shares of another publicly traded common stock.

recent low-interest-rate regimes, the zero-coupon nonaccreting structures have been the norm in Japan and Taiwan and occasionally have been issued in the United States also. Coupons payments and accrued interest are tax-deductible, and the issuer is accorded no equity credit from the rating agencies.[4] The products in this category include

- *Traditional convertible debt*. Typical maturities are five, seven, or 10 years, with a 15% to 40% conversion premium and a nonredemption period (*hard noncall*) of three years. The bond is issued at par, matures at par, and has a fixed conversion ratio[5] and hence a fixed conversion price during its life. Basic variations include a higher conversion premium with a higher associated coupon or a stock price trigger–based conditional redemption (also known as a *provisional call* or a *soft call protection*).[6] The combination of an initial period of hard noncall followed by a soft call is often used to trade off against a lower coupon and/or a higher conversion premium. As a rule, the greater the volatility of the underlying stock and the higher its growth expectations, the greater is the variation from the basic structure.[7] Reset or refix clauses are included

4. Equity credit from rating agencies is outside the scope of this chapter. Suffice it to say that rating agencies have repeatedly indicated that with the exception of common shares, which (by definition) are accorded 100% equity credit, they do not adhere to a formulaic approach to assigning ratings for securities or corporate issuers. Nonetheless, one of the rating agencies has indicated the general range of equity credit that may be expected for a list of financial instruments. See Libby Bruch, "Integration of Rating Scales and Re-evaluation of Equity Credit," *Standard & Poor's CreditWeek,* (February 24, 1999), pp. 9–11.
5. Conversion ratios for all converts are adjusted for stock splits and special situations, such as special dividends or distributions, as specified in the prospectus for each convert but are not adjusted for "regular" dividends or increases to these dividends.
6. A "two-year hard plus one year 130% soft" means that the convert is not redeemable in the first two years from issue date. It is conditionally redeemable in the third year only if the stock price is at least 30% above the conversion price for at least 20 out of 30 consecutive trading days. After the third year, the convert is redeemable unconditionally. Provisional triggers usually range from 120% to 150%.
7. For example, Amazon.com issued a $1.25 billion 10-year maturity convertible debt in January 1999 with a coupon of 4.75% and a conversion premium of 27%. Amazon.com is a very volatile stock with strong name recognition as a market leader in the Internet retail sector. It was able to issue the convert after a one-day marketing and increase the issue size from an initially announced $500 million to a finally executed $1.25 billion based on investor demand. The structure provided no hard call protection. Instead, it had a three-year "150% provisional redemption with investment *premium makewhole.*" This means that if the 150% trigger condition were satisfied during the first three years, then the issuer may force conversion. However, the issuer then simultaneously would have to pay the investor a cash amount of $212.60 [=$1,000.00 less ($1,000.00 divided by 1.27)] per bond. The net effect on conversion is as if the investor purchased Amazon.com common stock on the date of issue of the convert. A more common variation currently is the *coupon makewhole* as distinct from the premium makewhole. In this variation, if redeemed during the makewhole period, the issuer pays the arithmetic dollar difference between the stipulated coupon stream until the noncall date minus coupons already paid prior to the redemption date.

when the outlooks for the firm or for the firm's primary economic domicile country, or both, are unfavorable. Such has been the case for most of the 1990s to date for Japan and other Asian countries. Hence the development of the reset converts there. The conversion price is revised downward if some stock price triggers are not met. The reset clause lowers the risk to the investor and transfers it to the issuer.[8]

- *Zero-coupon convertible debt.* Also known as LYON,[9] this product is a zero-coupon putable, redeemable, convertible debenture with 15 to 30 years maturity; with one-day puts at accreted value at five, 10, and 15 years from the settlement date following new issuance; and with a hard noncall until the first put date. Thereafter, the issue is unconditionally redeemable at any time at the accreted value. The debenture is issued at a discount to par, calculated at the semiannually compounded yield-to-maturity of the security. For example, a 5% yield-to-maturity 20-year LYON will be issued at a price of 37.243% of par, which is the present value of $100 discounted at 2.5% for 40 periods. The initial conversion premium ranges in most cases from 15% to 40%. The conversion ratio established at issue remains constant during the life of the security. As a result, since the bond value is accreting toward par while the conversion ratio is fixed, the conversion price rises continuously.[10] Attractive features of this security from the perspective of the issuer include
    - Conservation of cash and the option to deploy it at the (presumably higher) internal rate of return of the issuer
    - Tax deduction on the accrued interest
    - On conversion, the per bond equity addition to the balance sheet is composed of the initial issue price plus the accrued interest amount
    - On conversion, there is no recapture (by the Treasury) of the accrued tax deduction
    - This LYON and the CoCo, all else being equal, are the most debtlike of all equity-linked securities with the highest effective conversion price
    - It signals to the market that the issuer is unwilling to sell equity at the spot price at issue but only at the high effective conversion price

8. To our knowledge, no publicly traded reset converts have been issued in the U.S. market in the last 15 years.
9. Liquid Yield Option Note is a service mark of Merrill Lynch & Co.
10. Continuing with the numerical illustration, assuming the stock price of the underlying share to be $45.00 per share and the initial conversion premium to be 25%, the initial conversion price is $45.00 × 1.25 = $56.25 per share. The conversion ratio per bond accreting at 5% and 20-year maturity will be the issue price divided by the initial conversion price (372.43/56.25 = 6.621 shares). In five years, the bond will accrete to $476.74, which is the issue price compounded at 2.5% for 10 semiannual periods. The effective conversion price will then be (476.74/6.621 shares) = $72.00 per share.

- The trade-offs to investors for the rising conversion price include the higher option value in the five years of hard noncall, a higher accretion rate, and the option to put the security back to the issuer at accreted value at the stated intervals.[11] Among the typical variations in the structure are higher conversion premiums for highly rated issuers and/or high-volatility, high-expected-growth stocks, sometimes in conjunction with a first put in year 3 with a corresponding hard noncall also for three years. Other variations include longer first put date, often in year 7, as well as nonsymmetric put and call dates, with the first call date occurring before the first put date.
- *Original issue discount convertible debt.* This structure (called the *OID convert*) combines aspects of the preceding two structures in that a small part of the yield-to-maturity is paid in the form of cash coupon, and the balance accretes. As is to be expected, all else being equal, the yield-to-maturity in this structure straddles those of the preceding two structures. The conversion price is also rising but at a rate lower than that for the zero-coupon structure; the tax deduction associated with the accrued interest therefore also is lower. Maturity for this product is five to seven years with a typical hard noncall protection of three years. The security usually is not putable prior to maturity, although there is no reason why it cannot be structured with, say, a put in year 3 and final maturity in year 5 or 7.
- *Premium redemption convertible debt.* This is simply another variation of the OID convert. The only difference between this variation and the OID is that the latter is issued at below par and accretes to par at maturity, whereas the premium redemption convertible is issued at par and accretes in exactly the same manner to a number above par, hence the name. This structure is very common for converts issued out of Europe and Asia, where regulations may require the issuance of bonds at par.
- *Step-up convertible debt.* This product follows a *pay-in-kind* (PIK) structure common in the non-investment-grade debt (*high yield*) market, wherein the security pays no coupon for a period of up to five years. The coupon then steps up to a higher level cash coupon than what it would have been if it were current coupon paying from the start. Adapted for the convertible market, this security pays a low cash coupon for the first three years, which is also the hard noncall period.

11. The puts are sequential European puts and can be either *hard puts* or *soft puts*. In the former, on exercise of the put, the investor is paid the put amount in cash. In the latter, it can be satisfied in cash or shares equal to the value of the put amount, or combination, at the option of the issuer. Earlier versions had an equal value of a new straight debt security as a third alternative; this alternative has been dropped due to ambiguities regarding the valuation of the new debt security.

The coupon then steps up for the balance of the life of the convert that ranges from another four to seven years. The effective conversion price rises continuously until the last low-coupon payment date and stays constant at its higher level thereafter until maturity. As might be expected, the absolute levels of the coupons in step-up convertibles are much lower than those in the high-yield market owing to the inclusion of the conversion option. Interest is expensed at the rate of the yield-to-maturity, which is higher than the cash coupon during the low coupon period but lower than the cash coupon rate in the later period. Therefore, the issuer has a strong incentive to redeem this security prior to the higher coupon kicking in. A flip-side variation of the structure, particularly in low-interest-rate environments, is the step-down convertible, wherein after an initial cash coupon period the coupon drops to a lower level or to zero with or without accretion.

- *Contingent convertible and contingent payable putable bonds.* This innovative structure has removed perhaps the most undesirable characteristic of convertible bond issuance from dilution-sensitive corporate issuers' perspective. Since in most convertibles the investor has an American option to convert into the underlying stock, generally accepted accounting principles (GAAP) require that the earnings-per-share calculation include in the denominator the existing number of shares outstanding as well as the new number of shares to be issued on conversion of this convertible. This inclusion occurs immediately on settlement of the newly issued convertible transaction based on the conservative assumption of immediate conversion by the investor thereby resulting in an immediate dilution in the reported earnings per share. In this nicknamed "CoCo/CoPay" convertible, the American conversion option is not granted the investor except under certain prespecified conditions. Instead, only contingent on the stock price meeting prespecified price hurdles does the conversion option knock in. In that event, the issuer has the option to make a contingent payment to the investor, in cash or in accretive form, thereby minimizing the incentive of the investor to convert the bond. By adopting these twists, the condition for GAAP recognition of immediate conversion is not met and hence no immediate dilutive impact to earnings per share.[12] The structure has been

12. There was a significant accounting development during the production process for this *Handbook*. The Emerging Issues Task Force of the Financial Accounting Standards Board released a proposal, on July 19, 2004, that calls for issuers of Contingent Convertible (CoCo) bonds to book these securities the same way as traditional convertibles. That is, an issuer would recognize earnings per share (eps) dilution as if conversion into common stock occurred on the date of issuance of the convertible. Furthermore, the proposal, effective December 15, 2004, requires retroactive restatement of the issuer's prior diluted eps to reflect the additional dilution caused by the CoCo bonds.

adapted into the LYON and OID structures. In other words, the structure typically has sequential European puts as in a LYON; it may be zero-coupon or full-cash-pay or partial-cash-pay and partial accretion or no accretion; tax deductibility of the cash and contingent coupon is retained at the issuer's otherwise identical nonconvertible debt rate rather than at the stated cash plus accretion rate under the U.S. Internal Revenue Service's Contingent Payment Debt Instrument regulation.

The structure allows for investor conversion, however, under certain conditions even if the contingent price threshold test is not met. These conditions may include issuer redemption of the bond or a merger or a special asset distribution deemed as a special distribution or a binding share exchange involving the underlying stock or if there is a ratings downgrade to a prespecified level or below.

A generic example of such a transaction is 1.5% coupon, issued at par, 20-year maturity senior debenture, European puts in years 5, 10, and 15 each at par, noncall period five years, initial conversion premium 45%, contingent threshold 20%; if contingent threshold is exceeded for 20 consecutive trading days in any quarter, then contingent conversion will knock in for the next quarter, and contingent payment will commence at a prespecified rate for a prespecified time. Suppose that the spot price of the underlying stock at issue is $30. Then the initial conversion price is 1.45 times $30 = $43.50, and the contingent threshold price is 1.20 times $43.50 = $52.20. Under the terms specified here, if the stock price does not exceed $52.20 for 20 consecutive trading days in any quarter, then the investor does not yet have the conversion option. If this condition persists until maturity, then there is *dead zone* between par and 120. What is the convertible worth at maturity if the stock price at maturity is, say, $48.00? Is the bond worth par or more than par because the stock is above the conversion value? If the bond lasts that long, and this is a big if, then technically the bond is worth only par or its accreted value, whichever is applicable, because it is not convertible. More recent transactions have built in a decline to a lower nonzero contingent threshold level over time or in the last six months prior to maturity the threshold needs to be exceeded just once in place of 20 consecutive days. Both these have been devised to increase the probability of a convertible not ending in a dead zone, although not totally eliminating it, and thereby address the inherent disadvantage to the investor while at the same time satisfying the GAAP requirements for nonimmediate earnings per share dilution.

Variations of the structure may include stepdown of coupon, a lower starting threshold than the 20% assumed in the generic example. Also, once knocked in, the conversion right may become an American-style investor option without having to meet the test repeatedly for each quarter. Final maturity may be 30 years, first put earlier or later than five years, nonsymmetric call, and put dates and all other potential variations of LYONs and OIDs. CoPay stipulations may vary widely from one structure to another and are too numerous to list here. Another variation employed has a floating-rate coupon pegged as a spread to LIBOR rather than a fixed coupon.

The CoCo/CoPay structure has grown to dominate U.S. convertible products since its introduction in late 1999. In 2003, it accounted for an overwhelming 70% of gross proceeds raised with modest help from its close relatives, the LYONs and OIDs, which do not share its attribute of postponing earnings per share dilution. Most issuers have been investment grade, and the transactions generally have been very large. Combined with the development of the CDS product and other hedging instruments, the CoCo/CoPay structure has become a mainstay of U.S. convertible new issue as well as secondary trading, with its features particularly attractive to issuers and hedge funds.[13]

- *Negative yield convertible debt.* Yield on the benchmark 10-year yen-denominated Japanese government debt has hovered around 1% for several years and was at 1.49% as of 5/19/04. Dividend yields on Japanese equity are traditionally very low. Under this scenario, consider a yen-denominated, zero-coupon, low conversion premium, unsubordinated convertible debt with an effective maturity of five years issued with a hard noncall also of five years. Its theoretical value most likely would be a few points above par. To make it equitable to both issuer and investor, such a convert might be issued at 1% to 3% above par, yet it matures at par, thereby resulting in a negative yield-to-maturity security. Not surprisingly, this structure will be used more frequently in low-interest-rate environment and particularly so when combined with high volatility in the underlying stock.

Over the last couple of years, many convertible debt new issues have been issued as senior unsubordinated debt *pari passu* with senior existing or future nonconvertible debt of the issuer. This is particularly so for CoCo/CoPay structures and has long been a common feature of convertible bonds issued out of Europe. Adding this feature has provided increased liquidity to the U.S. convertible

13. In response to the FASB requirement discussed in the prior footnote, there has been a significant drop-off in CoCo issuance, particularly by investment grade issuers (see Exhibit 60–2). In the now modified CoCo structures, par is repaid in cash upon conversion while the in-the-money component of the convertible is paid in shares. For example, if the conversion value of the convertible is $1,240, $1000 is paid in cash and $240 is paid in shares. This reduces the magnitude of the dilution while retaining the contingent conversion feature. Existing CoCo issues have also been amended accordingly, following bondholder consents and accompanying inducements for the consents.

product by making it investible for investment-grade and high-yield bond funds. Additionally, it facilitates capital structure arbitrage as well as credit hedging via CDSs.

Convertible Preferred Products

Convertible preferred products are senior only to the issuer's common stock. The preferred dividend is not tax deductible and hence is a costly source of funding on an earnings per share basis. Convertible preferreds are mostly issued, therefore, when the firm needs equity credit from the rating agencies, or when it is unable or unwilling to issue debt owing to leverage test ratios imposed on them by other classes of senior securities, or when the firm does not pay taxes owing to accumulated losses or a combination of these reasons. These products are viewed as "permanent" or long-term financing and provide the issuer with the option to skip payment of preferred dividends without triggering default. Hence they are generally accorded up to 50% equity credit from the rating agencies.[14,15] Withholding taxes and the low bond floor equivalent resulting from the perpetual maturity are the primary reasons why these structures are not commonly issued in Europe. The products in this category also include those which redeem at par if not converted, that is, without impairment to the original investment, and those which convert mandatorily into a formula number of common shares at maturity. In the latter case, investors may lose part of their initial investment if the stock price falls below that on the date of issue.

Non-mandatorily convertible preferred shares include

- *Perpetual maturity convertible preferred shares.* This is the preferred share counterpart of the traditional convertible debt. With a fixed conversion price and an easy to understand structure, it has been a staple of the convertible market for several decades. The main differences are its perpetual maturity and lower seniority. Consequently, the dividend on the convertible preferred will be higher than the coupon on an otherwise identical convertible debt. The higher rate on the preferred results from

14. While skipping preferred dividends does not result in default, it does tend to severely depress the stock price. Restrictions on common dividend payments and board seats to preferred shareholders and other remedies may be imposed on the firm until the arrears in preferred dividends are paid. Consequently, the option to skip preferred dividends, although embedded in the structure, is resorted to only when the firm is in financial distress.
15. Issuance of traditional preferred shares in most cases is viewed as helping prevent a ratings downgrade but may not necessarily help in a ratings upgrade. Since mandatorily convertible securities, by structure, are certain to convert into common shares within three years and at most in five years, they are viewed more akin to common shares and therefore may be accorded up to 85% equity credit. This applies to all flavors of mandatorily convertible securities—preferred, exchangeable debt, or hybrid tax-deductible preferred.

the fact that both the benchmark interest rate, the 30-year U.S. Treasury in this case, and the credit spread corresponding to this longer maturity is higher, and the two together form the base rate. The dividend rate on the convertible preferred is determined by adjusting downward from this higher base rate for the embedded equity option.[16,17]

- *Dated convertible preferred.* Again, a convertible adaptation from the high-yield market, this product has a maturity of 10 to 12 years, although 30-year dated convertibles also have been issued. Typically, it matches or is outside the maturity of high-yield debt, which is usually 10 and sometimes 12 years. If not converted, a dated convertible preferred must be redeemed at par at maturity. In all other aspects it is similar to the perpetual maturity convertible preferred. Rating agencies are understandably less likely to accord any equity credit owing to this product's debtlike redemption at maturity feature. While infrequent, it has been used by non-investment-grade issuers faced with covenant restriction limits.
- *Step-up convertible preferred.* This product is analogous to the step-up convertible debt but with perpetual maturity.

Mandatorily convertible preferred shares, in essence, transfer the downside risk of the stock to the investor in exchange for a higher preferred dividend. This category of converts includes

- *Capped common.* Also known as *PERCS*,[18] the capped common is essentially a combination of purchasing a common share and writing a 30% to 60% out-of-the-money call (relative to the spot price on the date of issue). Investors have no conversion option at any time during the life of the security, which is typically three years. The issuer, however, may redeem this convertible at any time, provided that the preferred dividend due until the maturity date is paid in its entirety. The premium for the call option that the investor is short is packaged in the form of quarterly preferred dividends. This packaging of a common options strategy, known as the *buy-write strategy,* allows convertible funds to invest in them. Were these three-year convertible securities unbundled, the charter of convertible funds generally would prohibit such investment. The investor in the capped common realizes all the stock price appreciation from the spot price at issue up to the cap level; anything beyond that

16. This logic applies to all converts.
17. A variation of this security allows the issuer the option to exchange the convertible preferred for an otherwise identical convertible subordinated debenture of maturity 10 years from the original date of issue. The issuer usually will exercise this option when it returns to tax paying status.
18. The Preferred Equity Redemption Cumulative Stock (PERCS) is a service mark of Morgan Stanley.

goes to the issuer. On the other hand, the investor loses part of her principal to the extent that the stock price at maturity is lower than the price at issue. In a rising equity market, the issuer has almost always exercised the call option, and hence this product has underperformed the common stock from an investor perspective. Consequently, its popularity has declined considerably. Rating agencies generally may be expected to accord equity credit of up to 85%.

- *Modified capped common*. A variation on the preceding, the modified capped common may be viewed as a PERC with some downside protection to the investor, in the form of an embedded put the investor purchases from the issuer. Microsoft Corporation issued $1 billion of this security in 1996 with a cap of 28% on the upside but without any downside risk to the investor—that is, with no hit to the principal. The embedded put purchased by the investor for this three-year-maturity security was an at-the-money European put on what was then a high-volatility stock and hence was very expensive. The net option premium paid to the investor in the form of preferred dividend was accordingly low.[19]
- *Traditional mandatorily convertible preferred*. Although invented in 1993, this structure, together with its hybrid version, the *trust mandatory preferred* (described below), has been used so frequently in the convertible market that it is already viewed as a "traditional" product with a host of acronyms.[20] Typically, it is issued at the same price as the underlying stock price and matures in three to five years, most frequently three-year maturity. It has a conversion premium in the 20% to 22% range but may be higher in low-interest-rate regimes. It is easiest to view this security (popularly known as a *mandatory*) as a traditional convertible with a three-year maturity that is share settled, packaged with an embedded at-the-money put purchased by the issuer from the investor. The number of shares received by the investor at maturity depends on the share price on the maturity date.[21] This security's popularity has stemmed from the high

19. Microsoft Corp. Series A 2.75% Convertible Preferred issued on 12/17/96 and maturing on 12/15/99; cap at 28%.

20. The service marked acronyms, followed in parenthesis by their respective investment banks, include DECS (Citigroup Salomon Smith Barney), PRIDES (Merrill Lynch), ACES (Goldman Sachs), PEPS (Morgan Stanley), SAILS (Credit Suisse First Boston), and PIES (Lehman Brothers).

21. Assuming a spot stock price of $100 a share, the mandatory also will be issued at $100. If the conversion premium is 20%, the minimum conversion ratio is the issue price divided by the conversion price = $100.00/120.00 = 0.8333 shares per mandatory. If the stock price at maturity is at or above $120, the investor receives 0.8333 shares. If the stock price is at $100 or below, he receives one share which is the maximum conversion ratio per mandatory. Thus, in the event that the stock price is $65 at maturity, the investor has a hit to the principal of $35 per share. If the stock price is between $100 and $120, the investor receives between 0.8333 and 1.0 shares so as to be worth the initial investment of $100.

equity credit from rating agencies, the transfer of risk to the investor in the event of a decline in the share price, and the traditional convertible features on the upside. Because the issue is settled in shares, the question of credit risk of the issuer with respect to payment of par is irrelevant. Only the credit risk with respect to payment of the preferred dividends remains. Consequently, the structure is relatively insensitive to the credit-worthiness of the issuer. The preferred dividend for a mandatory ranges from 5.5% to 8.50% depending on the dividend yield on the underlying common shares.

- *Modified mandatorily convertible preferred.* A variation on the preceding structure, the modified mandatory convertible preferred provides the investor with downside protection for the first 10% to 25% from the spot price in exchange for a lower preferred dividend. In effect, the net put component of the package purchased by the issuer is 10% to 25% out-of-the-money. Hence the put premium is lower, and this translates into a lower preferred dividend. The maximum number of shares is 1.111 for a 10% out-of-the-money put case rather than the one share in the at-the-money put case of the traditional mandatory. The equity credit accorded is identical. Daimler-Benz issued DM993 million (US$585 million) worth of this structure in 1997.

Mandatorily and modified mandatorily exchangeable securities (wherein the underlying stock is different from the issuer's common stock) can be issued as debt securities and were the primary motivation for invention of the mandatory structure. When a mandatorily convertible security is issued on the issuer's own stock, it is deemed as a forward sale of the common and hence is not tax deductible. Specialized structures are crafted in compliance with the applicable tax code in order to achieve effective tax deductibility. The next subsection briefly outlines these hybrid products.

Hybrid Convertible Products

This category consists of structures that are treated as preferred shares for financial reporting purposes, but their distributions are tax deductible. The development of hybrid convertible preferreds closely followed the invention of the MIPS and QUIPS[22] in the fixed-rate nonconvertible preferred market. The essential structure in this category is as follows: a trust[23] issues convertible preferred shares to investors and simultaneously uses the proceeds to purchase

22. Monthly Income Preferred Shares (MIPS) and Quarterly Income Preferred Shares (QUIPS) are service marks of Goldman Sachs. Trust Originated Preferred Securities (TOPRS) is a service mark of Merrill Lynch and is more descriptive of the structure.

23. The trust qualifies as a closed-end fund under the Investment Company Act of 1940.

convertible subordinated debt from the issuer. The convertible subordinated debt will be the sole asset of the trust. The coupon from the issuer to the trust exactly mirrors the preferred dividend paid by the trust. On conversion by the investors, the trust, in turn, converts the convertible debentures and passes through the shares to the investors.

- *Trust nonmandatory preferred.* The maturity of this product ranges from 15 to 30 years and equals the life of the trust; its cash distributions and maturity mirror that of the convertible debenture purchased by the trust from the issuer. Investors generally are not sensitive to the structural difference between these securities and the traditional perpetual convertible preferred. Rating agency equity credit may be equal to that of the traditional perpetual convertible preferred, although recent discussions might lead this product to be viewed as being closer to debt.
- *Trust mandatory debt.* This product is similar to its non-tax-deductible counterpart, except for the complexities involved with the trust and the forward purchase contract between the investor and the issuer, which is required to ensure mandatory conversion at the end of the life of the trust, typically three years. Variations relate to the structures and conditions regarding the forward purchase contract. Trust structure is also employed when the entity selling the shares is not a SEC registrant but rather an individual or an investment or venture capital partnership. Should the creditworthiness of the corporate issuer be less than acceptable, or if the seller is not a SEC registrant, preferred dividends due the investors over the life of the security are escrowed in the trust in the form of Treasury strips with maturities matching the scheduled preferred dividend payment dates. On the date of issue, proceeds from the sale of the trust mandatory to the investors, less the purchase price of the Treasury strips and trust administration costs, are forwarded to the issuer. The underlying shares are simultaneously escrowed in the trust so as to create a bankruptcy-remote trust with an implied AAA credit rating.[24]
- *Zero premium exchangeable debt.* This product is a 1999 invention with the acronym PHONES.[25] It is a 30-year zero conversion premium

24. "Treasury stock method" is applicable to trust mandatory converts as opposed to the "if converted" method applicable to most other convertible structures. In addition to the advantageous tax deductions resulting to issuers, this structure is particularly attractive to them because they receive equity credit immediately on issuance of the mandatory, yet earnings per share dilution is postponed to the third year because the incremental new shares are recognized only on settlement of the mandatory at the end of the third year.
25. Participating Hybrid Option Note Exchangeable Securities (PHONES) is a service mark of Merrill Lynch. Another investment bank calls it ZONES.

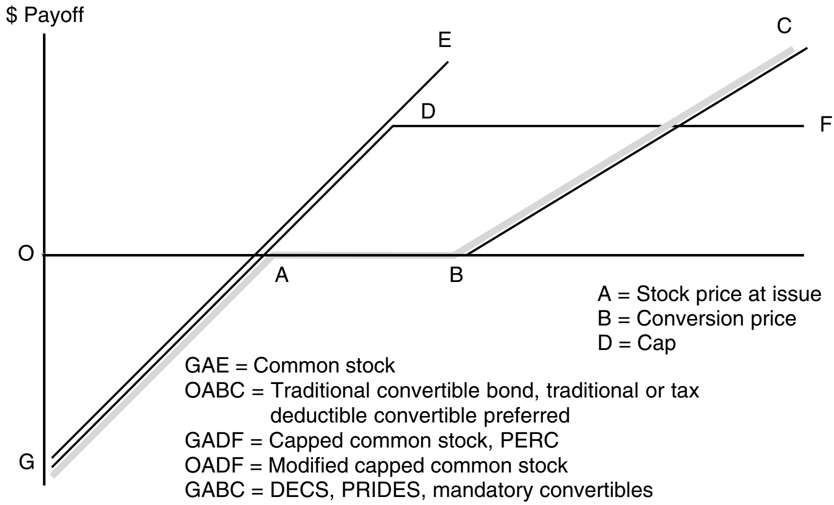
security issued at the same price as the underlying share into which it is exchangeable. It is redeemable by the issuer at any time and convertible by the investor at any time, although there may be an initial nonconversion period. However, if the security were to be converted by the investor in the initial 30-year maturity period, the conversion ratio will be 0.95, implying a 5% penalty for voluntary conversion. The security is extendible for a further 30 years, subject to certain minimal conditions, at which time the conversion ratio becomes one share. The investor receives a pass-through of the dividend paid by the underlying share plus a fixed interest component. Any increase in the dividend paid by the share is deemed return of principal and deducted from the residual "par value," which is initially equal to the original issue price. Investors are liable for taxes on income deemed as received at the issuer's subordinated straight debt rate, which considerably exceeds the interest paid by the issuer. In exchange, the investor's basis for the share will rise with time. Zero premium exchangeable debt, at its most basic level, is a tax-advantaged way for the issuer to monetize its holding of the underlying shares without actually transferring ownership of the shares. It thus potentially allows the issuer to defer the capital gains tax for as long as 60 years while enjoying a much larger interest deduction than cash coupon paid (9% imputed rate versus 1.75% actual cash coupon rate in one instance). Given the substantial tax advantage it provides the issuer, it is attractive for the issuer. However, owing to its material tax liability for a taxable investment entity, this product is most likely to appeal to tax-sheltered investment vehicles of the equity income type, to tax-sheltered index funds, and to offshore hedge funds.[26] Many investors do not consider this security to be a convertible because it lacks any meaningful convexity. After an initial flurry of issuance, these structures have not been used since 2001.

Exhibit 60–1 provides a schematic of the terminal payoff diagrams for the major convertible securities. Similar payoff diagrams can be drawn for the other convertible products.

26. Two sample transactions issued were (1) Comcast Corp. exchangeable into AT&T Corp., issued in March 1999, raising $718 million; it paid 1.75% coupon in addition to the 1.60% dividend on AT&T stock; the issue was redeemed in its entirety four months later; and (2) Tribune Company exchangeable into America Online, Inc. (AOL) in April 1999, raising $1.256 billion; the security paid 2% coupon, while AOL paid no dividend. AOL has since merged with Time Warner.

EXHIBIT 60–1

Equity-Linked Payoff Diagram



Investing in Convertible Securities

The most frequently cited reason to invest in convertibles is that convertibles provide upside participation with downside protection. While generally true, this does not fully apply to mandatory securities, where the holder retains the downside risk of the stock. Since convertibles span the space between equities and straight debt, the risk profile of each convertible product contains elements of both. Investors will choose from the subset of convertible offerings that matches their target risk/reward profile.

Institutional investors in convertible securities can be broadly classified into *outright* investors and hedgers. Outright investors include the dedicated convertible funds, equity income funds, insurance companies, and fixed income funds seeking to participate in the potential upside in the equity. Convertible mutual funds, money managers who manage third-party funds such as those from pension funds with specific allocation for convertibles as an asset class, as well as in-house managed funds earmarked for convertibles are also included in this category. The main hedge funds participants include those focused on convertible arbitrage, equity volatility arbitrage, and capital structure arbitrage.[27]

27. The market-making activity of an investment bank's convertible trading desk is also a de facto convertible arbitrage function. Since the activities of a hedge fund and an arbitrage fund, as they pertain to the convertible product, are identical, we will use the terms synonymously.

The common investment objective of the outright investors is to obtain equity exposure with portfolio volatility lower than that of common stocks. They are active money managers and are often benchmarked against the Standard & Poor's 500 Index or the Russell 2000 Index of small stocks and a risk-adjusted benchmark such as the Sharpe ratio.[28] An aspect of the charter of outright accounts is that they are only allowed to be long the convertibles and may not be allowed to hold the common shares received on conversion. Neither are they permitted to hedge their convertible positions. That flexibility is left to the convertible arbitrage funds.

The large amount of funds allocated to the convertibles, particularly by hedge funds, in the last few years has dramatically altered the size of this asset class, the way convertibles are structured, marketed, evaluated and traded. To varying degrees, this phenomenon also has occurred in the equity and straight debt markets. Convertible hedge funds are currently estimated to account for approximately 75% of the funds invested in U.S. convertible markets and perhaps an even larger percentage of the European market. Given their high portfolio turnover, convertible arbitrage funds account for a substantial portion of secondary market trading.

Compelling issuer credit profile and equity fundamentals of the underlying stock of a convertible attract investor attention. Ideal attributes include:

- A strong management team with a well-articulated business model
- Presence in a growing sector of the economy and competitive pricing power
- The firm being in the growth phase of its business cycle
- Strong or improving credit with the ability to undertake the fixed liability without jeopardizing its credit rating
- Credit spread established by actively traded nonconvertible debt of the issuer or credit default swaps or asset swaps
- High-volatility stock
- Little or no dividend on the common stock
- Liquid secondary market for the convertible and the underlying stock

Additional items considered by hedge funds include

- Cost to borrow the stock
- Richness or cheapness of the implied volatility of the options embedded in the convertible versus those of comparable listed equity options and

28. Sharpe ratio is defined as the excess return of the portfolio divided by the risk of the portfolio as measured by the standard deviation of its returns. Portfolio excess return is the realized return of the portfolio minus the return from the riskless asset. It attempts to measure the excess return per unit of risk undertaken by the portfolio manager. The measure can be applied to portfolios or to asset classes. Higher the Sharpe ratio, the better the performance of the portfolio manager or the asset class.

the historical volatility of the underlying stock (This forms the basis of volatility trading, also known as *gamma trading*.)

- Implied equity volatility of credit default swaps and *equity default swaps* (Together with implied volatility of comparable equity options, these form the basis of what may be called *equity-linked volatility arbitrage.*)
- Issuer's credit spreads for all levels of seniority of obligations including the convertible with a view to *capital structure arbitrage* [The idea is to arbitrage (1) credit spread mispricings or (2) differential implied probabilities of corporate default, or (3) recovery rate in the event of default embedded in the pricing of these obligations. Needless to say, this arbitrage is at the cutting edge of hedge-fund activity and is performed well by few.]

Thus, through a combination of fundamental equity research, valuation, and arbitraging of convertibles and related equity and credit derivatives, money managers seek to outperform their benchmarks and each other. To understand the impact of the recent funds flow into the convertible product and the change in relative importance of hedge funds, we discuss convertible new issues next.

Convertible New Issues

The publicly traded U.S. convertible new issue market has grown steadily in size from $12 billion in 1992 to over $106 billion in 2001 before easing to $90 billion in 2003 and declining in 2004.[29] (See Exhibit 60–2.) In addition to the previously mentioned $5 billion Ford Motors transaction, there have been 80 others of at least $1 billion each from 1998 through 2004. Twenty-seven of these were issued in the boom year of 2001 and 10 to 12 in each of the other years except 1998 and 2004. The average size of non-investment-grade issues has ranged between $200 and $350 million and approximately $600 to $750 million for investment-grade issues. These are healthy sizes reflecting the emergence of the convertible product as a legitimate funding source for all corporate issuers. In some of these years, the convertible market became the major source of funding for corporate issuers when equity, high-yield, and money market securities became relatively illiquid and expensive.

What determines the amount and type of convertible financing selected by issuers? One key factor, surely, is the economic cycle and, by implication, the

29. This only includes convertible securities that meet all the following criteria: (a) the issue is publicly traded, including registered and Sec. 144A securities, (b) the underlying common stock is primarily or solely traded in the United States and regulated by U.S. regulators or if the primary exchange is not the United States, the equity-linked security is substantially marketed to U.S. investors (e.g., Bell Atlantic Corporation's $2.455 billion exchangeable into Telecom Corporation of New Zealand issued in February 1998), and (c) gross proceeds from the issue is $50 million or larger.

equity and bond market environments. In early 1990s, U.S. firms undertook substantial restructuring of their balance sheets in order to lower the leverage added in the 1980s. To this end, convertible preferreds issued in those years included what were then considered very large transactions: (1) $2.3 billion from Ford Motors Co., (2) $1.725 billion from General Motors Corp. exchangeable into Electronic Data Systems Corp., and (3) $1.15 from Delta Air Lines, Inc. The interest-rate shock of February 1994 caused a substantial derailment of the bond and equity markets, leading, in turn, to a material decline in financing and the subsequent emergence of the mandatory convertible product. As the economic conditions recovered in 1995 and peaked in mid-1998, the tax-deductible mandatory convertible and the tax-deductible nonmandatory convertible preferred increased in importance. Issuance of traditional convertible debt declined substantially in 1998 and came to a virtual halt following the Russian government bond default in mid-1998 and the Asian/emerging-market contagion then in full swing. Convertible financing in the first half of 1999 was off significantly from that of the previous year owing to fears of rising interest rates, but it spurted in the last quarter of 1999 amid a recovery and start of the boom cycle. Convertible debt as a percent of total issuance jumped up to more than 80% in 2000 and 2001. With the burst of the Internet bubble, preferred share structures returned in favor at 42% of total gross proceeds in 2002. However, 2003 saw the resumption of the dominance of convertible debt issues, particularly the zero-coupon/part-coupon/CoCo structures, as interest rates continued to be extremely low in real terms and issuers exploited this opportunity to refinance existing liabilities at lower rates while extending their debt maturities and thus shoring up their balance sheets. The more than 60% of gross proceeds raised by investment-grade firms in 2001 and 2002 are indicative of the opportunistic financing by these higher-rated corporate issuers. The preponderance of non-investment-grade issues in 2003—and even more so in 2004—and their share of financing are noteworthy. Europe continues to be the next-largest market for convertible financing and trading. Adoption of the euro and the attendant rationalization of corporate balance sheets and monetization of cross-holding of shares have been major contributors to convertible issuance in the European sector. Leading the way have been France, Germany, Italy, The Netherlands, and the United Kingdom.[30]

Exhibit 60–2 also shows the breakdown of new issues between registered and 144A issues.[31] Many of the 144A issues are overnight transactions. That is,

30. Total issuance in Europe in US$ equivalent was $46.8 billion, $22.3 billion, and $48.4 billion in 2003, 2002, 2002, respectively, before declining to $17.9 billion in 2004.

31. As an alternative to an SEC-registered offering that can be sold to any investor, including individual investors or institutions with less than $100 million in net assets, 144A issues can be offered, sold, or resold only to the larger institutional investors and qualified institutional buyers (QIBs). The main reason for the market increase in 144A transactions is that they can be executed quickly without having to undergo the time-consuming registration process. This option is available to SEC-registrant firms who are current with respect to filing financial reports with the SEC or those that agree to make the financial reports available to investors.

EXHIBIT 60–2

U.S. Convertible New-Issue Profile

	2004	2003	2002	2001	2000	1999	1998
Total new issue ($ billion)	$46.2	$90.0	$54.9	$106.7	$60.2	$42.4	$38.3
Total number of issues	185	278	123	214	140	111	126
Number of investment-grade issues	19	53	58	99	36	18	27
Number of non-investment-grade issues	166	225	65	115	104	93	99
Investment grade ($ billion)	11.0	$40.3	$35.9	$65.7	$24.6	$11.0	$18.2
Investment grade $ as % of total gross proceeds	24%	45%	65%	62%	41%	26%	48%
Non-investment-grade $ as % of total gross proceeds	76%	55%	35%	38%	59%	74%	52%
Average size of investment-grade issue ($ mil)	580	761	618	663	683	611	676
Average size of non-investment-grade issue ($ mil)	212	221	293	357	342	337	202
No of 144A issues	151	232	70	140	96	58	76

	Percent of Gross Proceeds by Product						
Product	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Traditional convertible debt	13.5	18.5	19.5	31.9	50.2	37.2	30.1
Zero/part coupon/CoCo putable convertible debt	59.7	70.5	35.3	49.3	32.9	8.8	13.9
Mandatory pref or debt, all variations	12.9	7.2	26.2	5.8	4.2	15.3	22.7
Traditional and trust nonmandatory convertible preferred	13.9	2.4	16.0	13.0	11.6	20.4	24.0
Miscellaneous	0.0	1.4	3.0	0.0	1.1	18.3	9.3
Total new issue ($ billion)	$46.2	$90.0	$54.9	$106.7	$60.2	$42.4	$38.3

they are announced after the trading day is over, orders are solicited that same night or early the next morning, and the transaction is completed before trading starts that morning. The high proportion of 144A issues indicates (1) that the demand for the product is strong; issuers do not need to provide investors a number of days, as is done in registered offerings, to study the details of the company's finances and/or the transactions prospectus; and (2) the dominant role played by hedge funds, institutional buyers, and QIBs in the investment process because they can quickly respond to the new issue offer. This brings us to the question of how to value convertibles.

BASIC CHARACTERISTICS OF CONVERTIBLE SECURITIES

The simplest convertible security, namely, a traditional convertible bond, can be viewed from a fixed income investor's perspective as a combination of an otherwise identical nonconvertible bond plus a call option to exchange the bond for the underlying shares. From the equity-oriented investor's viewpoint, it may be viewed as a combination of a long position in the underlying shares, a put option to exchange the underlying shares for an otherwise identical nonconvertible bond, and a swap to receive coupons of the convertible bond in exchange for dividends on the underlying shares. This is an immediate implication of the European version of the put/call parity theorem.[32] The introduction of redemption features and other embedded options in the more varied convertible structures discussed earlier may complicate but does not invalidate the basic equivalence concept.

Value Diagram and Descriptive Measures

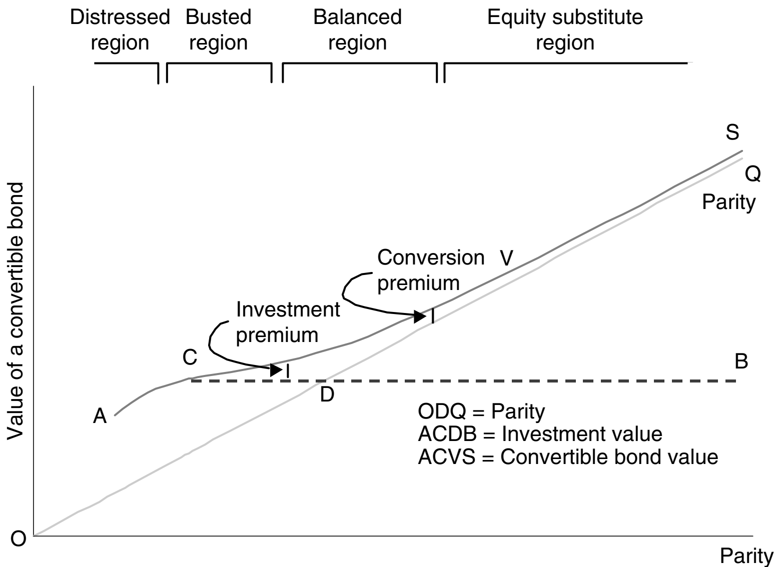
The price behavior of a convertible security can be explained by its value diagram (see Exhibit 60–3), which shows how the value of a convertible bond is determined by its debt and equity components.[33] The horizontal axis in the diagram is the value of the underlying shares and equals the stock price times the conversion ratio. This value is often called the convertible's *parity value* or, simply, *parity*. The line *ODQ* also represents parity. *ACDB* is the value of the corresponding straight debt, and *ACVS* represents the value of the convertible bond. Because a convertible bond provides the holder with rights beyond those provided by an otherwise identical nonconvertible bond, in that it can be converted into the underlying shares, its

32. See John Cox and Mark Rubinstein, *Option Markets* (Englewood Cliffs, NJ:, Prentice Hall, 1985), pp. 41–43.

33. The value of a convertible in a two-factor valuation model would be represented by a three dimensional surface with the value of the convertible on the *y* axis, stock price—the first factor—or, equivalently, parity on the *x* axis, and interest rates—the second factor—on the *z* axis. The simpler two-dimensional representation above is, therefore, a section of the pricing surface parallel to the *x*, *y* plane, at a particular level of interest rate.

EXHIBIT 60–3

Convertible Value Diagram



value should equal or exceed the larger of the corresponding debt or parity. Accordingly, in the value diagram, *ACVS* is equal to or above the segment *OD*, where bond value exceeds parity, and is equal to or above *DQ,* where parity exceeds bond value.

Three measures of premium are commonly used in convertible parlance. They are the *conversion premium*, the *points premium,* and the *investment premium*. The vertical distance between *ACVS,* denoting the value of the convertible bond, and the bond floor (or investment value) line *ACDB* represents the convertible bond value in excess of its investment value. This is expressed as the i*nvestment premium,* defined as

$$\text{Investment premium} = [(\text{convertible price}/\text{investment value}) - 1] \times 100 \qquad (60\text{–}1)$$

The vertical distance between the convertible bond value *ACVS* and parity *ODQ* represents *premium over parity*. This may be stated in *points premium,* defined as the dollar value of the convertible bond minus the dollar value of parity, expressed as a percent of par. For example, if the bond price were \$1047.50 and parity were \$920, then points premium would be 12.75 points. Alternately, the premium may be stated as the c*onversion premium,* defined as

$$\text{Conversion premium} = [(\text{convertible price}/\text{parity}) - 1] \times 100 \qquad (60\text{–}2)$$

The conversion premium is 13.86% in this exhibit. Conversion premium or, simply, the *premium* is an important and commonly used measure. Together with the investment premium and the notion of the *delta* of the convertible (defined below), the conversion premium helps to characterize the change in the value of the convertible with a changing underlying share price.

The ratio of the change in the value of the convertible to the change in the value of the underlying shares, or parity, is called the convertible's *parity delta*. Like the equity call option delta, the parity delta ranges from 0 to 1.0 and is the per-share delta of the convertible. Therefore, it is also called the *delta,* or the *neutral hedge ratio;* the per-share basis is the unstated assumption. At zero delta, the convertible behaves like straight debt, and at 1.0, it behaves like common stock. Therefore, the delta of the convert may be viewed as the correlation of the change in the price of the convert to the price change in the underlying share. A 65% delta means that for small moves in the underlying share price of, say, \$0.125, the change in parity equals the change in the price per share times the number of shares per convertible (= \$0.125 × 6.621 = \$0.8276). The expected change in the value of the convertible bond, then, is the change in parity times the hedge ratio (= \$0.8276 × 0.65 = \$0.5380, or 0.0538 bond points). If a holder of the convert wanted to hedge the equity risk, she would in theory have to sell short

Conversion ratio × delta = 6.621 × 0.65
= 4.3037 shares per bond to establish a *delta neutral* position.

The neutral hedge ratio is the tangent to and the slope of the convertible bond valuation curve at a particular stock price. For infinitesimal moves up or down in the stock price from this initial level, a hedged portfolio consisting of long the convert and short the shares, as illustrated earlier, will result in neither a loss nor a gain. Larger moves in either direction will lead to gains in the hedged portfolio because the tangent to the convertible bond valuation curve always touches the curve from below. Thus, for noninfinitesimal stock price change upward, the gain arising from the long position in the convert always will be greater than the loss incurred owing to the short position in the shares. This feature is termed the *positive convexity* or *positive gamma* of the convert and hence of the hedged portfolio.[34] A simple explanation of the impact of the positive convexity is that in the event of a large move up (down), the *ex-ante* neutral hedged position turns out to be ex-post underhedged (overhedged) and hence the profit.

Stages of a Convertible Security

The price response of a convertible to a change in parity can be segmented conceptually into four stages or regions. These approximate regions are delineated in Exhibit 60–3. They are

34. Gamma is the second derivative of the convertible value with respect to parity and is the rate of change of delta with respect to the share price. Position gamma and portfolio gamma are risk measures used for quantification of potential profit/loss exposure. A positive gamma is always desirable and negative gamma "a Giffen good."

Balanced converts. In the first half of the 1990s, an overwhelming majority of new-issue convertibles were priced with a conversion premium of around 20% to 25%, whereas very few were priced at the extreme ends of the new-issue range of 10% to 60%. With the lower interest rates in late 1990s to 2004, premiums have tended to be higher at issue. Convertibles with conversion premium of 25% to 40%, and investment premium of 15% to 25% respond materially to changes in the underlying stock price as well as interest rates and credit spreads. Hence converts with these attributes, either on issuance or subsequently as a result of stock price evolution, are called *balanced* convertibles. Their hedge ratios, or equivalently, their correlation with stock price changes, range from roughly 55% to 80%.[35] Their upside/downside participation and risk/return trade-off characteristics appeal to outright convertible funds and some equity funds seeking a lower risk alternative to common stock from an issuer with attractive equity fundamentals, an issuer in which they usually already have equity holdings.

Equity substitute converts. When the stock price is above the fixed conversion price of a traditional convert or, in the case of an accreting convert above the then-effective conversion price, the convert is in-the-money. Such a convert is referred to as being *equity-like* or as an *equity substitute*. Its conversion premium is usually less than 25%, whereas its investment premium higher than 40%. Such a convert will respond sharply to changes in parity and to a lesser extent to changes in the interest rates or interest spreads, and its delta is usually above 80% to 85%. While share price is the prime determinant of the value of a convert in this phase, it cannot be emphasized enough that other factors, such as remaining call protection and stock price volatility, also materially affect its value. The shorter (longer) the remaining call protection, the lower (higher) the conversion premium an investor would be willing to pay.

The more in-the-money the convert, the more its risk/return dynamics mimic those of the underlying shares, and as a result its value increases and declines with parity in proportion to its high delta. Clearly, this movement is due to the investor put option to exchange the convert for its redemption price being now deep-out-of-the-money. Outright convert funds sell the security at this stage in favor of other balanced converts. Equity income funds tend to buy in at this stage, as do convertible hedge funds. The latter group trades actively in this phase as the stock moves up and down—gamma trading—and tend to

35. Higher (lower) the credit rating, higher (lower) the delta of a new-issue convert. High bond floor makes the convert respond more to interest rates and less to equity. Issues with wide credit spreads have, correspondingly, a lower bond floor, and hence it stands to reason that the delta is higher.

leverage the portfolio. With high-delta shorts, little net capital is employed.

Busted converts. If the share price were to decline such that the conversion option were deep-out-of-the-money, and, correspondingly, the put option deep-in-the-money, the conversion premium would increase, whereas the investment premium would decline. The conversion premium in this stage is usually larger than 50% and may be as high as 200% or even higher, but the investment premium is less than 15%. Since the conversion option is worth very little, the convertible bond value approaches that of an otherwise equivalent nonconvertible bond. Its price falls to a level determined by the relevant yield measures. For traditional converts, those measures are the current yield and the yield-to-maturity. For the accreting converts, they are the yield-to-put and/or yield-to-maturity. Outright convert funds exit their positions in these converts, to be replaced by fixed income funds seeking equity participation and hedge funds with credit analysis expertise. Credit risk becomes important for lower-grade issues in this stage and interest-rate risk perhaps less so. Credit risk may be offset by buying CDSs if they are available. In the absence of CDS on the particular issuer, proxy credit hedging methods include purchasing CDS of a similar credit in the same industry sector, shorting straight bonds of the issuer, particularly if they are *pari passu* in seniority at a duration-based hedge ratio, or buying equity puts or overhedging by shorting more shares than suggested by the bond's equity delta. Some funds, though, may choose to retain exposure to the credit if their fundamental credit analysis or analytical models conclude that the risk/reward ratio is compelling, The yield giveup in exchange for the deep-out-of-the-money conversion option is relatively minor and sometimes may even be negative owing to market inefficiencies in this region. However, unless the convert is unsubordinated, fixed income funds that traditionally invest in senior or senior-subordinated bonds may be reluctant to buy because they have a lower priority in the event of bankruptcy. Fixed income funds do not generally buy busted convertible preferreds.

Distressed converts. These converts may be considered a subset of the busted converts with the distinction that the stock price has fallen so far as to materially increase the probability of default. The ratings may be lowered either explicitly by the rating agencies or implicitly by the market as reflected in a substantial widening of its credit spread over the Treasury rate or materially increased CDS premiums. Unlike the other stages in which the bond floor holds up reasonably well (see Exhibit 60–3), here the bond floor falls rapidly with the stock price. At this stage, the fixed income funds exit, and *distress funds* or *vulture funds* are the primary investors. These funds specialize in assessing the default probability and recovery-rate estimation in the event of default. Both the conversion premium and the investment premium are declining in this stage. Interestingly, the gamma with respect to the stock price is extremely high because small changes in the low stock price may change the delta very significantly. Distressed funds may be long or short the convertibles based on the relative values of other senior or *pari passu* debt used as hedging instruments as well as depending on the availability and relative attractiveness of establishing deep-out-of-the-money protective put hedges.

Several important conclusions may be drawn from this discussion. First, the stages discussed do not have discrete boundaries. For instance, newly issued converts in Europe may have high conversion premiums but a low investment premium and a delta in the region of 55% to 70%. This is due to the very high implied ratings of the investment-grade converts resulting in a high bond floor. Second, convertible securities are not static, in that their price response changes, and they may become more equity-like or debt-like with the attendant changes in the risk/return profile. Consequently, analytical tools for fundamental equity research, as well as those for valuing fixed income securities and derivatives, would be needed to select and manage a portfolio of convertible securities. Third, while the conversion premium is often used as a readily available measure to determine the current stage of the convertible, i.e., whether it is a busted convert or in-the-money or something else, the more appropriate measure is the investment premium. For example, an in-the-money convert with extended period of remaining call protection on a volatile, low-dividend-paying underlying stock can trade at substantial conversion premium. However, higher (lower) the investment premium, unambiguously more (less) in-the-money is the convert.

TRADITIONAL VALUATION METHOD

The traditional valuation method is based on the premise that buying a convertible is the equivalent of buying common stock at a premium with the premium recouped over time from the difference between the higher income from the convertible coupon and the lower dividend on the underlying stock.[36] *Payback period* or *break-even period* is the chief quantitative measure employed in assessing the relative attractiveness of the convert versus the common stock. The shorter the payback period, the more attractive is the convertible, especially if the payback period is shorter than the call protection period. As we shall see below, the concept

36. Note the difference between this approach and the contingent claims approach, which views the convert as a combination of equity, a put option to exchange into straight debt, and the swap to receive coupons of the convertible for dividends on the underlying shares.

of payback period is flawed, yet this concept continues to be used by some equity-oriented investors as an adjunct to their fundamental analysis of the underlying stock. Unfortunately, this measure is not applicable to some of the newer structures and may even prove misleading. Even within the traditional structures, most convertible new issues in the past decade would fail the payback period test, and yet investors in the new convertibles have done well owing to the embedded optionality. We will use the following example to explain the traditional valuation method.

Example

On March 24, 1998, Clear Channel Communications, Inc. (CCU), issued $575 million of a senior convertible note with 2.625% annual coupon and a five-year maturity. Each par $1,000 bond could be converted into 16.1421 (dividend adjusted for a 2:1 split that occurred in July 1998) shares of CCU common stock. On March 26, 1999, the bond traded at 121 (bond points, in percent of the par amount) and the CCU common stock at $65 1/16. The common pays no dividend.

If an investor purchased one CCU 2.625% 4/1/2003 convertible note instead of buying CCU common shares equal to the conversion ratio of the note, she paid a premium of $159.75 (= $1,000 × 121% – $65.0625 × 16.1421), or 15.975 bond points. However, this premium would be compensated for by the cash-flow differential between the convertible bond and the underlying shares:

$$\begin{aligned}\text{Annual cash-flow differential} &= \text{par amount} \times \text{coupon rate} - \text{parity} \\ &\quad \times \text{dividend yield} \\ &= \$1{,}000 \times 2.625\% - \$1{,}050.25 \times 0\% \\ &= \$26.25\end{aligned}$$

This implies that each year, the bondholder receives $26.25 more income than she would from dividends on the CCU common shares. Thus the payback period is

$$\begin{aligned}\text{Premium paid/annual cash-flow differential} &= \$159.75/26.25 \\ &= 6.09\ \text{years}\end{aligned}$$

Simple derivation leads to the following formula for computing the cash-flow payback[37]:

$$\text{Cash-flow payback period} = \frac{\text{conversion premium}/(1+\text{conversion premium})}{\text{current yield} - [\text{dividend yield}/(1+\text{conversion premium})]} \qquad (60\text{–}3)$$

37. For convertibles with changing coupons or dividends, such as step-up convertibles, this formula does not apply. The payback period can be calculated by directly using the definition.

where current yield refers to the current yield of the convertible. For the CCU convertible note, the conversion premium was 15.211%, and the current yield is 2.625%/121 = 2.169%, and the dividend yield on the common was zero. Using these inputs, Eq. (60–3) results in the same payback period of 6.09 years. All inputs for the computation should be in decimals.

An alternate method of calculating payback period, though less defensible, is used more commonly. It is called the *dollar-for-dollar payback*. Under this method, the implicit question asked is, "If I were to invest the same dollar amount in buying the common shares as I would in buying the convertible, what would be the payback period of the premium?"

In the preceding example, if the same dollar amount were invested in CCU stock, one could buy \$1210/\$65.0625 = 18.60 shares. The annual cash-flow differential would still be the same as before, as would the payback period under this method, on account of the fact that CCU pays no dividends. However, if the stock paid a significant dividend, the latter method would result in a larger payback period.[38] The formula for this latter method can be derived as

$$\text{Dollar-for-dollar payback} = \frac{\text{conversion premium}/(1+\text{conversion premium})}{\text{current yield} - \text{dividend yield}} \qquad (60\text{–}4)$$

The denominator of Eq. (60–4) is called the *yield advantage*. Note that the payback period of over six years is longer than the remaining maturity of the CCU convertible bond, which is about four years. Is this a valuation anomaly, or is the valuation approach lacking?

While the definitions of paybacks can be refined by using dividend growth rates and discounting the cash-flow streams, the basic flaw in the traditional valuation approach lies in its failure to consider the optionality embedded in the convert, that is, in its assuming conversion into common stock with absolute certainty. In the case of the traditional convertible, bondholders have the right, but not the obligation, to convert should the stock price not exceed the conversion price, in which event they would receive par at maturity. And the meaning of payback period becomes even more problematic for accreting securities. For example, investors in zero-coupon convertible bonds do not receive current cash income. Thus the convertible's income advantage would be zero or negative, and its payback period could not be calculated. One may be tempted to substitute the yield-to-maturity or yield-to-the-next-put for the current yield. However, this

38. Consider the Pennzoil-Quaker State Company's 4.95% bonds maturing on 8/15/2008. The bonds are exchangeable into 9.3283 shares of Chevron Corporation (CHV) with the first redemption date on 8/15/2000. On 8/27/99 this bond traded at \$100.125 with CHV common share at \$92.75 and its quarterly dividend at \$0.61. We leave it for the reader to verify that the two payback periods, in this case, are 5.09 and 5.87 years, respectively.

again implicitly assumes a conversion probability of 100% and excludes the possibility of default by the issuer.

CONVERTIBLE VALUATION MODELS

Virtually all valuation models for convertible securities currently in use by market professionals follow the economic framework of contingent claims analysis pioneered by Fischer Black, Myron Scholes, and Robert Merton.[39] The models differ from each other in the number of *stochastic variables* used in their construction.[40] The simpler one-factor model assumes that the stock price or, more correctly, the stock return is the only underlying stochastic variable. All other items that affect the value of a convertible are descriptors and variables. The more complex two-factor models assume both stock returns and interest rates to be stochastic.

Descriptors and Variables That Affect Convertible Valuation

Descriptors are the attributes of a security that are known with certainty, such as its stated maturity, coupon, and call and put schedules. *Variables* are inputs that can be estimated, albeit with estimation error. Examples include future dividends and the costs involved in hedging the security. Descriptors and variables that affect the value of a convertible security include

- *Spot price of the underlying security*. The higher the stock price, the more the conversion option is likely to be in-the-money (or less out-of-the-money), and hence the higher is the value of the convert, as described in Exhibit 60–3.
- *The dividend yield of the underlying common stock*. The higher the dividend yield of the underlying stock, the lower is the value of the convert because it results in a lesser yield advantage, thereby reducing the attractiveness of the convert as an alternative to the common stock. Looked at another way, a higher dividend restrains the stock price appreciation and the convert's potential to go in-the-money. The same logic holds for the dividend growth rate.
- The U.S. tax law change, effective May 2003, which reduced the recipient's tax rate on corporate dividends, has encouraged companies to

39. See Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* (May–June 1973), pp. 637–659; and Robert C. Merton, "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science* (Spring 1973), pp. 141–183.

40. A variable whose value changes over time in a nondeterministic or an uncertain way is said to follow a *stochastic process*.

increase dividend payouts. This has increased the dividend risk of convertibles that heretofore were not protected for increases in ordinary dividends. As a result, existing issues have been marked down to reflect the dividend increase potential of their underlying stocks. This followed several severe declines in convertible inventory valuations resulting from unexpectedly large dividend increases. New convertible issues now specifically include dividend protection language in their offering documents.

- *Coupon or preferred dividend*. The higher the distributions from the convert, the higher is the yield advantage, and hence the higher is the value of the convert.
- *Issuer redemption.* A longer noncall period increases the value of the convert in two ways. First, the investor enjoys the yield advantage for a longer period. Second, absent a voluntary conversion by the investor, the minimum maturity of the conversion option equals the convert's first redemption date; hence the longer the conversion option, the higher is the value of the convert. A hard noncall is worth more to the investor than a soft call of the same maturity.
- *Maturity*. Consider two converts identical in all respects except their maturity dates. The longer-maturity convert will have the lower value. This may seem contradictory because we know that the longer the maturity of a call option, the higher will be its value. But while longer maturity does increase the value of the conversion option, it is swamped by the decrease in the value of the bond floor caused by the discounting the cash-flow stream at a higher rate over a longer period. For deep-in-the-money converts, the direct impact of increasing rates is smaller because conversion value of the convert acts as the lower bound. However, if rate increase affects the stock price adversely, which is plausible, then the second-order impact of rates on deep-in-the-money can also be negative.
- *Investor put.* Redemption at maturity is the equivalent of an investor put at maturity. A convert with a put prior to maturity will be worth more than one without. The earlier the put date, all else being equal, the higher is the convert's value; also, the higher the put price, the higher is the convert's value.
- *Liquidity and hedging cost*. The more illiquid the convert or its underlying common stock, the lower is the value of the convert because even moderate-sized trades are likely to materially change convert prices, causing sellers to realize less than they otherwise would and buyers to pay more. The cost of borrowing the shares to short against the convert is also likely to be higher. The cost to borrow the stock has the same impact as an increase in the dividend of the underlying stock. When the

convert is illiquid and/or the stock borrow cost is high, the convert may trade below parity, leading holders voluntarily to exercise their conversion option, which would normally they would not. Outright investors are also affected by liquidity and hedging costs. Investment banks' trading desks are less likely to provide liquidity and respond to the outright investors' sell order because it would entail holding the position unhedged or underhedged until another buyer is found. Since this less-than-appropriate hedging increases their risk position, bid-offer spreads are likely to be wider and/or the transaction sizes smaller. Most likely, the sell order will be accepted subject to finding the appropriate short position in the stock or executed in stages as new buyers are located. The resulting delay continues the exposure of the seller to market moves even though he has decided to exit the position. Anticipating these conditions, the value of the convert will be lower than it would be. The same logic applies to converts with conversion restrictions, as in the case of some converts issued out of Asia. Restrictions on short sale of common shares also lower the value of the convert. A cash-settled convert generally trades at a discount to physically settled converts, especially when the convert is in-the-money and currently redeemable or is approaching the end of the call protection period. The magnitude of the discount for a cash-settled convert is again a function of the liquidity of the stock. The less liquid the stock, more the stock price is likely to move up as hedgers try to cover their short position during the usual 30-day redemption notice period and hence greater the discount.

- *Country risk*. Most U.S.-based outright convert funds and fundamental equity-oriented funds tend not to invest when the country risk is very high, as may be the case in some emerging markets. International funds, specific regional funds, and hedge funds account for the bulk of the investment pool, the latter because they can hedge away part of the country risk. Since all risk elements cannot be hedged away, converts originating from these countries typically are issued at comparatively lower premiums, and/or their equity volatility is not fully priced. On the other hand, converts from large multinational firms, especially from the G-10 countries, are well received owing to their usually high credit ratings and low country risk.

Stochastic variables increasingly commonly used to model the value of a convert include

- *Stock returns*. This is the most natural explanatory variable and is part of all convertible valuation models. A single-factor model assumes stock returns to be the sole stochastic variable, all others being nonstochastic. Models using the Black/Scholes/Merton approach[41] are responsive to the volatility of stock returns. As input, some models use a flat volatility for all time and stock price levels, whereas the more sophisticated ones use a term structure of volatility and also incorporate option volatility skew.

- *Interest rates*. Valuation models for bond options have interest rates as the main stochastic variable. Since the price dynamics of a convertible are influenced to a considerable degree by the straight bond component and its convexities, it stands to reason that two-factor convertible models include interest rates as the second factor. Its volatility, called the *yield volatility,* is an estimated parameter analogous to stock return volatility in the single-factor model.

  As stated earlier, higher interest rates reduce the value of the bond floor of a convert by discounting the convert's cash flows at the higher rate. The impact of interest rates on the embedded options is more complex. An increase (decrease) in the interest rate increases (decreases) the value of the conversion option and decreases (increases) that of the option to put the convert, if there is an investor put feature. From the issuer's perspective, if the convert is out-of-the-money, higher (lower) interest rates will reduce (increase) the value of the issuer's call option because it would entail financing the redemption value by new debt at a higher (lower) rate. In the case of in-the-money converts, which should in most cases be called as soon as possible, the issuer's incentive for a conversion-forcing call will increase with rising interest rates.

- *Credit spread*. The lower the credit quality of the issuer, as determined by leverage and other measures, the higher is the probability of default, and hence the higher is the credit spread. For example, a Baa3/BBB– rated issuer may have a credit spread of 140 basis points for a five-year maturity subordinated debt. With the five-year Treasury rate at 3.70% as of 1/12/2005, the total straight debt rate is 3.70% + 1.4% = 5.10%. If the rating were a notch lower at Ba1/BB+, the spread would be wider by about 40 basis points.[42] Thus spreads have the same impact on converts as do interest rates. The credit spread is increasingly viewed as a stochastic variable in its own right, and its volatility is tracked very closely.[43]

41. The common assumption is that the process governing stock price returns is a geometric Weiner process. Log of stock returns over time Δt are normally distributed with mean $\mu\Delta t$ and variance $\sigma^2\Delta t$, where μ and σ^2 are the instantaneous mean and variance of the stock price returns, respectively.

42. The spreads are based on market conditions as of 1/12/2005.

43. The widening of credit spreads globally, despite falling Treasury rates, during the Asian and Russian debt crises of the latter half of 1998 have caused portfolio managers to monitor credit spreads more closely.

Development of liquid CDSs on individual corporate issues, standardization of swap languages, liquidly traded CDS indexes, and asset swaps allow investors to hedge credit risk for a majority of investment-grade issues and many non-investment-grade issues as well. Credit-linked products are an exciting growth area for convertible investment and arbitrage trading, as well as in relative-value trading in capital structure and equity volatility.

- *Exchange rates.* Consider the Bell Atlantic Financial 4.25% bond maturing on 9/15/2005 and exchangeable into 87.287 shares of Cable and Wireless Communications PLC (CWZ). Both the coupon and par are US$-denominated. In addition to the equity risk associated with the investor's conversion option into CWZ ordinary shares, a U.S.-based investor is exposed to exchange-rate risk because CWZ shares are denominated in British pounds (GBP). With the number of shares per bond fixed at 87.287 shares, any increase in the value of the GBP against the US$ would benefit the investor, and any decline would reduce the value of her position. Thus the investor has an embedded call on GBP or, equivalently, an embedded put on US$, in the convert.

  Since exchange rates are stochastic, they could be the third factor in the valuation of a convert. Exchange-rate volatility would have to be estimated.
- *Value of the firm.* Finance literature has demonstrated that the value of the firm can be conceived as the underlying asset, with common stock, straight bonds, convertibles, and indeed all corporate securities valued as its derivatives. An equilibrium model that values corporate securities as derivatives of the underlying value of the firm would lead to a consistent valuation paradigm for all corporate securities as opposed to stand-alone models for each security based on, sometimes, inconsistent assumptions. We will use the Brennan and Schwartz model that is based on the value of the firm and interest rates as the two stochastic factors as our point of departure.[44]

Choosing between Multiple-Factor Alternatives

Convertibles are complex securities and do not lead to closed-form solutions. Partial differential equations (p.d.e.), subject to several boundary conditions, need to be solved using computationally intensive numerical methods. The number of computations increases exponentially with each additional stochastic variable included in the valuation model. Consequently, even in nonconvertible bond

44. Michael J. Brennan and Eduardo S. Schwartz, "Analyzing Convertible Bonds," *Journal of Financial and Quantitative Analysis* (November 1980), pp. 907–929.

option modeling, where the interest rates for short maturity and long maturity are two logical stochastic variables, most practitioners employ a single-factor model for the short rate and assume the evolution of the long rate in relation to the short rate. The inclusion or exclusion of a stochastic variable, therefore, involves a trade-off between theoretical elegance and/or incremental gain in accuracy, on the one hand, and computational complexity, on the other. As a rule, when estimation errors are likely to swamp the computational precision achieved through the inclusion of an additional stochastic variable, it is better to spend more effort in improving the input estimates and to opt for a simpler model.

One-factor models, with the stock returns as the stochastic variable, are the most commonly used models. Two-factor models, with interest rates as the second factor, are gaining in popularity. Virtually all models sacrifice the candidates for a third or fourth factor in favor of computational ease. Credit spreads are bundled together with interest rates, and the two together are assumed to follow a stochastic process. The impact of exchange rates on a convertible with two currencies is similarly addressed by creating a price series of, for example, CWZ stock price in GBP multiplied by the exchange rate of dollars per GBP and estimating the volatility of the price series thus generated in US$. As a proxy for the term structure of volatility of stock price returns, volatility is estimated by applying subjective corrections to historical and implied volatilities, and the estimate is assumed to be constant over the life of the security.

Notwithstanding the theoretical elegance of a single valuation model that encompasses all corporate securities, individual valuation models for the various assets are, for several reasons, still used more commonly. Chief among them is that the value of a firm is not a traded asset. Consequently, price observations are rarely, if ever, available, and their distributional properties cannot be established empirically. The complexities of the individual securities and their correlations with each other necessitate assumptions that are not always palatable. Nonetheless, progress has been made in modeling corporate securities as options on the value of the firm, and some of these are available commercially.[45]

Analytical Valuation Model: An Outline

The interest-rate process in the two-factor Brennan/Schwartz model is assumed to follow a stochastic process wherein, over short time interval Δt, the change in the interest rate Δr is approximated by

$$\Delta r = \alpha(\mu_r - r) + r\sigma_r z_r \qquad \alpha > 0 \tag{60–5}$$

45. CreditGrades and Moody's KMV are two such models.

where z_r is normally distributed with mean of zero and a variance of unity. This is a common assumption in most interest-rate models and is called a *mean reverting process*. The change in the interest rate has a nonrandom component represented by the first term of the right-hand side of the equation and a random component represented by the second term. The nonrandom component is a function of the current interest rate r. The difference between μ_r, the mean of the interest-rate process, and r determines the direction of reversion toward the mean, while α is the coefficient or speed of this mean reversion. The random change in the interest rate is a function of the standard deviation of the interest rate process $r\sigma_r$ and is superimposed on the mean reverting change.

The change in the value of the firm ΔV is similarly assumed to be approximated by

$$\Delta V = [V\mu_v - Q(V, t)] + V\sigma_v z_v \qquad (60\text{–}6)$$

where μ_v is the expected total rate of return on the value of the firm, and $Q(V, t)$ represents the cash distributions paid out to the various securities in the firm and is a function of the value of the firm and of time. The random component of the value of the firm has a standard deviation of $\sigma_v V$, and z_v is a unit normal. Brennan/Schwartz, then, by using $dz_r^2 = dt$, $dz_v^2 = dt$, and $dz_r dz_v = \rho dt$, where ρ is the instantaneous correlation between dz_r and dz_v, and applying Ito's lemma and the risk-neutral valuation argument arrive at the p.d.e. (60–7) that the value of a convertible bond needs to satisfy[46]

$$\begin{aligned} &0.5V^2\sigma_v^2 C_{vv} + r\rho V\sigma_v\sigma_r C_{vr} + 0.5r^2\sigma_r^2 C_{rr} + C_r[\alpha(\mu_r - r) - \lambda r\sigma_r] \\ &\quad + C_v[rV - Q(V, t)] - rC + cF + C_t = 0 \end{aligned} \qquad (60\text{–}7)$$

where $C(V, r, t)$ is the value of the convertible bond. Subscripts of C denote its partial derivatives with respect to V, r and t; F is the face value of the convert; c is the coupon rate; and λ is the market price of interest-rate risk. λ is the reward for the incremental risk of a portfolio whose return is perfectly correlated with changes in the interest rate. It is a concept very similar to the Sharpe measure.

The Ingersoll single-factor model is also based on the value of the firm. For a firm with only two types of securities, namely, common stock and convertible bonds, the p.d.e. in the case of a non-dividend-paying stock thus becomes a special case of (60–7) and reduces to[47]

$$0.5V^2\sigma_v^2 C_{vv} + + Cv[rV - Q(V, t)] - rC + cF + C_t = 0 \qquad (60\text{–}8)$$

Most convertible models currently in use substitute the underlying stock for the value of the firm owing to the frequency and accurate recording of trading in

46. See Brennan and Schwartz, "Analyzing Convertible Bonds."
47. Jonathan E. Ingersoll, Jr., "A Contingent-Claims Valuation of Convertible Securities," *Journal of Financial Economics* (1977), pp. 289–322.

common stock. Equation (60–7) then becomes

$$0.5S^2\sigma_s^2 C_{ss} + r\rho S\sigma_s\sigma_r C_{sr} + 0.5r^2\sigma_r^2 C_{rr} + C_r[\alpha(\mu_r - r) - \lambda r\sigma_r] + + C_s(rS - cF) - rC + cF + C_t = 0 \qquad (60\text{–}9)$$

Finally, a single-factor model variation of Eq. (60–9) leads to

$$0.5S^2\sigma_s^2 C_{ss} + C_s(rS - cF) - rC + cF + C_t = 0 \qquad (60\text{–}10)$$

The value of a convertible bond is obtained by solving the p.d.e. selected subject to the boundary constraints applicable for the convertible. These constraints require that the value of the convertible

1. Be the higher of par or the conversion value at maturity
2. Be less than or equal to its redemption price during the redemption period
3. If putable, be higher than or equal to the put price
4. At other times, be at least as large as its conversion value

The two-factor model given by Eq. (60–9) requires the estimation of several more inputs than does the single-factor model given by Eq. (60–10). These additional inputs are the yield volatility σ_r, the speed of mean reversion α, the market price of interest rate risk λ, and the correlation between the interest-rate process and the stock price process ρ. All inputs except for the last are estimated by using Treasury-bill or LIBOR data and employing standard term-structure models. The estimate of ρ is notoriously unstable. In most cases, this parameter is therefore set to zero.

As an aside, note that the p.d.e. for the Black/Scholes and Merton warrant valuation models is a special case of Eq. (60–10). As discussed previously, only when the convertible is nonredeemable and nonconvertible until maturity are its debt and warrant components separable and the debt plus warrant valuation applicable. An American-style conversion adds an interest option in favor of the investor whereby the investor can turn in the convertible bond to satisfy the exercise price, even if the bond component is worth less than the exercise price, which usually equals the bond's par value. This *usable bond* feature of the convert is absent in a bond plus warrant. In the event of exercise prior to maturity of a warrant, the warrant exercise price is payable in cash and equals the par value, never anything less.

Clearly, the theoretical value of a convertible security will be a function of the particular p.d.e. chosen, with Eq. (60–10) being the most prevalent. In this case, the interest rate is assumed to be an input parameter, and several variations are used to compensate for the stochastic interest-rate attributes lost in a single-factor model.

Implementing a Convertible Bond Valuation Model

Since convertible valuation is not amenable to closed-form solutions, numerical methods need to be employed. Implicit finite-difference method and explicit finite-difference method are commonly used. They are Taylor series approximations for partial derivatives in partial differential equations. While the implicit finite-difference has better stability properties than does the explicit finite-difference approach, it is computationally more time-consuming; the explicit finite-difference method is more flexible and more easily understood. A special case of the explicit finite-difference method is the binomial method, by far the most widely used approach for derivative valuations.

Space considerations do not permit us to describe the details of the construction of the binomial tree and the backward induction.[48] We will discuss the interest-rate and volatility parameters in detail because they materially affect the value of the convert.

Interest Rate

While some use a flat-term-structure assumption, others estimate the zero-coupon yield curve from the on-the-run Treasury securities or use the LIBOR curve as a proxy for the riskless rate. A flat credit spread is the most common, although a term structure of credit spreads is also used. The interest-rate input for each node is obtained from the derived zero-coupon yield curve.

Note that all the p.d.e.s above use a single interest rate. This makes the resulting models more analytically tractable and the results conform to the put/call parity theorem. However, there is a problem. Consider a convertible that is separable into a bond and a warrant. Using a single interest rate equal to the riskless rate plus the applicable spread in valuing this convertible implies that both the bond component and the warrant component are discounted at the same rate. Warrants and options, however, when traded separately, do not use the credit spread in their valuations because the risk-neutral valuation approach of derivatives is independent of the default risk of the underlying stock. When the single rate is used, it tends to overvalue the embedded net conversion option. To achieve consistency with the option markets, the riskless rate alone is used for the optionality and the riskless rate plus the spread for the coupons and par. In practice, the short equity position in a hedged portfolio earns the short-term riskless rate and not the riskless rate plus the spread rate used to discount the cash flows of the convertible. Note that the put/call parity attribute is then lost.

A further modification of the two interest rates is to use a hedge ratio weighted mix of the riskless rate and the riskless rate plus the credit spread. If the convert is deep-out-of-the-money, the probability of conversion is very low, and the convert behaves like straight debt; its delta equals zero. Hence all cash flows associated with the convert are discounted at the riskless rate plus the credit spread. At the other extreme, with the convert is deep-in-the-money, the

48. Interested readers are referred to Kevin B. Connolly, *Pricing Convertible Bonds* (New York: Wiley, 1998).

probability of conversion is very high, and the convert behaves like a common stock; its delta equals 1. With a 100% hedge, the probability of loss vanishes, and the portfolio should earn the riskless rate. At intermediate points, the weighted-average rate, weighted by the delta at the node, is employed.

Stock Volatility

In any contingent claim model, an estimate of the future volatility likely to occur during the life of the contingent claim security is the required input. Volatility estimation is even more critical for the very long dated options embedded in converts. The following data are collected to estimate volatility:

1. Historical volatility for periods ranging from 1 month to 12 months and their trend.
2. The implied volatility trends for listed options and LEAPs, the latter being equity (and index) options with maturities longer than nine months. Particular attention is paid to the *implied volatility skew*.
3. The implied volatility of any existing converts from the same issuer.
4. The implied volatility of converts in the sector.
5. Volatility implied in the pricing of CDS of the issuer (or close proxies) matching the first put date or maturity of the convertible as appropriate.

Based on these data and with a downward correction if the common stock and/or convert are not likely to be liquid, a volatility estimate is established. Very high volatility estimates, above 50% to 60%, are usually capped in anticipation of volatility mean reversion.[49]

Applying the Valuation Model

Obviously, valuation models are used most commonly to establish the theoretical worth of a security at any point in time. If the theoretical value is, say, 104.5, and the security is trading at par, it is said to be 4.5% cheap. This cheapness depends, of course, on the inputs and the particular valuation model employed. A valuation model will need to be calibrated periodically against market prices of liquid converts to catalog its biases. After this initial calibration, most practitioners are more

49. A more elaborate method for estimating volatility is the generalized autoregressive conditional heteroskedasticity (GARCH) approach, which gives progressively increasing weight to more recent observations of volatility. The weighting scheme is defined by an estimated decay parameter, analogous to the mean reversion parameter in interest rate models. See T. Bollerslev, "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics* (1986), pp. 307–327.

concerned with the consistency of the model than with its absolute accuracy. The task is made easier by the availability of several off-the-shelf valuation models from vendors that are often used as primary valuation calculators usually with built-in portfolio management, risk analytics, and trade execution systems. Or these also may be used as backup valuation models for consistency checks.

Theoretical rich/cheap analysis is but one of the inputs to determine whether a convertible is a buy or a sell candidate. Other determinants may include a fundamental analysis of inputs about the underlying equity and credit, the relative value of the convert compared with other candidate converts, scenario analysis, and the risk/expected-return profile of the individual security and its contribution to the portfolio as a whole. We discuss some of the analytical items among these next.

Partial derivatives. The partial derivatives commonly used in monitoring equity and bond derivative risk/reward profiles are also applicable here. Briefly, in addition to the hedge ratio or delta, the other partial derivatives, collectively called the *greeks*, are

- Theta measures the time decay of the value of the options embedded in the convertible. Theta decays rapidly for short maturity options, such as during the call notice period or close to maturity.
- Vega measures the change in the value of the convertible for small changes in volatility. For high-volatility underlying shares, such as those in the Internet, technology, and telecommunication sectors currently, vega helps to define the aspect of the valuation risk as firms mature and their volatilities decline. Volatility collapse during market corrections or market illiquidity leads to collapse in the premium and the value of convertibles. This occurs episodically, such as during 1994 and again during the Russian and emerging markets crises of 1998. The continuing decline of volatility into 2005 following the collapse of the Internet bubble is another case in point. Vega estimates for a position or portfolio's potential profit/loss exposure to sudden large moves are common in risk reports.
- Gamma is a measure of convexity or rate of change of delta and is a very closely watched second derivative. A negative gamma position resulting from short option positions such as writing a put or writing a call can quickly cause significant losses in the event of large moves in the underlying. A long convertible position in a deep-in-the-money convertible that is delta-hedged by a short stock position, on the other hand, is a positive equity convexity position owing to its equivalence to a long put position. However, a long convertible bond position, unless credit hedged by long CDS position, is equivalent to a short credit convexity or credit gamma because the holder is exposed to the credit risk of the bond. The concepts of credit duration or credit delta, credit gamma, and credit volatility are now integral parts of the risk metrics that guide convertible trading.

- Rho measures the change in the value of the convert owing to a small change in the interest rate. As the volatility of interest rates or *yield volatility* has increased, traders and investors need to be aware of the interest-rate duration and negative convexity embedded in the convertible, and deliberate decisions need to be made about retaining or hedging away these risks via interest-rate futures or options.
- Cross partials are second-order, though important, risk elements. Two of these are the impact of a change in stock price on the credit spread of the bond and on equity volatility. Estimating these is still an art, although there are commercially available analytical models that address some of these issues.[50]

Implied default probability and implied recovery rates. A holder can hedge the credit risk of a convertible (or straight bond) via an appropriate long CDS position with the bond as the reference security. Asset swaps, on the other hand, are used to hedge both the rate risk and the credit risk of the bond. Implied in the pricing of the CDS and asset swaps are estimates of default probability and asset recovery rates in the event of default. These are also cross-partials estimated by the same contingent claim models for corporate securities mentioned earlier.

Implied volatility and implied credit spread. Valuation models are particularly useful in helping investors and issuers select between the disparate aspects of the different convertible structures by boiling down the alternative securities and their particular attributes to a few metrics that establish their relative value. One such metric is the implied volatility of the convert. From a holder's perspective, the higher (lower) the implied volatility, the richer (cheaper) is the security. Similarly, credit spreads implied by convertibles are compared with those of comparable converts and straight bonds.

While implied volatility and implied credit spread are very useful metrics, a few words of caution are in order. Estimates of implied volatility and implied credit spread are conditioned on the validity of the other inputs and the valuation model itself. Thus they are "joint estimates" of the parameter being inferred, as well as of the rest of the inputs. Furthermore, there is an element of circularity in sequentially estimating the volatility and then the credit spread with the same set of inputs. It is well known that the value of a convertible is most sensitive to volatility when the convert is near-the-money and to credit spread when deep-out-of-the-money; it is less sensitive to either when deep-in-the-money. Misleading implied volatility estimates may result if one is not mindful of or controls for the in-the-moneyness of the option.

50. See footnote 45.

Scenario analysis. Theoretical values and total returns at different levels of stock price, interest-rate levels, holding-period horizons, credit spreads, and volatility are essential tools for portfolio managers attempting to gauge the future potential risk/rewards in a convertible trade.

EXERCISING THE EMBEDDED OPTIONS

In this section we discuss the decisions that investors and issuers face with respect to the options embedded in the convert. Clearly, there are some game-theoretic aspects to the anticipatory or responsive actions taken by these parties.

Investors' Options

Conversion Option

When a convert is redeemed by the issuer, it loses the conversion privilege on the last day of the *redemption notice period,* which is generally 15 to 30 calendar days following the redemption notice, with 30 days the norm. Most often redemption is intended to force the convert into equity. For this to occur, the convert should be in-the-money when the investor turns in the bond. And this raises the question of when during the 30-day period should the investor tender the bond for conversion. Following the redemption notice, if the stock price falls below the effective per share redemption price,[51] the investor can choose to receive the redemption price. Thus the redemption notice triggers a put, with maturity equal to the number of days in the redemption notice period, during which time the investor has the right to tender the convert and receive the redemption price. As is well known, all long positions in American options have nonnegative value. Consequently, under normal circumstances, they should not be exercised prematurely. The investor should wait to exercise either option until the moment before the expiration of the redemption period. By then it will be clear whether the convert is in-the-money and hence worth more than the redemption value, in which case it should be tendered for conversion, or whether should be tendered for the redemption value. Investors who choose to exit during the redemption notice period can find ready buyers among convertible arbitrage funds who usually will pay some value for the remaining optionality, less their transaction cost.

In the vast majority of cases, conversions occur in response to issuer redemptions. We know that the holder of a typical convertible is net long a conversion, that

51. *Effective conversion price* is defined as the redemption price divided by the conversion ratio. For example, if the bond is redeemable at 103.5 and the conversion ratio is 14.865 shares, the effective conversion price is $1035/14.865 shares = $69.627 per share, although the conversion price is $1000/14.865 shares = 67.272 per share.

is, a call option, and that a call option should never be exercised prior to maturity for stocks that do not pay dividends. For a dividend paying stock, a call should be exercised prior to maturity only in the event that the present value of the dividend stream during the life of the call is greater than the present value of interest likely to be earned on the exercise price. This roughly implies that voluntary conversion of a convertible is rational when the dividend yield on the common exceeds the current yield on the convert, and the yield advantage becomes negative.[52] These situations seldom arise. Occasionally, voluntary conversion may occur when the stock borrow cost is very large and thus has the same effect as a negative yield advantage. The voting right of a common share rarely will be the reason to voluntarily terminate the life of the convert and receive the shares.

This brings us to the notion of the *critical stock price*. As the stock price rises, there will come a point at which the yield advantage will turn negative for dividend-paying stocks. The stock price level at which the value of the put option exactly equals the absolute value (of the now negative value) of the swap to receive the coupon in place of dividends is called the *critical stock price*. At this point, conversion premium is zero, and the investor is indifferent between holding the convert and receiving common stock. If the stock price rises above this level, voluntary conversion then will be optimal. A convert model is able to take these considerations into account and alert the investor should the stock price reach the critical level and the issuer has not yet redeemed the convert. The higher the dividend yield, the lower is the critical stock price. For most stocks, this point is approximately at 175% of the conversion price.[53]

Put Option

In the case of a putable convert, an investor would be expected to exercise the put if the estimated value of the convert immediately following the put date is lower than the put price. The valuation model is useful in establishing the optimal put condition. Some issuers want to know the scenarios under which the convert will be put to them, and this can be an important consideration in their choice of financing instrument.

Change of Control Put Option

Most converts include an investor put at par or slightly above par in the event that a specified percent, usually 51%, of the shares of the underlying stock is acquired by another entity. The put price is payable in cash and has the deterrent effect of

52. We say "roughly" because some converts on high-dividend-yielding stocks have been issued with negative yield advantage. Investors correctly view them as equity with very valuable puts and hence as very defensive securities.
53. This explains why following a hard noncall period, a year of provisional call protection at 175% or higher is roughly worth equal to another year of hard call protection.

a "poison pill," particularly if the convert is out-of-the-money. For those trading above the put price, the put exercise results in loss of the conversion premium in excess of the put price, and the convert is terminated. Investors need to monitor the cash-takeover risk of a convertible. Quite often the acquirer's common stock will replace the target firm's common shares according to a specified exchange ratio. This will preserve the conversion option and some, or all, of the conversion premium. The decision rule for investors, as always, is to choose the value-maximizing alternative. Depending on the circumstances, value maximization may or may not entail exercising the change of control put.

Issuer's Options

Redemption Option

The optimal issuer action is to minimize the gain of the convert holder and maximize the benefit to the shareholder. Conceptually, in the absence of the redemption notice period, the optimal redemption moment is exactly when parity equals the redemption price. Since the redemption notice period does exist, the optimal decision and its timing become a function of the issuer's intent and of whether the convert is in-the-money and by how much. If the issuer is indifferent as to whether the issue converts or is redeemed for cash, then the issuer's optimal decision will be to redeem at the earliest opportunity. This situation occurs when the convert constitutes an insignificant component of a large firm's balance sheet or if the convert can be refinanced at a lower cost. In all other cases, though, issuers will be guided by one of the following two objectives:

- *Conversion forcing redemption*. The benefits to the shareholder of forcing conversion include saving the interest expense, lower leverage, and an increase in debt capacity owing to the additional equity in the balance sheet resulting from the conversion. If the after-tax cost of the coupon on the convertible is lower than the dividend yield or, in the case of accreting converts, if the after-tax cash flow is positive to the issuer, the issuer may choose to defer redemption. Given the redemption notice period, the issuer needs to allow for a margin of safety such that the probability of the stock's falling below the effective conversion price is at an acceptable level. The greater the risk aversion of the issuer to the adverse effects of nonconversion, the higher will be the cushion, and this results in what is known as the *call delay*. The negative impact of a failed attempt at forcing conversion may be severe, and in smaller firms it may lead to financial distress. At the very least, the issuer will have to refinance the redemption value with cash or debt and thereby cause the capital structure to be different than intended. Alternately, the issuer may have to pay an unwilling investment bank to write a put guaranteeing conversion. Such puts are difficult to hedge, and banks therefore are reluctant to sell them. Even if they do as a favor to the client, these puts are expensive owing to the large gamma and event risk. The greater the call delay, the higher is the value of the convert.

Empirical studies have documented the existence of call delays, although their average size has declined from higher than 40% in the 1970s to about 15% to 30% today. The call delay is a function of the volatility of the underlying stock, the length of the redemption notice period, and the issuer's risk aversion. Specifically, it is equal to $\sigma\sqrt{t}$, where t is the length in years of the redemption notice period. As a numerical illustration, if t is one month, the short-term volatility estimate is 0.30 per annum, and absent any jumps, the stock is expected to move $0.30 \times \sqrt{(1/12)} = 0.866$, that is, ±8.66% in one month with a probability of 68%. The two standard deviation or, equivalently, a 95% confidence interval implies a call delay of 2 × 8.66 = 17.32% above the effective conversion price.

- *Debt refinancing redemption*. If the issuer does not want conversion to occur, the logic of the call delay also applies here, except that now the stock price has to be below the effective redemption price so as to provide the desired cushion. The issuer's reasons for redeeming the convert for debt may include reduction in equity dilution, refinancing at a lower rate, extending maturity, or general balance sheet strengthening. The cost of debt of matching seniority and maturity is the appropriate benchmark from a cost of capital perspective.
- *Put extension sweeteners*. In situations where it is economically optimal for holders to exercise a put option, but the issuer does not want the put exercised, put extension sweeteners are used. This consists of adding cash payment and/or lowering the conversion price of the convertible, usually in conjunction with the insertion of another near-term put between the next put date or maturity whichever is earlier, at an appropriate put price. The basic objective is to increase the value of the holder's conversion option, thereby inducing her not to put the bond to the issuer at least until the next put date.
- *Issuer buybacks.* Often illiquid or deep-out-of-the-money convertibles or convertibles with heavy carry costs (dividends and cost of stock borrow) are presented to the issuer by hedge funds interested in selling the bonds back to the issuer in exchange for a sweetener to where the bonds may be trading or are marked. By buying these bonds back in one-off transactions and mindful not to trigger a "creeping tender" violation of SEC regulations, the issuer can lower his debt/equity ratio as well as recognize a gain for buying the bond back under par. Typically, the sweetener can range from half a bond point to 3 bond points above the estimated value or mark of the convertible and is paid in either cash or equivalent increased number of shares as agreed on by the two parties.

LOOKING FORWARD

Growth in the convertible asset class has been accompanied by increased levels of analytical and trading sophistication, as well as product diversity and complexity. The dominant role of hedge funds and institutional investors has made the asset class more efficient. With hedge funds being the most active traders in convertible secondary markets, it is easy to view them as the marginal trader that drives pricing. What, then, are the risk/return and funds flow implications on the convertible asset class of hedge funds and of the development of risk mitigating products such as asset swaps and credit default swaps?

- *Hedge funds*. Issuers generally dislike this class of investors because they are seen to exert downward pressure on the stock when they buy the convert and short the stock. As the stock price rises, the hedge ratio tends toward 1.0, and the number of shares to be shorted increases. However, the point overlooked is that hedge funds also support the stock were it to decline. In this event, they would buy back the stock to reduce their hedge ratio and arrive at a lower neutral hedge position. Thus hedge funds contribute toward lowering the volatility of the underlying share. Imagine a situation in which hedging were not permitted. Since most convert portfolio managers are, by charter, prevented from holding common stock following conversion and receipt of the shares, they would have to sell their shares. Severe disruptions most likely would occur in anticipation of conversion. But this does not happen currently. On conversion, the underlying shares tend to decline by about 2% to 3% but recover within two to four weeks. This is largely due to the short position in the shares by the hedge funds against their holdings of deep-in-the-money converts. In effect, hedging is equivalent to preconverting over time so that the single-day rush to the exits that otherwise would have occurred does not occur. Additionally, hedge funds provide liquidity to dedicated convert and equity funds seeking to exit their positions and in turn seek liquidity from outright accounts. Lately, the funds flows into hedge funds have helped issuers transfer the several days' market risk exposure that used to come from a fully marketed transaction to hedge funds and institutional accounts by pricing the deals overnight.
- *Asset swaps*. Buyers of asset swaps are fixed income portfolios and financial institutions that take on the interest-rate and credit risks embedded in the convert. Trading desks enter into callable swaps on the underlying convert with a back-to-back redemption feature. If the issuer redeems the convert, the trading desk may redeem the convert from the asset swap buyer. Until then, the cash flows of the convert are passed through; the trading desk retains the equity optionality. This separation of the fixed income risk from the equity optionality of the convert makes the market more efficient by segmenting the elements of risk and

trading in them by participants specializing in assuming and valuing these risks. It also helps to provide liquidity to the busted converts, subject to credit quality constraints, and to new-issue investment-grade converts, which may be larger as a result.

- *Credit default swaps*. The development of this product and similar or related credit products will bring ever closer corporate debt and equity liabilities trading via the "bridge products" such as convertibles. Already, in several leading investment banks, credit derivative desks are either integrated with or are physically located in proximity to convertible trading desk. Equity derivative desks are also similarly situated. Integrated approaches to valuing corporate liabilities is an exciting development phase and should result in the creation of newer derivative products with the aim of isolating in even finer granularity the embedded risks in the securities and allowing a portfolio manager make deliberate choices of retaining or hedging away some of these risks, resulting in more efficient and liquid markets.

SUMMARY

Convertible securities are fairly complex, with several interwoven embedded options. Traditional methods of evaluation are often flawed, sometimes even misleading. This chapter described the products in the convertible asset class, the evolution of the convert market, and the modern analytical valuation approach. This approach, in conjunction with the fundamental equity analysis of the underlying equity security, plays a crucial role in the issuance, trading, and hedging of equity-linked securities. The valuation models discussed in this chapter have become indispensable in convertible investment and portfolio management.

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APPENDIX

A

A REVIEW OF THE TIME VALUE OF MONEY

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The notion that money has a time value is one of the basic concepts in the analysis of any financial instrument. Money has a time value because of the opportunities for investing money at some interest rate. In this appendix we review the three fundamental concepts involved in understanding the time value of money: future value, present value, and yield. These concepts are applied in Chapter 5, where we discuss bond pricing and yield measures.

FUTURE VALUE

Suppose an investor places $1,000 in a bank account and the bank agrees to pay interest of 7% a year. At the end of one year, the account will contain $1,070, or $1,000, the original principal, plus $70 interest. Suppose that the investor decides to let the $1,070 remain in the bank account for another year and that the bank agrees to continue paying interest of 7% a year. The amount in the bank account at the end of the second year will equal $1,144.90, determined as follows:

Principal at beginning of year 2	$1,070.00
Interest for year 2 ($1,070 × 0.07)	74.90
Total in bank account	$1,144.90

In terms of our original $1,000 investment, the $1,144.90 represents the following:

Original investment at beginning of year 1	$1,000.00
Interest for year 1 ($1,000 × 0.07)	70.00
Interest for year 2 based on original investment	70.00
Interest for year 2 earned on interest for year 1 ($70 × 0.07)	4.90
Total	$1,144.90

The additional interest of \$4.90 in year 2 above the \$70 interest earned on the original principal of \$1,000 is the interest on the interest earned in year 1.

After eight years, \$1,000 will grow to \$1,718.19 if allowed to accumulate tax-free at an annual interest rate of 7%. We refer to the amount at the end of eight years as the *future value.*

Notice that the total interest at the end of eight years is \$718.19. The total interest represents \$560 of interest earned on the original principal (\$70 × 8) plus \$158.19 (\$718.19 – \$560) earned by the reinvestment of the interest.

Computing the Future Value of an Investment

To compute the amount to which \$1,000 will grow by the end of eight years if interest is earned at an annual interest rate of 7%, the following formula is used:

$$\$1{,}000(1.07)^8 = \$1{,}718.19$$

To generalize the formula, suppose that \$1,000 is invested for N periods at an annual interest rate of i (expressed as a decimal). Then the future value N periods from now can be expressed as follows:

$$\$1{,}000(1 + i)^N$$

For example, if \$1,000 is invested for four years at an annual interest rate of 10% ($i = 0.10$), then it will grow to \$1,464.10:

$$\$1{,}000(1.10)^4 = \$1{,}000(1.4641) = \$1{,}464.10$$

The expression $(1 + i)^N$ is the amount to which \$1 will grow at the end of N years if an annual interest rate of i is earned. This expression is called the *future value of \$1*. By multiplying the future value of \$1 by the original principal, we can determine the future value of the original principal.

For example, we just demonstrated that the future value of \$1,000 invested for four years at an annual interest rate of 10% is \$1,464.10. The future value of \$1 is \$1.4641. Therefore, if instead of \$1,000, \$50,000 is invested, the future value is

$$\$50{,}000(1.4641) = \$73{,}205.00$$

We can generalize the formula for the future value as follows:

$$\text{FV} = P(1 + i)^N$$

where

FV = future value (\$)
P = original principal (\$)
i = interest rate (in decimal form)
N = number of years

The following three illustrations show how to apply the future value formula.

Illustration 1. A pension fund manager invests \$10 million in a financial instrument that promises to pay 8.7% per year for five years. The future value of the \$10 million investment is \$15,175,665, as shown below:

$$\begin{aligned} P &= \$10{,}000{,}000 \\ i &= 0.087 \\ N &= 5 \\ \text{FV} &= \$10{,}000{,}000(1.087)^5 \\ &= \$10{,}000{,}000(1.5175665) \\ &= \$15{,}175{,}665 \end{aligned}$$

Illustration 2. Suppose that a life insurance company has guaranteed a payment of \$14 million to a pension fund four years from now. If the life insurance company receives a premium of \$11 million and can invest the entire premium for four years at an annual interest rate of 6.5%, will it have sufficient funds from this investment to meet the \$14 million obligation?

The future value of the \$11 million investment at the end of four years is \$14,151,130, as shown below:

$$\begin{aligned} P &= \$11{,}000{,}000 \\ i &= 0.065 \\ N &= 4 \\ \text{FV} &= \$11{,}000{,}000(1.065)^4 \\ &= \$11{,}000{,}000(1.2864664) \\ &= \$14{,}151{,}130 \end{aligned}$$

Because the future value is expected to be \$14,151,130, the life insurance company will have sufficient funds from this investment to satisfy the \$14 million obligation to the pension fund.

Illustration 3. The portfolio manager of a tax-exempt fund is considering investing \$400,000 in an instrument that pays an annual interest rate of 5.7% for four years. At the end of four years, the portfolio manager plans to reinvest the proceeds for three more years and expects that, for the three-year period, an annual interest rate of 7.2% can be earned. The future value of this investment is \$615,098.

The future value of the $400,000 investment for four years at 5.7% is as follows:

$$\begin{aligned} P &= \$400{,}000 \\ i &= 0.057 \\ N &= 4 \\ \text{FV} &= \$400{,}000(1.057)^4 \\ &= \$400{,}000(1.248245) \\ &= \$499{,}298 \end{aligned}$$

The future value of $499,298 reinvested for three years at 7.2% is computed below:

$$\begin{aligned} i &= 0.072 \\ N &= 3 \\ \text{FV} &= \$499{,}298(1.072)^3 \\ &= \$499{,}298(1.231925) \\ &= \$615{,}098 \end{aligned}$$

Fractional Periods

In our illustrations we have computed the future value for whole years. The future-value formula, however, is the same if an investment is made for part of a year.

For example, suppose that $100,000 is invested for seven years and three months. Because three months is 0.25 of one year, N in the future-value formula is 7.25. Assuming an annual interest rate of 5%, the future value of $100,000 invested for seven years and three months is $142,437, as shown below:

$$\begin{aligned} P &= \$100{,}000 \\ i &= 0.05 \\ N &= 7.25 \\ \text{FV} &= \$100{,}000(1.05)^{7.25} \\ &= \$100{,}000(1.424369) \\ &= \$142{,}437 \end{aligned}$$

Compounding More Than One Time per Year

An investment may pay interest more than one time per year. For example, interest may be paid semiannually, quarterly, monthly, weekly, or daily. Our future-value formula can handle interest payments that are made more than once per year.

This is done by adjusting the annual interest rate and the exponent. The annual interest rate is divided by the number of times that interest is paid per year. The exponent, which represents the number of years, is multiplied by the number of times interest is paid per year.

Mathematically, we can express the future value when interest is paid m times per year as follows:

$$\text{FV} = P(1+i)^n$$

where

i = annual interest rate divided by m
n = number of interest payments ($= N \times m$)

Illustration 4. Suppose that a portfolio manager invests \$1 million in an investment that promises to pay an annual interest rate of 6.4% for six years. Interest on this investment is paid semiannually. The future value is \$1,459,340, as shown below:

$$\begin{aligned}
P &= \$1{,}000{,}000 \\
m &= 2 \\
i &= 0.032\,(= 0.064/2) \\
N &= 6 \\
n &= 12\,(= 6 \times 2) \\
\text{FV} &= \$1{,}000{,}000\,(1.032)^{12} \\
&= \$1{,}000{,}000\,(1.459340) \\
&= \$1{,}459{,}340
\end{aligned}$$

If interest is paid only once per year, the future value would be \$1,450,941 instead of \$1,459,340. The higher future value when interest is paid semiannually reflects the more frequent opportunity for reinvesting the interest paid.

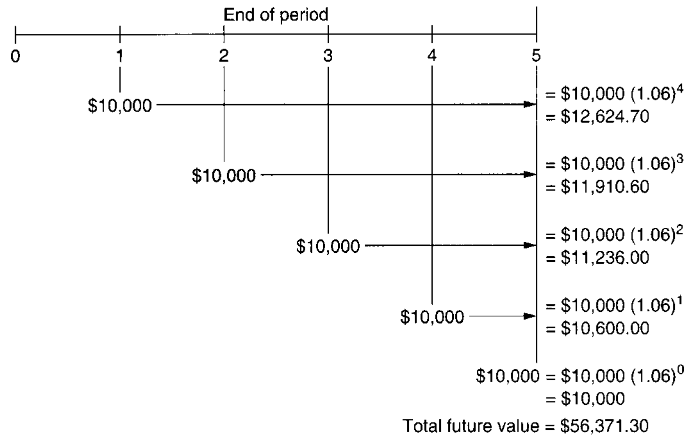
Future Value of an Ordinary Annuity

Suppose that an investor expects to receive \$10,000 a year from some investment for each of the next five years starting one year from now. Each time the investor receives the \$10,000, he plans to invest it. Let's assume that the investor can earn an annual interest rate of 6% each time \$10,000 is invested. How much money will the investor have at the end of five years?

Our future value formula makes it simple to determine to what amount each \$10,000 investment will grow. This calculation is illustrated graphically in Exhibit A–1. The total future value of \$56,371.30 shown in Exhibit A–1 is

EXHIBIT A–1

Future Value of an Ordinary Annuity of $10,000 per Year for Five Years



composed of the five payments of $10,000, or $50,000, plus $6,371.30 of interest earned by investing the $10,000 annual payments.

When the same amount of money is received (or paid) periodically, it is referred to as an *annuity*. When the first receipt occurs one period from now, it is referred to as an *ordinary annuity*.

The following formula can be used to calculate the future value of an ordinary annuity:

$$FV = A\left[\frac{(1+i)^N - 1}{i}\right]$$

where

A = amount of the annuity ($)
i = annual interest rate (in decimals)

The term in the square brackets is the *future value of an ordinary annuity of $1 per year*. Multiplying the future value of an ordinary annuity of $1 by the amount of the annuity produces the future value of an ordinary annuity of any amount.

For example, if $10,000 is invested at 6% each year for the next five years, starting one year from now, we have

$$A = \$10{,}000$$
$$i = 0.06$$
$$N = 5$$

Therefore,

$$\begin{aligned} FV &= \$10{,}000\left[\frac{(1.06)^5 - 1}{0.06}\right] \\ &= \$10{,}000\left(\frac{1.3382256 - 1}{0.06}\right) \\ &= \$10{,}000(5.63710) \\ &= \$56{,}371 \end{aligned}$$

This value agrees with our earlier calculation.

PRESENT VALUE

We illustrated how to compute the future value of an investment. Now we will illustrate how to work the process in reverse; that is, given the future value of an investment, we will illustrate how to determine the amount of money that must be invested today in order to realize the future value. The amount of money that must be invested today is called the *present value.*

Present Value of an Amount to Be Received in the Future

What we are interested in is how to determine the amount of money that must be invested today, earning an interest rate of i for N years, in order to produce a specific future value. This can be done by solving the future value formula given earlier for P, the original principal:

$$P = FV\left[\frac{1}{(1+i)^N}\right]$$

Instead of using P in the preceding formula, we shall denote the present value as PV. Therefore, the present value formula can be rewritten as

$$PV = FV\left[\frac{1}{(1+i)^N}\right]$$

The term in the brackets is equal to the present value of \$1; that is, it indicates how much must be set aside today, earning an interest rate of i, in order to have \$1 N years from now.

The process of computing the present value is also referred to as *discounting.* Therefore, the present value is sometimes referred to as the *discounted value,* and the interest rate is referred to as the *discount rate.*

There are two facts you should note about present value. First, the greater the number of periods over which interest could be earned, the less must be set aside today for a given dollar amount to be received in the future, that is, the lower the present value. Second, the higher the interest rate that can be earned on any amount invested today, the less must be set aside to obtain a specified future value.

The following two illustrations demonstrate how to compute the present value.

Illustration 5. A pension fund manager knows that he must satisfy a liability of \$9 million six years from now. Assuming that an annual interest rate of 7.5% can be earned on any sum invested today, the pension fund manager must invest \$5,831,654 today in order to have \$9 million six years from now, as shown below:

$$\begin{aligned}
\text{FV} &= \$9{,}000{,}000 \\
i &= 0.075 \\
N &= 6 \\
\text{PV} &= \$9{,}000{,}000\left[\frac{1}{(1.075)^6}\right] \\
&= \$9{,}00{,}00\left(\frac{1}{1.543302}\right) \\
&= \$9{,}0{,}00(0.647961) \\
&= \$5{,}831{,}654
\end{aligned}$$

Illustration 6. Suppose a money manager has the opportunity to purchase a financial instrument that promises to pay \$800,000 four years from now. The price of the financial instrument is \$572,000. Should the money manager invest in this financial instrument if she wants a 7.8% annual interest rate?

To answer this, the money manager must determine the present value of the \$800,000 to be received four years from now. The present value is \$592,400, as shown below:

$$\begin{aligned}
\text{FV} &= \$800{,}000 \\
i &= 0.078 \\
N &= 4 \\
\text{PV} &= \$800{,}000\left[\frac{1}{(1.078)^4}\right] \\
&= \$800{,}000\left(\frac{1}{1.350439}\right) \\
&= \$800{,}000(0.740500) \\
&= \$592{,}400
\end{aligned}$$

Because the price of the financial instrument is only $572,000, the money manager will realize more than a 7.8% annual interest rate if the financial instrument is purchased and the issuer pays $800,000 four years from now.

Fractional Periods

If a future value is to be received or paid over a fractional part of a year, the number of years is adjusted accordingly. For example, if $1,000 is to be received nine years and three months from now and the interest rate is 7%, the present value is determined as follows:

$$
\begin{aligned}
F &= \$1{,}000 \\
i &= 0.07 \\
N &= 9.25 \text{ years (3 months is 0.25 years)} \\
\text{PV} &= \$1{,}000\left[\frac{1}{(1.07)^{9.25}}\right] \\
&= \$1{,}000\left(\frac{1}{1.86982}\right) \\
&= \$1{,}000(0.53481) \\
&= \$534.81
\end{aligned}
$$

Present Value of a Series of Future Values

In most applications in investment management and asset/liability management, a financial instrument will offer a series of future values. To determine the present value of a series of future values, the present value of each future value must first be computed. Then the present values are added together to obtain the present value of the series of future values. This procedure is demonstrated in the following illustration.

Illustration 7. An investor is considering the purchase of a financial instrument that promises to make the following payments:

Years from Now	Promised Payment by Issuer
1	$ 100
2	100
3	100
4	100
5	1,100

This financial instrument is selling for $1,243.83. Assume that the investor wants a 6.25% annual interest rate on this investment. Should he purchase this investment?

To answer this question, the investor first must compute the present value of the future amounts that will be received, as follows:

Years from Now	Future Value of Payment	Present Value of $1 at 6.25%	Present Value of Payment
1	$ 100	0.9412	$ 94.12
2	100	0.8858	88.58
3	100	0.8337	83.37
4	100	0.7847	78.47
5	1,100	0.7385	812.35
		Total present value =	$1,156.89

Because the present value of the series of future values promised by the issuer of this financial instrument is less than the price of $1,243.83, the investor would earn an annual interest rate of less than 6.25%. Thus, this financial instrument is unattractive.

Present Value of an Ordinary Annuity

One way to compute the present value of an ordinary annuity is to compute the present value of each future value and then total the present values. There is a formula that can be employed to compute—in one step—the present value of an ordinary annuity:

$$PV = A\left[\frac{1-\frac{1}{(1+i)^N}}{i}\right]$$

where A = amount of the annuity ($). The term in the brackets is the *present value of an ordinary annuity of $1 for N years.*

Illustration 8. An investor has the opportunity to purchase a financial instrument that promises to pay $500 a year for the next 20 years, beginning one year from now. The financial instrument is being offered for a price of $5,300. The investor seeks an annual interest rate of 5.5% on this investment. Should she purchase this financial instrument?

Because the first payment is to be received one year from now, the financial instrument is offering a 20-year annuity of \$500 per year. The present value of this ordinary annuity is calculated as follows:

$$A = \$500$$
$$i = 0.055$$
$$N = 20$$

$$\text{PV} = \$500\left[\frac{1 - \dfrac{1}{(1.055)^{20}}}{0.055}\right]$$

$$= \$500\left(\frac{1 - \dfrac{1}{2.917757}}{0.055}\right)$$

$$= \$500\left(\frac{1 - 0.342729}{0.055}\right)$$

$$= \$500(11.950382)$$

$$= \$5,975.19$$

Because the present value of an ordinary annuity of \$500 per year when discounted at 5.5% exceeds the price of the financial instrument (\$5,300), this financial instrument offers an annual interest rate greater than 5.5%. Therefore, it is an attractive investment for this investor.

YIELD (INTERNAL RATE OF RETURN)

The yield on any investment is computed by determining the interest rate that will make the present value of the cash flow from the investment equal to the price of the investment. Mathematically, the yield on any investment, y, is the interest rate that will make the following relationship hold:

$$p = \frac{C_1}{(1+y)^1} + \frac{C_2}{(1+y)^2} + \frac{C_3}{(1+y)^3} + \cdots + \frac{C_N}{(1+y)^N}$$

where

C_t = cash flow in year t
p = price
N = number of years

The individual terms that are being summed on the right-hand side of the preceding relationship are the present values of the cash flow. The yield calculated from the above relationship is also called the *internal rate of return.*

Solving for the yield *y* requires a trial-and-error procedure. The objective is to find the interest rate that will make the present value of the cash flows equal to the price. The following two illustrations demonstrate how it is carried out.

Illustration 9. A financial instrument offers the following annual payments:

Years from Now	Promised Annual Payments (Cash Flow to Investor)
1	$2,000
2	2,000
3	2,500
4	4,000

Suppose that the price of this financial instrument is $7,704. What is the yield, or internal rate of return, offered by this financial instrument?

To compute the yield, we must try different interest rates until we find one that makes the present value of the cash flows equal to $7,704 (the price of the financial instrument). Trying an annual interest rate of 10% gives the following present value:

Years from Now	Promised Annual Payments (Cash Flow to Investor)	Present Value of Cash Flow at 10%
1	$2,000	$1,818
2	2,000	1,652
3	2,500	1,878
4	4,000	2,732
	Total present value =	$8,080

Because the present value computed using a 10% interest rate exceeds the price of $7,704, a higher interest rate must be tried. If a 14% interest rate is assumed, the present value is $7,348, as shown below:

Years from Now	Promised Annual Payments (Cash Flow to Investor)	Present Value of Cash Flow at 14%
1	$2,000	$1,754
2	2,000	1,538
3	2,500	1,688
4	4,000	2,368
	Total present value =	$7,348

At 14%, the present value of the cash flows is less than the price of the financial instrument. Therefore, a lower interest rate must be tried. A 12% interest rate gives the following results:

Years from Now	Promised Annual Payments (Cash Flow to Investor)	Present Value of Cash Flow at 12%
1	$2,000	$1,786
2	2,000	1,594
3	2,500	1,780
4	4,000	2,544
	Total present value =	$7,704

The present value of the cash flow is equal to the price of the financial instrument when a 12% interest rate is used. Therefore, the yield is 12%.

Although the formula for the yield is based on annual cash flows, the formula can be generalized to any number of periodic payments in a year. The generalized formula for determining the yield is

$$p = \frac{C_1}{(1+y)^1} + \frac{C_2}{(1+y)^2} + \frac{C_3}{(1+y)^3} + \cdots + \frac{C_n}{(1+y)^n}$$

where

C_t = cash flow in period t
n = number of periods

Keep in mind that the yield computed is now the yield for the period. That is, if the cash flows are semiannual, the yield is a semiannual yield. If the cash flows are monthly, the yield is a monthly yield. The annual interest rate is computed by multiplying the yield for the period by the appropriate factor (the frequency of payments per year). We reconsider this procedure for annualizing yields later.

Illustration 10. An investor is considering the purchase of a financial instrument that promises the following *semiannual* cash flows:

10 payments of $50 every six months.

$1,000 10 six-month periods (five years) from now.

Suppose that the price of this financial instrument is $1,243.88. What yield is this financial instrument offering?

The yield can be computed by a trial-and-error procedure, as summarized in the table below:

Annual Interest Rate	Semiannual Interest Rate	Present Value of 10 Six-Month Payments of $50*	Present Value of $1,000 10 Six-Month Periods from Now†	Total Present Value
6.000%	3.000%	$426.51	$744.09	$1,160.60
5.500	2.750	432.00	762.40	1,194.40
5.000	2.500	437.50	781.20	1,218.80
4.500	2.250	443.31	800.51	1,243.83

*$50 × present value of an ordinary annuity of $1 for 10 periods.

†$1,000 × present value of $1 10 periods from now.

As can be seen from the calculation, when a semiannual interest rate of 2.250% is used to find the present value of the cash flows, the present value is equal to the price of $1,243.83. Hence, 2.250% is the six-month yield. Doubling this yield would give an annual interest rate of 4.5%.

Yield Calculation When There Is Only One Cash Flow

There is a special case when it is not necessary to go through the time-consuming trial-and-error procedure to determine the yield. This is the case where only one cash flow is provided by the investment. The formula to determine the yield is

$$y = (\text{future value per dollar invested})^{1/n} - 1$$

where n = number of periods until the cash flow will be received

$$\text{Future value per dollar invested} = \frac{\text{cash flow from investment}}{\text{amount invested (or piece)}}$$

Illustration 11. An investment offers a payment 20 years from now of $84,957. The price of the investment is $20,000. The yield for this investment is 7.50%, as shown below:

$$\text{Future value per dollar invested} = \frac{\$84{,}957}{\$20{,}000} = 4.24785$$

$$\begin{aligned} y &= (4.24785)^{1/20} - 1 \\ &= 1.07499 - 1 \\ &= 0.74999, \text{ or } 7.5\% \end{aligned}$$

Annualizing Yields

We might want to annualize interest rates by simply multiplying by the frequency of payments per year. The resulting rate is called the *annual interest rate.* For example, if we computed a semiannual yield, we can annualize it by multiplying by 2. Alternatively, if we had an annual interest rate and wanted to determine a semiannual interest rate, we can divide by 2.

This procedure for computing the annual interest rate, given a periodic (weekly, monthly, quarterly, semiannual, etc.) interest rate is not correct. To see why, suppose that $100 is invested for one year at an annual interest rate of 8%. At the end of one year, the interest is $8. Suppose, instead, that $100 is invested for one year at an annual interest rate of 8%, but interest is paid semiannually at 4% (one-half the annual interest rate). The future value at the end of one year is $108.16. Interest is therefore $8.16 on a $100 investment. The interest rate, or yield, on the $100 investment is therefore 8.16% ($8.16/$100). The 8.16% is called the *effective annual yield.*

To obtain the effective annual yield associated with a periodic interest rate, the following formula can be used:

$$\text{Effective annual yield} = (1 + \text{periodic interest rate})^m - 1$$

where m = frequency of payments per year

For instance, in the previous example, the periodic yield is 4% and the frequency of payments is twice per year. Therefore,

$$\begin{aligned}\text{Effective annual yield} &= (1.04)^2 - 1 \\ &= 1.0816 - 1 \\ &= 0.0816, \text{ or } 8.16\%\end{aligned}$$

If interest is paid quarterly, then the periodic interest rate is 2% (8%/4), and the effective annual yield is 8.24%, as shown below:

$$\begin{aligned}\text{Effective annual yield} &= (1.02)^4 - 1 \\ &= 1.0824 - 1 \\ &= 0.0824, \text{ or } 8.24\%\end{aligned}$$

We also can determine the periodic interest rate that will produce a given annual interest rate. For example, suppose we wanted to know what quarterly interest rate would produce an effective annual yield of 12%. The following formula can be used:

$$\text{Periodic interest rate} = (1 + \text{effective annual yield})^{1/m} - 1$$

Applying this formula to determine the quarterly interest rate to produce an effective annual yield of 12%, we find that

$$\begin{aligned}\text{Periodic interest rate} &= (1.12)^{1/4} - 1 \\ &= 1.0287 - 1 \\ &= 0.0287, \text{ or } 2.87\%.\end{aligned}$$

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