Chapter 18 Bond Fundamentals*

After you read this chapter, you should be able to answer the following questions:

- What are some of the basic features of bonds that affect their risk, return, and value?
- What is the current country structure of the world bond market and how has the makeup of the global bond market changed in recent years?
- What are the major components of the world bond market and the international bond market?
- What are bond ratings and what is their purpose? What is the difference between investment-grade bonds and high-yield (junk) bonds?
- What are the characteristics of bonds in the major bond categories, such as governments (including TIPS), agencies, municipalities, and corporates?
- How does the makeup of the bond market differ in major countries, such as the United States, Japan, the United Kingdom, and Germany?
- What are the important characteristics of corporate bond issues developed in the United States during the past decade, such as mortgage-backed securities, other asset-backed securities, zero coupon and deep discount bonds, high-yield bonds, and structured notes?
- How do you read the quotes available for the alternative bond categories (e.g., governments, municipalities, corporates)?

The global bond market is large and diverse and represents an important investment opportunity. This chapter is concerned with publicly issued, long-term, nonconvertible debt obligations of public and private issuers in the United States and major global markets. In later chapters, we consider preferred stock and convertible bonds. An understanding of bonds is helpful in an efficient market because U.S. and foreign bonds increase the universe of investments available for the creation of a diversified portfolio.[1]

In this chapter, we review some basic features of bonds and examine the structure of the world bond market. The bulk of the chapter involves an in-depth discussion of the major fixed-income investments. The chapter ends with a brief review of the price information sources for bond investors. Chapter 19 discusses the valuation of bonds and considers several factors that influence bond value and bond price volatility.

*Material on bonds and world bond markets in this chapter is based on information from "Size and Structure of the World Bond Market: 2001," ed. Dave Mozina, International Fixed Income Research, Merrill Lynch & Co., April 2001. Reprinted by permission.

[1]Meir Statman and Neal L. Ushman, "Bonds versus Stocks: Another Look," *Journal of Portfolio Management* 13, no. 3 (Winter 1987): 33–38.

Basic Features of a Bond

Public bonds are long-term, fixed-obligation debt securities packaged in convenient, affordable denominations for sale to individuals and financial institutions. They differ from other debt, such as individual mortgages and privately placed debt obligations, because they are sold to the public rather than channeled directly to a single lender. Bond issues are considered fixed-income securities because they impose fixed financial obligations on the issuers. Specifically, the issuer agrees to

1. Pay a fixed amount of *interest periodically* to the holder of record
2. Repay a fixed amount of *principal* at the date of maturity

Normally, interest on bonds is paid every six months, although some bond issues pay in intervals as short as a month or as long as a year. The principal is due at maturity; this *par value* of the issue is rarely less than $1,000. A bond has a specified term to maturity, which defines the life of the issue. The public debt market typically is divided into three time segments based on an issue's original maturity:

1. Short-term issues with maturities of one year or less. The market for these instruments is commonly known as the **money market**.
2. Intermediate-term issues with maturities in excess of 1 year but less than 10 years. These instruments are known as **notes**.
3. Long-term obligations with maturities in excess of 10 years, called *bonds.*

The lives of debt obligations change constantly as the issues progress toward maturity. Thus, issues that have been outstanding in the secondary market for any period of time eventually move from long-term to intermediate to short-term. This change in maturity is important because a major determinant of the price volatility of bonds is the remaining life (maturity) of the issue.

Bond Characteristics

A bond can be characterized based on (1) its intrinsic features, (2) its type, (3) its indenture provisions, or (4) the features that affect its cash flows and/or its maturity.

Intrinsic Features The coupon, maturity, principal value, and the type of ownership are important intrinsic features of a bond. The **coupon** of a bond indicates the income that the bond investor will receive over the life (or holding period) of the issue. This is known as *interest income, coupon income,* or *nominal yield.*

The **term to maturity** specifies the date or the number of years before a bond matures (or expires). There are two different types of maturity. The most common is a **term bond**, which has a single maturity date. Alternatively, a **serial obligation bond** issue has a series of maturity dates, perhaps 20 or 25. Each maturity, although a subset of the total issue, is really a small bond issue with generally a different coupon. Municipalities issue most serial bonds.

The **principal**, or **par value**, of an issue represents the original value of the obligation. This is generally stated in $1,000 increments from $1,000 to $25,000 or more. Principal value is *not* the same as the bond's market value. The market prices of many issues rise above or fall below their principal values because of differences between their coupons and the prevailing market rate of interest. If the market interest rate is above the coupon rate, the bond will sell at a discount to par. If the market rate is below the bond's coupon, it will sell at a premium above par. If the coupon is comparable to the prevailing market interest rate, the market value of the bond will be close to its original principal value.

Finally, bonds differ in terms of ownership. With a **bearer bond**, the holder, or bearer, is the owner, so the issuer keeps no record of ownership. Interest from a bearer bond is obtained by clipping coupons attached to the bonds and sending them to the issuer for payment. In contrast, the issuers of **registered bonds** maintain records of owners and pay the interest directly to them.

Types of Issues In contrast to common stock, companies can have many different bond issues outstanding at the same time. Bonds can have different types of collateral and be either senior, unsecured, or subordinated (junior) securities. **Secured (senior) bonds** are backed by a legal claim on some specified property of the issuer in the case of default. For example, mortgage bonds are secured by real estate assets; equipment trust certificates, which are used by railroads and airlines, provide a senior claim on the firm's equipment.

Unsecured bonds (debentures) are backed only by the promise of the issuer to pay interest and principal on a timely basis. As such, they are secured by the general credit of the issuer. **Subordinate (junior) debentures** possess a claim on income and assets that is subordinated to other debentures. Income issues are the most junior type because interest on them is paid only if it is earned. Although income bonds are unusual in the corporate sector, they are very popular municipal issues, where they are referred to as **revenue bonds**. Finally, **refunding issues** provide funds to prematurely retire another issue.

The type of issue has only a marginal effect on comparative yield because it is the credibility of the issuer that determines bond quality. A study of corporate bond price behavior found that whether the issuer pledged collateral did not become important until the bond issue approached default.[2] The collateral and security characteristics of a bond influence yield differentials only when these factors affect the bond's quality ratings.

Indenture Provisions The *indenture* is the contract between the issuer and the bondholder specifying the issuer's legal requirements. A trustee (usually a bank) acting on behalf of the bondholders ensures that all the indenture provisions are met, including the timely payment of interest and principal. All the factors that dictate a bond's features, its type, and its maturity are set forth in the indenture.

Features Affecting Bond's Maturity Investors should be aware of the three alternative call option features that can affect the life (maturity) of a bond. One extreme is a *freely callable* provision that allows the issuer to retire the bond at any time with a typical notification period of 30 to 60 days. The other extreme is a *noncallable* provision wherein the issuer cannot retire the bond prior to its maturity.[3] Intermediate between these is a *deferred call* provision, which means the issue cannot be called for a certain period of time after the date of issue (e.g., 5 to 10 years). At the end of the deferred call period, the issue becomes freely callable. Callable bonds have a **call premium**, which is the amount above maturity value that the issuer must pay to the bondholder for prematurely retiring the bond.

A *nonrefunding provision* prohibits a call and premature retirement of an issue from the proceeds of a lower-coupon refunding bond. This is meant to protect the bondholder from a typical refunding, but it is not foolproof. An issue with a nonrefunding provision can be called and retired prior to maturity using other sources of funds, such as excess cash from operations, the sale of assets, or proceeds from a sale of common stock. This occurred on several occasions

[2] W. Braddock Hickman, *Corporate Bond Quality and Investor Experience* (Princeton, N.J.: Princeton University Press, 1958).

[3] The main issuer of noncallable bonds between 1985 and 2002 was the U.S. Treasury. Corporate long-term bonds typically have contained some form of call provision, except during periods of relatively low interest rates (e.g., 1994–2001) when the probability of exercising the option was very low. We discuss this notion in more detail in Chapter 19 in connection with the analysis of embedded options.

during the 1980s and 1990s when many issuers retired nonrefundable high-coupon issues early because they could get the cash from one of these other sources and felt that this was a good financing decision.

Another important indenture provision that can affect a bond's maturity is the **sinking fund**, which specifies that a bond must be paid off systematically over its life rather than only at maturity. There are numerous sinking-fund arrangements, and the bondholder should recognize this as a feature that can change the stated maturity of a bond. The size of the sinking fund can be a percentage of a given issue or a percentage of the total debt outstanding, or it can be a fixed or variable sum stated on a dollar or percentage basis. Similar to a call feature, sinking fund payments may commence at the end of the first year or may be deferred for 5 or 10 years from date of the issue. The amount of the issue that must be repaid before maturity from a sinking fund can range from a nominal sum to 100 percent. Like a call, the sinking-fund feature typically carries a nominal premium but is generally smaller than the straight call premium (e.g., 1 percent). For example, a bond issue with a 20-year maturity might have a sinking fund that requires that 5 percent of the issue be retired every year beginning in year 10. By year 20, half of the issue has been retired and the rest is paid off at maturity. Sinking-fund provisions have a small effect on comparative yields at the time of issue but have little subsequent impact on price behavior.

A sinking-fund provision is an obligation and must be carried out regardless of market conditions. Although a sinking fund allows the issuer to call bonds on a random basis, most bonds are retired for sinking-fund purposes through direct negotiations with institutional holders. Essentially, the trustee negotiates with an institution to buy back the necessary amount of bonds at a price slightly above the current market price.

Rates of Return on Bonds

The rate of return on a bond is computed in the same way as the rate of return on stock or any asset. It is determined by the beginning and ending price and the cash flows during the holding period. The major difference between stocks and bonds is that the interim cash flow on bonds (i.e., the interest) is contractual and accrues over time as discussed subsequently, whereas the dividends on stock may vary. Therefore, the holding period return (HPR) for a bond will be

➤18.1 $$\text{HPR}_{i,t} = \frac{P_{i,t+1} + Int_{i,t}}{P_{i,t}}$$

where:

$\text{HPR}_{i,t}$ = the holding period return for bond *i* during period *t*
$P_{i,t+1}$ = the market price of bond *i* at the end of period *t*
$P_{i,t}$ = the market price of bond *i* at the beginning of period *t*
$Int_{i,t}$ = the interest paid or accrued on bond *i* during period *t*. Because the interest payment is contractual, it accrues over time and if a bond owner sells the bond between interest payments, the sale price includes accrued interest[4]

The holding period yield (HPY) is:

➤18.2 $$\text{HPY} = \text{HPR} - 1$$

Note that the only contractual factor is the amount of interest payments. The beginning and ending bond prices are determined by market forces, as discussed in Chapter 11. Notably, the ending price is determined by market forces unless the bond is held to maturity, in which case the

[4]The concept of accrued interest will be discussed further in Chapter 19 when we consider the valuation of bonds.

investor will receive the par value. These price variations in bonds mean that investors in bonds can experience capital gains or losses. Interest rate volatility has increased substantially since the 1960s, and this has caused large price fluctuations in bonds.[5] As a result, capital gains or losses have become a major component of the rates of return on bonds.

The Global Bond Market Structure[6]

The market for fixed-income securities is substantially larger than the listed equity exchanges (NYSE, TSE, LSE) because corporations tend to issue bonds rather than common stock. Federal Reserve figures indicate that in the United States during 2001, 20 percent of all new security issues were equity, which included preferred as well as common stock. Corporations issue less common or preferred stock because firms derive most of their equity financing from internally generated funds (i.e., retained earnings). Also, although the equity market is strictly corporations, the bond market in most countries has four noncorporate sectors: the pure government sector (e.g., the Treasury in the United States), government agencies (e.g., FNMA), state and local government bonds (municipals), and international bonds (e.g., Yankees and Eurobonds in the United States).

The size of the global bond market and the distribution among countries can be gleaned from Exhibit 18.1, which lists the dollar value of debt outstanding and the percentage distribution for the major bond markets for the years 1998–2000. There has been substantial overall growth, including an 11 percent increase in the total in 2000 compared with 1998. Also, the country trends are significant. Specifically, the U.S. market went from about 48 percent of the total world bond market in 1998 to almost 52 percent in 2000. In contrast, Japan went from almost 20 percent in 1999 to less than 19 percent in 2000. The other significant change is the creation of the Euroland sector, which includes a large part of Europe (i.e., Germany, Italy, France) with the significant exception of the United Kingdom.

Participating Issuers

There are generally five different issuers in a country: (1) the federal government (e.g., the U.S. Treasury), (2) agencies of the federal government, (3) various state and local political subdivisions (known as municipalities), (4) corporations, and (5) international issues. The division of bonds among these five types for the three largest markets and the United Kingdom during 1998–2000 is contained in Exhibit 18.2.

Government The market for government securities is the largest sector in Japan. It involves a variety of debt instruments issued to meet the growing needs of this government. In Germany, the government sector is smaller but is growing in size due to deficits related to reunification of the country.

Government Agencies Agency issues have become a major segment in the U.S. market (over 25 percent) but are a smaller proportion in other countries (e.g., about 18 percent in Japan and nonexistent in the United Kingdom). These agencies represent political subdivisions of the government, although the securities are *not* typically direct obligations of the government. The

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[5]The analysis of bond price volatility is discussed in detail in Chapter 19.

[6]For a further discussion of global bond markets, see Christopher Steward and Adam M. Greshin, "International Bond Markets and Instruments"; Christopher Steward and Adam Greshin, "International Bond Investing and Portfolio Management"; and Michael R. Rosenberg, "International Fixed Income Investing: Theory and Practice," all in *The Handbook of Fixed-Income Securities,* 6th ed., ed. Frank J. Fabozzi (New York: McGraw-Hill, 2000).

EXHIBIT 18.1 *THE SIZE AND STRUCTURE OF THE WORLD BOND MARKET:* 1998–2000 (NOMINAL VALUE OUTSTANDING IN BILLIONS OF U.S. DOLLARS)*

COUNTRY	2000	%	1999	%	1998	%
United States	15,417.5	51.7	14,283.6	50.0	12,803.8	47.7
Japan	5,549.3	18.6	5,668.9	19.8	4,884.4	18.2
Germany					2,704.1	10.1
Euroland	6,223.8	20.9	6,140.8	21.5	—	—
Italy					1,474.4	5.5
United Kingdom	1,065.3	3.6	939.2	3.3	891.1	3.3
France					1,160.4	4.3
Canada	540.6	1.8	548.4	1.9	502.4	1.9
Belgium					375.6	1.4
The Netherlands					420.1	1.6
Spain					301.3	1.1
Switzerland	277.5	0.9	269.3	0.9	284.5	1.1
Denmark	254.8	0.9	263.6	0.9	300.5	1.1
Australia	182.1	0.6	197.8	0.7	163.2	0.6
Sweden	155.3	0.5	188.1	0.7	208.0	0.8
Austria					150.1	0.6
Greece	72.3	0.2	—	—	—	—
Norway	46.9	0.2	51.3	0.2	56.1	0.2
Finland					64.1	0.2
Portugal					57.7	0.2
Ireland					34.0	0.1
New Zealand	18.7	0.1	23.2	0.1	22.4	0.1
Total	**29,804.1**	100.0	**28,574.2**	100.0	**26,858.2**	100.0
Annual Growth %	*4.3*		*6.4*			

*Excludes emerging/converging markets.

For 1999 and 2000, only the total for Euroland is displayed. Prior to 1999, data for the component countries are displayed. Greece was added to this table in 2000, as it is no longer considered a converging market.

Source: "Size and Structure of the World Bond Market: 2001," Merrill Lynch International Fixed Income Research, April 2001.

U.S. agency market has two types of issuers: government-sponsored enterprises and federal agencies. The proceeds of agency bond issues are used to finance many legislative programs. In most countries, the market yields of agency obligations generally exceed those from pure government bonds. Thus, they represent a way for investors to increase returns with only marginally higher risk.

Municipalities Municipal debt includes issues of states, school districts, cities, or other political subdivisions. Unlike government and agency issues, the interest income on municipal bonds in the United States is not subject to federal income tax, although capital gains are taxable. Moreover, these bonds are exempt from state and local taxes when they are issued by the investors' home state.

EXHIBIT 18.2 *MAKEUP OF BONDS OUTSTANDING IN THE UNITED STATES, JAPAN, GERMANY, AND THE UNITED KINGDOM: 1998–2000*

	2000		1999		1998	
	Total Value	Percent of Total	Total Value	Percent of Total	Total Value	Percent of Total
A. United States (Dollars in Billions)						
Government	2,305.0	15.0	2,492.9	17.5	2,649.5	20.7
Federal agency	4,344.0	28.2	3,912.3	27.4	3,320.5	25.9
Municipal	1,376.9	8.9	1,350.4	9.5	1,296.3	10.1
Corporate	4,515.9	29.3	4,129.0	28.9	3,679.0	28.7
International	2,875.7	18.7	2,399.0	16.8	1,858.5	14.5
Total	15,417.5	100.0	14,283.6	100.0	12,803.8	100.0
B. Japan (Yen in Trillions)						
Government—JGBs	329.7	52.0	296.5	50.6	265.5	48.1
Government associated organization	111.1	17.5	108.6	18.5	104.6	19.0
Municipal	16.1	2.5	14.6	2.5	13.2	2.4
Corporate—Nonfinancial	61.6	9.7	59.0	10.1	57.6	10.4
Corporate—financial	49.7	7.8	56.7	9.7	56.9	10.3
International	66.4	10.5	50.8	8.7	53.7	9.7
Total	634.6	100.0	586.2	100.0	551.5	100.0
C. Germany (Billions of Marks; Euros)*						
Government	805.8	35.6	768.8	36.6	1,431.6	31.8
Corporate—ex bank	996.9	44.0	959.4	45.7	1,657.1	36.8
Bank	462.5	20.4	369.8	17.6	605.5	13.4
International	—	—	—	—	808.6	18.0
Total	2,265.2	100.0	2,098.0	100.0	4,502.8	100.0
D. United Kingdom (Billions of British Pounds)						
Government	278.6	39.1	289.4	49.2	281.8	52.3
Corporate	47.2	6.6	30.4	5.2	21.8	4.0
International	386.5	54.3	268.6	45.6	235.7	43.7
Total	712.3	100.0	588.3	100.0	539.3	100.0

*1998 in marks; 1999 and 2000 in euros.

Source: "Size and Structure of the World Bond Market: 2001," Merrill Lynch International Fixed Income Research, April 2001.

As shown in Exhibit 18.2, the municipal bond market has declined in the United States from 10 percent to 9 percent. In Japan, the municipal bond market has declined to less than 3 percent. It is nonexistent in the United Kingdom. Also, although each country has unique tax laws, the income from a non-U.S. municipal bond typically would not be exempt for a U.S. investor.

Corporations The major nongovernmental issuer of debt is the corporate sector. The importance of this sector differs dramatically among countries. It is a stable factor in the United States; a small sector in Japan where it is supplemented by bank debentures; and a small proportion of the U.K. market. Finally, it is a growing part of the German market as more German firms get their financing through the public market rather than from banks.

The market for corporate bonds is commonly subdivided into several segments: industrials, public utilities, transportation, and financial issues. The specific makeup varies between countries. Most U.S. issuers are industrials and utilities.

The corporate sector in the United States provides the most diverse issues in terms of type and quality. In effect, the issuer can range from the highest investment-grade firm, such as American Telephone and Telegraph or IBM, to a relatively new, high-risk firm that issues bonds rated noninvestment grade (i.e., high yield).[7]

International The international sector has two components: (1) foreign bonds, such as Yankee bonds and Samurai bonds; and (2) Eurobonds, including Eurodollar, Euroyen, Eurodeutschemark, and Eurosterling bonds.[8] Although the relative importance of the international bond sector varies by country (from a low of 10 percent in Japan to a high of over 54 percent in the United Kingdom), it has grown in both absolute and relative terms in all these countries. Although Eurodollar bonds have historically made up over 50 percent of the Eurobond market, the proportion has declined as investors have attempted to diversify their Eurobond portfolios. Specifically, Eurodollar bonds constituted about 85 percent of the market in 1984, but only 50 percent in 2001. Clearly, the desire for diversification changes with the swings in the value of the U.S. dollar.

Participating Investors

Numerous individual and institutional investors with diverse investment objectives participate in the bond market. Individual investors are a minor portion because of the market's complexity and the high minimum denominations of most issues. Institutional investors typically account for 90 to 95 percent of the trading, although different segments of the market are more institutionalized than others. For example, institutions are involved heavily in the agency market, but they are less active in the corporate sector.

A variety of institutions invest in the bond market. Life insurance companies invest in corporate bonds and, to a lesser extent, in Treasury and agency securities. Commercial banks invest in municipal bonds and government and agency issues. Property and liability insurance companies concentrate on municipal bonds and Treasuries. Private and government pension funds are heavily committed to corporates and invest in Treasuries and agencies. Finally, fixed-income mutual funds have grown substantially in size and their demand spans the full spectrum of the market as they develop bond funds that meet the needs of a variety of investors. As we will discuss in Chapter 25, municipal bond funds and corporate bond funds (including high-yield bonds) have experienced significant growth.

Alternative institutions tend to favor different sectors of the bond market based on two factors: (1) the tax code applicable to the institution and (2) the nature of the institution's liability structure. For example, because commercial banks are subject to normal taxation and have fairly short-term liability structures, they favor short- to intermediate-term municipals. Pension funds are virtually tax-free institutions with long-term commitments, so they prefer high-yielding, long-term government or corporate bonds. Such institutional investment preferences can affect the short-run supply and demand of loanable funds and impact interest rate changes.

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[7]This sector of the bond market is described in more detail later in this chapter. It is possible to distinguish another sector that exists in the United States but not in other countries—institutional bonds. These are corporate bonds issued by a variety of *private, nonprofit institutions,* such as schools, hospitals, and churches. They are not broken out because they are only a minute part of the U.S. market and do not exist elsewhere.

[8]These bonds will be discussed in more detail later in this chapter.

Bond Ratings

Agency ratings are an integral part of the bond market because most corporate and municipal bonds are rated by one or more of the rating agencies. The exceptions are very small issues and bonds from certain industries, such as bank issues. These are known as *nonrated bonds.* There are three major rating agencies: (1) Fitch Investors Service, (2) Moody's, and (3) Standard and Poor's.

Bond ratings provide the fundamental analysis for thousands of issues. The rating agencies analyze the issuing organization and the specific issue to determine the probability of default and inform the market of their analyses through their ratings.[9]

The primary question in bond credit analysis is whether the firm can service its debt in a timely manner over the life of a given issue. Consequently, the rating agencies consider expectations over the life of the issue, along with the historical and current financial position of the company. We consider default estimation further when we discuss high-yield (junk) bonds.

Several studies have examined the relationship between bond ratings and issue quality as indicated by financial variables. The results clearly demonstrated that bond ratings were positively related to profitability, size, and cash flow coverage, and they were inversely related to financial leverage and earnings instability.[10]

The original ratings assigned to bonds have an impact on their marketability and effective interest rate. Generally, the three agencies' ratings agree. When they do not, the issue is said to have a *split rating.*[11] Seasoned issues are regularly reviewed to ensure that the assigned rating is still valid. If not, revisions are made either upward or downward. Revisions are usually done in increments of one rating grade. The ratings are based on both the company and the issue. After an evaluation of the creditworthiness of the total company is completed, a company rating is assigned to the firm's most senior unsecured issue. All junior bonds receive lower ratings based on indenture specifications. Also, an issue could receive a higher rating than justified because of credit-enhancement devices, such as the attachment of bank letters of credit, surety, or indemnification bonds from insurance companies.

The agencies assign letter ratings depicting what they view as the risk of default of an obligation. The letter ratings range from AAA (Aaa) to D. Exhibit 18.3 describes the various ratings assigned by the major services. Except for slight variations in designations, the meaning and interpretation are basically the same. The agencies modify the ratings with + and – signs for Fitch and S&P or with numbers (1-2-3) for Moody's. As an example, an A+ (A1) bond is at the top of the A-rated group.

The top four ratings—AAA (or Aaa), AA (or Aa), A, and BBB (or Baa)—are generally considered to be *investment-grade securities.* The next level of securities is known as *speculative bonds* and includes the BB- and B-rated obligations. The C categories are generally either income obligations or revenue bonds, many of which are trading flat. (Flat bonds are in arrears

[9]For a detailed listing of rating classes and a listing of factors considered in assigning ratings, see "Bond Ratings" in *The Financial Analysts Handbook,* 2d ed., ed. Sumner N. Levine (Homewood, Ill.: Dow Jones–Irwin, 1988). For a study that examines the value of two bond ratings, see L. Paul Hsueh and David S. Kidwell, "Bond Ratings: Are Two Better Than One?" *Financial Management* 17, no. 1 (Spring 1988): 46–53. An analysis of the bond rating industry is contained in Richard Cantor and Frank Packer. "The Credit Rating Industry," *Journal of Fixed Income* 5, no 3 (December 1995): 10–34.

[10]See, for example, Ahmed Belkaoui, "Industrial Bond Ratings: A New Look," *Financial Management* 9, no. 3 (Fall 1980): 44–52; and James A. Gentry, David T. Whitford, and Paul Newbold, "Predicting Industrial Bond Ratings with a Probit Model and Funds Flow Components," *The Financial Review* 23, no. 3 (August 1988): 269–286.

[11]Split ratings are discussed in R. Billingsley, R. Lamy, M. Marr, and T. Thompson, "Split Ratings and Bond Reoffering Yields," *Financial Management* 14, no. 2 (Summer 1985): 59–65; L. H. Ederington, "Why Split Ratings Occur," *Financial Management* 14, no. 1 (Spring 1985): 37–47; and P. Liu and W. T. Moore, "The Impact of Split Bond Ratings on Risk Premia," *The Financial Review* 22, no. 1 (February 1987).

EXHIBIT 18.3 *DESCRIPTION OF BOND RATINGS*

	FITCH	MOODY'S	STANDARD & POOR'S	DEFINITION
High grade	AAA	Aaa	AAA	The highest rating assigned to a debt instrument, indicating an extremely strong capacity to pay principal and interest. Bonds in this category are often referred to as *gilt edge securities.*
	AA	Aa	AA	High-quality bonds by all standards with strong capacity to pay principal and interest. These bonds are rated lower primarily because the margins of protection are less strong than those for Aaa and AAA bonds.
Medium grade	A	A	A	These bonds possess many favorable investment attributes, but elements may suggest a susceptibility to impairment given adverse economic changes.
	BBB	Baa	BBB	Bonds are regarded as having adequate capacity to pay principal and interest, but certain protective elements may be lacking in the event of adverse economic conditions that could lead to a weakened capacity for payment.
Speculative	BB	Ba	BB	Bonds regarded as having only moderate protection of principal and interest payments during both good and bad times.
	B	B	B	Bonds that generally lack characteristics of other desirable investments. Assurance of interest and principal payments over any long period of time may be small.
Default	CCC	Caa	CCC	Poor-quality issues that may be in default or in danger of default.
	CC	Ca	CC	Highly speculative issues that are often in default or possess other marked shortcomings.
	C			The lowest-rated class of bonds. These issues can be regarded as extremely poor in investment quality.
		C	C	Rating given to income bonds on which no interest is being paid.
	DDD, DD, D		D	Issues in default with principal or interest payments in arrears. Such bonds are extremely speculative and should be valued only on the basis of their value in liquidation or reorganization.

Sources: *Bond Guide* (New York: Standard & Poor's, monthly); *Bond Record* (New York: Moody's Investors Services, Inc., monthly); *Rating Register* (New York: Fitch Investors Service, Inc., monthly).

on their interest payments.) In the case of D-rated obligations, the issues are in outright default, and the ratings indicate the bonds' relative salvage values.[12]

ALTERNATIVE BOND ISSUES

We have described the basic features available for all bonds and the overall structure of the global bond market in terms of the issuers of bonds and investors in bonds. In this section, we provide a detailed discussion of the bonds available from the major issuers of bonds. The presentation is longer than you would expect because when we discuss each issuing unit,

[12]Bonds rated below investment grade are also referred to as "high-yield bonds" or "junk" bonds. These high-yield bonds are discussed in the subsequent section on corporate bonds.

such as governments, municipalities, or corporations, we briefly consider the bonds available in several of the major world financial centers, such as Japan, Germany, and the United Kingdom.

Domestic Government Bonds

United States As shown in Exhibit 18.2, a significant percent of the U.S. fixed-income market is U.S. Treasury obligations. The U.S. government, backed by the full faith and credit of the U.S. Treasury, issues Treasury bills (T-bills), which mature in less than one year, and two forms of long-term obligations: government notes, which have maturities of 10 years or less, and Treasury bonds, with maturities of 10 to 30 years. Current Treasury obligations come in denominations of \$1,000 and \$10,000. The interest income from the U.S. government securities is subject to federal income tax but exempt from state and local levies. These bonds are popular because of their high credit quality, substantial liquidity, and noncallable feature.

Short-term T-bills differ from notes and bonds because they are sold at a discount from par to provide the desired yield. The return is the difference between the purchase price and the par at maturity. In contrast, government notes and bonds carry semiannual coupons that specify the nominal yield of the obligations.

Government notes and bonds have unusual call features. First, the period specified for the deferred call feature on Treasury issues is very long and is generally measured relative to the maturity date rather than from date of issue. They generally cannot be called until five years prior to their maturity date. Notably, *all* U.S. Treasury issues since 1989 have been noncallable.

Treasury Inflation Protected Securities (TIPS)[13] The Treasury began issuing these inflation-indexed bonds in January 1997 to appeal to investors who wanted or needed a *real* default-free rate of return. To ensure the investors will receive the promised yield in real terms, the bond principal and interest payments are indexed to the *Consumer Price Index for All Urban Consumers (CPI-U)* published by the Bureau of Labor Statistics. Because inflation is generally not known until several months after the fact, the index value used has a three-month lag built in—for example, for a bond issued on June 30, 2003, the beginning base index value used would be the CPI value as of March 30, 2003. Following the issuance of a TIPS bond, its principal value is adjusted every six months to reflect the inflation since the base period. In turn, the interest payment is computed based on this adjusted principal—that is, the interest payments equal the original coupon times the adjusted principal. The example in Exhibit 18.4 demonstrates how the principal and interest payments are computed. As shown in this example, both the interest payments and the principal payments are adjusted over time to reflect the prevailing inflation, thereby ensuring that the investor receives a *real* rate of return on these bonds of 3.50 percent.

Notably, these bonds can also be used to derive the prevailing market estimate of the expected rate of inflation during the remaining maturity of the TIPS bond. For example, if we assume that when the bond is issued on July 15, 2003, it sells at par for a YTM of 3.50 percent, while a nominal Treasury note of equal maturity is sold at a YTM of 5.75 percent. This differential implies that investors expect an average annual rate of inflation of 2.25 percent during this five-year period. If, a year later, the spread increased to 2.45 percent, it would indicate that investors expect a further increase in the inflation rate during the next four years.

[13]This section draws heavily from the following excellent article: Pu Shen, "Features and Risks of Treasury Inflation Protection Securities," Federal Reserve Bank of Kansas City *Economic Review* (First Quarter 1998): 23–38. Other brief articles on the topic are: William R. Emmons, "Indexed Bonds and Falling Inflation Expectations," *Monetary Trends* (Federal Reserve Bank of St. Louis, September 1997); and Frank A. Schmid, "Extracting Inflation Expectations from Bond Yields," *Monetary Trends* (Federal Reserve Bank of St. Louis, April 1999).

EXHIBIT 18.4 *PRINCIPAL AND INTEREST PAYMENT FOR A TREASURY INFLATION PROTECTED SECURITY (TIPS)*

Par Value—$1,000
Issued on July 15, 2003
Maturity on July 15, 2008
Coupon—3.50%
Original CPI Value—185.00

DATE	INDEX VALUE[a]	RATE OF INFLATION	ACCRUED PRINCIPAL	INTEREST PAYMENT[b]
7/15/03	185.00	—	$1,000.00	—
1/15/04	187.78	0.015	1,015.00	$17.76
7/15/04	190.59	0.015	1,030.22	18.03
1/15/05	193.83	0.017	1,047.74	18.34
7/15/05	197.51	0.019	1,067.65	18.68
1/15/06	201.46	0.020	1,089.00	19.06
7/15/06	205.49	0.020	1,110.78	19.44
1/15/07	209.19	0.018	1,130.77	19.79
7/15/07	212.96	0.018	1,151.13	20.14
1/15/08	217.22	0.020	1,174.15	20.55
7/15/08	222.65	0.025	1,203.50	21.06

[a]The CPI index value is for the period three months prior to the date.
[b]Semiannual interest payment equals 0.0175 (accrued principal).

Japan[14] The second-largest government bond market in the world is Japan's. It is controlled by the Japanese government and the Bank of Japan (Japanese Central Bank). Japanese government bonds (JGBs) are an attractive investment vehicle for those favoring the Japanese yen because their quality is equal to that of U.S. Treasury securities (they are guaranteed by the government of Japan) and they are very liquid. There are three maturity segments: medium-term (2, 3, or 4 years), long-term (10 years), and super-long (private placements for 15 and 20 years). Bonds are issued in both registered and bearer form, although registered bonds can be converted to bearer bonds through the registrar at the Bank of Japan.

Medium-term bonds are issued monthly through a competitive auction system similar to that of U.S. Treasury bonds. Long-term bonds are authorized by the Ministry of Finance and issued monthly by the Bank of Japan through an underwriting syndicate consisting of major financial institutions. Most super-long bonds are sold through private placement to a few financial institutions. Very liquid federal government bonds account for over 50 percent of the Japanese bonds outstanding and over 80 percent of total bond trading volume in Japan.

At least 50 percent of the trading in Japanese government bonds will be in the so-called *benchmark issue* of the time. The benchmark issue is selected from 10-year coupon bonds. (As of early 2002, the benchmark issue was a 1.50 percent coupon bond maturing in 2011.) The designation of a benchmark issue is intended to assist smaller financial institutions in their trading

[14]For additional discussion, see Aron Viner, *Inside Japanese Financial Markets* (Homewood, Ill.: Dow Jones-Irwin, 1988); Edwin J. Elton and Martin J. Gruber, eds., *Japanese Capital Markets* (New York: Harper & Row, 1990); and Frank J. Fabozzi, ed., *The Japanese Bond Markets* (Chicago: Probus Publishing, 1990).

of government bonds by ensuring these institutions that they would have a liquid market in this particular security. Compared to the benchmark issue, the comparable most active U.S. bond within a class accounts for only about 10 percent of the volume.

The yield on this benchmark bond is typically about 30 basis points below other comparable Japanese government bonds, reflecting its superior marketability. The benchmark issue changes when a designated issue matures or because of a decision by the Bank of Japan.

Germany[15] The third-largest bond market in the world is the German market, although the government segment of this market is relatively small. Exhibit 18.2 showed that approximately 40 percent of domestic deutschemark bonds are issued by the nonbank corporations, whereas the federal government issues about 36 percent through the German Central Bank.

Bonds issued by the Federal Republic of Germany, referred to as *bund* bonds, are issued in amounts up to DM 4 billion (4 billion deutschemarks) with a minimum denomination of DM 100. Original maturities are normally 10 or 12 years, although 30-year bonds have been issued.

Although bonds are issued as bearer bonds, individual bonds do not exist. A global bond is issued and held in safekeeping within the Germany Securities Clearing System (the *Kassenverein*). Contract notes confirming the terms and ownership of each issue are then distributed to individual investors. Sales are based on these contract notes. These government bunds are very liquid because the Bundesbank makes a market at all times. They also are the highest credit quality because they are guaranteed by the German government. Although listed on the exchanges, government bonds are primarily traded over the counter and interest is paid annually.

United Kingdom[16] The U.K. government bond market is made up of jobbers and brokers who act as principals or agents with negotiated commission structures. In addition, there are 27 primary dealers similar to the U.S. Treasury market.

Maturities in this market range from short gilts (maturities of less than 5 years) to medium gilts (5 to 15 years) to long gilts (15 years and longer). Government bonds either have a fixed redemption date or a range of dates with redemption at the option of the government after giving appropriate notice. Alternatively, some bonds are redeemable on a given date or at any time afterward at the option of the government. Government bonds are normally registered, although bearer delivery is available.

Gilts are issued through the Bank of England (the British central bank) using the tender method, whereby prospective purchasers tender offering prices at which they hope to be allotted bonds. The price cannot be less than the minimum tender price stated in the prospectus. If the issue is oversubscribed, allotments are made first to those submitting the highest tenders and continue until a price is reached where only a partial allotment is required to fully subscribe the issue. All successful allottees pay the lowest allotment prices.

These issues are extremely liquid and are highly rated because they are guaranteed by the British government. All gilts are quoted and traded on the London Stock Exchange and pay interest semiannually.

Government Agency Issues

In addition to pure government bonds, the federal government in each country can establish agencies that have the authority to issue their own bonds. The size and importance of these agencies differ among countries. They are a large and growing sector of the U.S. bond market, a much smaller component of the bond markets in Japan and Germany, and nonexistent in the United Kingdom.

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[15]For additional information on the German bond market, see *The European Bond Markets,* ed. The European Bond Commission (Chicago: Probus Publishing, 1989).

[16]For further discussion, see *The European Bond Markets.*

EXHIBIT 18.5 *AGENCY ISSUES: SELECTED CHARACTERISTICS*

Type of Security	Minimum Denomination	Form	Life of Issue	Tax Status		How Interest Is Earned
Government Sponsored						
Banks for cooperatives (co-ops)	$ 5,000	B,BE	No longer issued	Federal: State: Local:	Taxable Exempt Exempt	Semiannual interest, 360-day year
Federal farm credit banks	50,000	BE	5 to 365 days	Federal:	Taxable	Discount actual, 360-day year
Consolidated systemwide notes				State: Local:	Exempt Exempt	
Consolidated systemwide bonds	5,000	BE	6 and 9 months	Federal: State: Local:	Taxable Exempt Exempt	Interest payable at maturity, 360-day year
	1,000	BE	13 months to 15 years	Federal: State: Local:	Taxable Exempt Exempt	Semiannual interest
Federal Home Loan Bank						
Consolidated discount notes	100,000	BE	30 to 360 days	Federal: State: Local:	Taxable Exempt Exempt	Discount actual, 360-day year
Consolidated bonds	10,000[a]	B, BE	1 to 20 years	Federal: State: Local:	Taxable Exempt Exempt	Semiannual interest, 360-day year
Federal Home Loan Mortgage						
Corporation debentures	10,000[a]	BE	18 to 30 years	Federal: State: Local:	Taxable Taxable Taxable	Semiannual interest, 360-day year
Participation certificates	100,000	R	30 years (12-year average life)	Federal: State: Local:	Taxable Taxable Taxable	Monthly interest and principal payments
Federal interstate credit banks	5,000	B, BE	No longer issued	Federal: State: Local:	Taxable Exempt Exempt	Semiannual interest, 360-day year
Federal National Mortgage Association discount notes	50,000[a]	B	30 to 360 days	Federal: State: Local:	Taxable Taxable Taxable	Discount actual, 360-day year
Debentures	10,000[a]	B, BE	1 to 30 years	Federal: State: Local:	Taxable Taxable Taxable	Semiannual interest, 360-day year

(continued)

United States Agency securities are obligations issued by the U.S. government through either a government agency or a government-sponsored corporation. Six government-sponsored enterprises and over two dozen federal agencies issue these bonds. Exhibit 18.5 lists selected characteristics of the more popular government-sponsored and federal agency obligations.[17]

[17]We will no longer distinguish between federal agency and government-sponsored obligations; instead, the term *agency* shall apply to either type of issue.

EXHIBIT 18.5 *(continued)*

Type of Security	Minimum Denomination	Form	Life of Issue	Tax Status	How Interest Is Earned
Government National Mortgage Association					
Mortgage-backed bonds	25,000	B, R	1 to 25 years	Federal: Taxable State: Taxable Local: Taxable	Semiannual interest, 360-day year
Modified pass-throughs	25,000[a]	R	12 to 40 years (12-year average)	Federal: Taxable State: Taxable Local: Taxable	Monthly interest and principal payments
Student Loan Marketing Association discount notes	100,000	B	Out to 1 year	Federal: Taxable State: Exempt Local: Exempt	Discount actual, 360-day year
Notes	10,000	R	3 to 10 years	Federal: Taxable State: Exempt Local: Exempt	Semiannual interest, 360-day year
Floating rate notes	10,000[a]	R	6 months to 10 years	Federal: Taxable State: Exempt Local: Exempt	Interest rate adjusted weekly to an increment over the average auction rate of 91-day Treasury bills and payable quarterly
Tennessee Valley Authority (TVA)	1,000	R, B	5 to 25 years	Federal: Taxable State: Exempt Local: Exempt	Semiannual interest, 360-day year
U.S. Postal Service	10,000	R, B	25 years	Federal: Taxable State: Exempt Local: Exempt	Semiannual interest, 360-day year

Notes: Form B = Bearer; R = Registered; BE = Book entry form. Debt issues sold subsequent to December 31, 1982, must be in registered form.

[a]Minimum purchase with increments in $5,000.

Source: *United States Government Securities* (New York: Merrill Lynch Government Securities, Inc., 1996).

Agency issues usually pay interest semiannually, and the minimum denominations vary between $1,000 and $10,000. These obligations are not direct Treasury issues, yet they carry the full faith and credit of the U.S. government. Moreover, some of the issues are subject to state and local income tax, whereas others are exempt.[18]

One agency issue offers particularly attractive investment opportunities: GNMA *(Ginnie Mae)* pass-through certificates, which are obligations of the Government National Mortgage Association.[19] These bonds represent an undivided interest in a pool of federally insured mortgages. The bondholders receive monthly payments from Ginnie Mae that include both principal and interest because the agency "passes through" mortgage payments made by the original borrower (the mortgagee) to Ginnie Mae.

[18]Federal National Mortgage Association (Fannie Mae) debentures, for example, are subject to state and local income tax, whereas the interest income from Federal Home Loan Bank bonds is exempt. In fact, a few issues are exempt from federal income tax as well (e.g., public housing bonds).

[19]For a further discussion of mortgage-backed securities, see Frank J. Fabozzi and Chuck Ramsey, "Mortgages and Overview of Mortgage-Backed Securities"; Lakhbir S. Hayre, Cyrus Mohebbi, and Thomas A. Zimmerman, "Mortgage Pass-Through"; and Lehman Bros., Inc, "Collateralized Mortgage Obligations," all in *The Handbook of Fixed-Income Securities,* 6th ed., ed. Frank J. Fabozzi (New York: McGraw-Hill, 2001).

The coupons on these pass-through securities are related to the interest charged on the pool of mortgages. The portion of the cash flow that represents the repayment of the principal is tax-free, but the interest income is subject to federal, state, and local taxes. The issues have minimum denominations of $25,000 with maturities of 25 to 30 years but an average life of only 12 years because, as mortgages in the pool are paid off, payments and prepayments are passed through to the investor. Therefore, unlike most bond issues, the monthly payment is not fixed because of the prepayment schedule that can vary dramatically over time when interest rates change.

As we will note in Chapter 19 in connection with the valuation of bonds with embedded options, mortgages generally have a call option whereby the homeowner has the option to prepay the mortgage. There are prepayments on these securities for two reasons: (1) because homeowners pay off their mortgages when they sell their homes and (2) because owners refinance their homes when mortgage interest rates decline as they did in 1997 and 2001. Therefore, a major disadvantage of GNMA issues is that their *maturities are very uncertain.*

Japan The agencies in Japan, referred to as *government associate organizations,* account for about 17 percent of the total Japanese bond market. This agency market includes public debt, but almost twice as much is privately placed with major financial institutions. Public agency debt is issued like government debt.

Germany The agency market in Germany finances about 5 percent of the public debt. The major agencies are the Federal Railway and the Federal Post Office. These Bahns are issued up to DM 2 billion. The issue procedure is similar to that used for regular government bonds and are relatively liquid, although less liquid than government bunds. These agency issues are implicitly guaranteed by the government.

United Kingdom As shown in Exhibit 18.2, there are no agency bonds in the United Kingdom.

Municipal Bonds

Municipal bonds are issued by states, counties, cities, and other political subdivisions. Again, the size of the municipal bond market (referred to as *local authority* in the United Kingdom) varies substantially among countries. It is about 10 percent of the total U.S. market, compared to about 3 percent in Japan, 15 percent in Germany, and nonexistent in the United Kingdom. Because of the size and popularity of this market in the United States, we will discuss only the U.S. municipal bond market.

Municipalities in the United States issue two distinct types of bonds: general obligation bonds and revenue issues. **General obligation bonds (GOs)** are essentially backed by the full faith and credit of the issuer and its entire taxing power. **Revenue bonds,** in turn, are serviced by the income generated from specific revenue-producing projects of the municipality, such as bridges, toll roads, hospitals, municipal coliseums, and waterworks. Revenue bonds generally provide higher returns than GOs because of their higher default risk. Should a municipality fail to generate sufficient income from a project designated to service a revenue bond, it has no legal debt service obligation until the income becomes sufficient.

GO municipal bonds tend to be issued on a serial basis so that the issuer's cash flow requirements will be steady over the life of the obligation. Therefore, the principal portion of the total debt service requirement generally begins at a fairly low level and builds up over the life of the obligation. In contrast, most municipal revenue bonds are term issues, so the principal value is not due until the final maturity date.[20]

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[20]For a more detailed discussion of the municipal bond market, see Sylvan G. Feldstein, Frank J. Fabozzi, and Patrick M. Kennedy, "Municipal Bonds." For discussion of the credit analysis of these bonds, see Sylvan G. Feldstein, "Guidelines in the Credit Analysis of General Obligation and Revenue Municipal Bonds." Both chapters are in *The Handbook of Fixed-Income Securities.* 6th ed.

The most important feature of municipal obligations is that the interest payments are exempt from federal income tax and from taxes in the locality and state in which the obligation was issued. This means that their attractiveness varies with the investor's tax bracket.

You can convert the tax-free yield of a municipal to an equivalent taxable yield (ETY) using the following equation:

18.3
$$\text{ETY} = \frac{i}{(1-t)}$$

where:

ETY = equivalent taxable yield
***i* = coupon rate of the municipal obligations**
***t* = marginal tax rate of the investor**

An investor in the 35 percent marginal tax bracket would find that a 5 percent yield on a municipal bond selling close to its par value is equivalent to a 7.69 percent fully taxable yield according to the following calculation:

$$\text{ETY} = \frac{0.05}{(1-0.35)} = 0.0769$$

Because the tax-free yield is the major benefit of municipal bonds, an investor's marginal tax rate is a primary concern in evaluating them. As a rough rule of thumb, using the tax rates expected in 2002, an investor must be in the 28 to 30 percent tax bracket before the lower yields available in municipal bonds are competitive with those from fully taxable bonds. However, although the interest payment on municipals is tax-free, any capital gains are not (which is why the ETY formula is correct only for a bond selling close to its par value).

Municipal Bond Insurance A significant feature of the U.S. municipal bond market is *municipal bond insurance,* which provides that an insurance company will guarantee to make principal and interest payments in the event that the issuer of the bonds defaults. The insurance is placed on the bond at date of issue and is *irrevocable* over the life of the issue. The issuer purchases the insurance for the benefit of the investor, and the municipality benefits from lower interest costs due to lower default risk, which causes an increase in the rating on the bond and increased marketability. Those who would benefit from the insurance are small government units not widely known and bonds with a complex security structure.

As of 2002, approximately 40 percent of all new municipal bond issues were insured. There are six private bond insurance firms: The Municipal Bond Investors Assurance (MBIA), American Municipal Bond Assurance Corporation (AMBAC), the Financial Security Assurance (FSA), the Financial Guaranty Insurance Company (FGIC), Capital Guaranty Insurance Company (CGIC), and Connie Lee Insurance Company. These firms will insure either general obligation or revenue bonds. To qualify for private bond insurance, the issue must initially carry an S&P rating of BBB or better. Currently, the rating agencies will give an AAA (Aaa) rating to bonds insured by these firms because all the insurance firms have AAA ratings. Issues with these private guarantees have enjoyed a more active secondary market and lower required yields.[21]

[21]For a discussion of municipal bond insurance, see Sylvan Feldstein, Frank J. Fabozzi, and Patrick M. Kennedy, "Municipal Bonds," in *The Handbook of Fixed-Income Securities;* 6th ed. and D. S. Kidwell, E. H. Sorenson, and J. M. Wachowicz, "Estimating the Signaling Benefits of Debt Insurance: The Case of Municipal Bonds," *Journal of Financial and Quantitative Analysis* 22, no. 3 (September 1987): 299–313.

Corporate Bonds

Again, the importance of corporate bonds varies across countries. The absolute dollar value of corporate bonds in the United States is substantial and has grown overall and as a percentage of U.S. long-term capital. At the same time, corporate debt as a percentage of total U.S. debt has stabilized at about 30 percent because of the faster growth of agency debt. The pure corporate sector in Japan is small and declining and the pure corporate sector in Germany has grown to be about 44 percent. The proportion of corporate debt in the United Kingdom is in the 5 to 6 percent range.

U.S. Corporate Bond Market Utilities dominate the U.S. corporate bond market. Other important segments include industrials, rail and transportation issues, and financial issues. This market is very diverse and includes debentures, first-mortgage issues, convertible obligations, bonds with warrants, subordinated debentures, income bonds (similar to municipal revenue bonds), collateral trust bonds backed by financial assets, equipment trust certificates, and asset-backed securities (ABS) including mortgage-backed bonds.

If we ignore convertible bonds and bonds with warrants, the preceding list of obligations varies by the type of collateral behind the bond. Most bonds have semiannual interest payments, sinking funds, and a single maturity date. Maturities range from 25 to 40 years, with public utilities generally on the longer end and industrials preferring the 25- to 30-year range. Most corporate bonds provide for deferred calls after 5 to 10 years. The deferment period varies directly with the level of the interest rates. Specifically, during periods of higher interest rates, bond issues typically will carry a 7- to 10-year deferment, while during periods of lower interest rates, the deferment periods decline.

On the other hand, corporate notes—with maturities of five to seven years—are generally noncallable. Notes become popular when interest rates are high because issuing firms prefer to avoid long-term obligations during such periods. In contrast, during periods of low interest rates, such as 1997 and 2001, most corporate issues did not include a call provision because corporations did not believe that they would be able to exercise the call option and did not want to pay the required higher yield.

Generally, the average yields for industrial bonds will be the lowest of the three major sectors, followed by utility returns. The difference in yield between utilities and industrials occurs because utilities have the largest supply of bonds, so yields on their bonds must be higher to increase the demand for these bonds.[22]

Mortgage Bonds The issuer of a mortgage bond has granted to the bondholder a first-mortgage lien on some piece of property or possibly all the firm's property. Such a lien provides greater security to the bondholder and a lower interest rate for the issuing firm.

Equipment Trust Certificates Equipment trust certificates are issued by railroads (the biggest issuers), airlines, and other transportation firms with the proceeds used to purchase equipment (freight cars, railroad engines, and airplanes), which serves as the collateral for the debt. Maturities range from 1 to about 15 years. The fairly short maturities reflect the nature of the collateral, which is subject to substantial wear and tear and tends to deteriorate rapidly.

Equipment trust certificates are appealing to investors because of their attractive yields, low default record, and fairly liquid secondary market.

Collateral Trust Bonds As an alternative to pledging fixed assets or property, a borrower can pledge financial assets, such as stocks, bonds, or notes, as collateral. These bonds are termed *collateral trust bonds.* These pledged assets are held by a trustee for the benefit of the bondholder.

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[22]For a further discussion, see Frank J. Fabozzi, Richard Wilson, and Richard Todd, "Corporate Bonds," in *The Handbook of Fixed-Income Securities,* 6th ed.

Collateralized Mortgage Obligations (CMOs)[23] Earlier we discussed mortgage bonds backed by pools of mortgages. You will recall that the pass-through monthly payments are necessarily both interest and principal and that the bondholder is subject to early retirement if the mortgagees prepay because the house is sold or the mortgage refinanced. Therefore, when you acquire the typical mortgage pass-through bonds, you would be uncertain about the size and timing of the payments.

Collateralized mortgage obligations (CMOs) were developed in the early 1980s to offset some of the problems with the traditional mortgage pass-throughs. The main innovation of the CMO instrument is the segmentation of irregular mortgage cash flows to create short-term, medium-, and long-term securities. Specifically, CMO investors own bonds that are serviced with the cash flows from mortgages; but, rather than the straight pass-through arrangement, the CMO substitutes a *sequential distribution process* that creates a series of bonds with varying maturities to appeal to a wider range of investors.

The prioritized distribution process is as follows:

- Several classes of bonds (these are referred to as *tranches*) are issued against a pool of mortgages, which are the collateral. For example, assume a CMO issue with four classes (tranches) of bonds. In such a case, the first three (e.g., Classes A, B, C) would pay interest at their stated rates beginning at their issue date and the fourth class would be an accrual bond (referred to as a *Z bond*).[24]
- The cash flows received from the underlying mortgages are applied first to pay the interest on the bonds and then to retire these bonds.
- The classes of bonds are retired sequentially. All principal payments are directed first to the shortest-maturity class A bonds until they are completely retired. Then all principal payments are directed to the next shortest-maturity bonds (i.e., the class B bonds). The process continues until all the classes have been paid off.
- During the early periods, the accrual bonds (the class Z bonds) pay no interest, but the interest accrues as additional principal, and the cash flow from the mortgages that collateralize these bonds is used to pay interest on and retire the bonds in the other classes. Subsequently, all remaining cash flows are used to pay off the accrued interest, pay any current interest, and then to retire the Z bonds.

This prioritized sequential pattern means that the A-class bonds are fairly short term and each subsequent class is a little longer term until the Z-class bond, which is a long-term bond. It also functions like a zero coupon or PIK bond for the initial years.

Besides creating bonds that pay interest in a more normal pattern (quarterly or semiannually) and that have more predictable maturities, these bonds are considered very high quality securities (AAA) because of the structure and quality of the collateral. To obtain an AAA rating, CMOs are structured to ensure that the underlying mortgages will always generate enough cash to support the bonds issued, even under the most conservative prepayment and reinvestment rates. In fact, most CMOs are overcollateralized.

Further, the credit risk of the collateral is minimal because most are backed by mortgages guaranteed by a federal agency (GNMA, FNMA) or by the FHLMC. Those mortgages that are

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[23]For a detailed discussion, see Lehman Bros., "Collateralized Mortgage Obligations," in *The Handbook of Fixed-Income Securities,* 6th ed.

[24]The four-class CMO was the typical configuration during the 1980s and is used here for demonstration purposes. By 2001, CMOs were issued with 18 to 20 classes. More advanced CMOs are referred to as REMICs, which are intended to provide greater certainty regarding the cash flow patterns for various components of the pool or some of those investing in the pool.

not backed by agencies carry private insurance for principal and interest and mortgage insurance. Notably, even with this AAA rating, the yield on these CMOs typically has been higher than the yields on AA industrials. This premium yield has, of course, contributed to their popularity and growth.

Asset-Backed Securities (ABSs) A rapidly expanding segment of the securities market is that of *asset-backed securities (ABSs),* which involve *securitizing debt.* This is an important concept because it substantially increases the liquidity of these individual debt instruments, whether they be individual mortgages, car loans, or credit card debt. This general class of securities was introduced in 1983. Since then, more than $700 billion in asset-backed securities have been issued. Beyond the mortgage securities, this market is dominated by securities backed by automobile loans and credit card receivables.

Certificates for Automobile Receivables (CARs) CARs are securities collateralized by loans made to individuals to finance the purchase of cars. Auto loans are self-amortizing, with monthly payments and relatively short maturities (i.e., two to five years). These auto loans can either be direct loans from a lending institution or indirect loans that are originated by an auto dealer and sold to the ultimate lender. CARs typically have monthly or quarterly fixed interest and principal payments, and expected weighted average lives of one to three years with specified maturities of three to five years. The expected actual life of the instrument typically is shorter than the specified maturity because of early payoffs when cars are sold or traded in. The cash flows of CARs are comparable to short-term corporate debt. They provide a significant yield premium over General Motors Acceptance Corporation (GMAC) commercial paper, which is the most liquid short-term corporate alternative. The popularity of these collateralized securities makes them important not only by themselves but also as an indication of the potential for issuing additional collateralized securities backed by other assets and/or other debt instruments.[25]

Credit Card Receivables Since 1992, the fastest-growing segment of the ABS market has been securities supported by credit card loans. Credit card receivables are considered to be a revolving credit ABS, in contrast to auto loan receivables that are referred to as an installment contract ABS—because of the nature of the loan. Specifically, whereas the mortgaged-backed and auto loan securities amortize principal, the principal payments from credit card receivables are not paid to the investor but are retained by the trustee to reinvest in additional receivables. This allows the issuer to specify a maturity for the security that is consistent with the needs of the issuer and the demands of the investors.

When buying a credit card ABS, the indenture specifies (1) the intended maturity for the security; (2) the "lockout period" during which no principal will be paid; and (3) the structure for repaying the principal, which can be accomplished through a single-bullet payment, such as a bond, or distributed monthly with the interest payment over a specified amortization period. For example, a 5-year credit card ABS could have a lockout period of 4 years followed by a 12-month amortization of the principal.

Beyond this standard arrangement, revolving credit securities are protected by early amortization events that can force early repayment if specific payout events occur that are detrimental to the investor (e.g., if there is an increase in the loss rate or if the issuer goes into bankruptcy or receivership). Although this early amortization feature protects the investor from credit problems, it causes an early payment that may not be desirable for the investor.[26]

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[25]For further discussion, see W. Alexander Roever, John McElravey, and Glenn Schultz, "Securities Backed by Automobile Loans," in *The Handbook of Fixed-Income Securities,* 6th ed.

[26]For further discussion, see John N. McElravey, "Securities Backed by Credit Card Receivables; in *The Handbook of Fixed-Income Securities,* 6th ed.

Variable-Rate Notes Introduced in the United States in the mid-1970s, **variable-rate notes** became popular during periods of high interest rates. The typical variable-rate note possesses two unique features:

1. After the first 6 to 18 months of the issue's life, during which a minimum rate is often guaranteed, the coupon rate floats, so that every six months it changes to follow some standard. Usually it is pegged 1 percent above a stipulated short-term rate. For example, the rate might be the preceding three weeks' average 90-day T-bill rate.
2. After the first year or two, the notes are redeemable at par, at the *holder's* option, usually at six-month intervals.

Such notes represent a long-term commitment on the part of the borrower yet provide the lender with all the characteristics of a short-term obligation. They typically are available to investors in minimum denominations of $1,000. However, although the six-month redemption feature provides liquidity, the variable rates can cause these issues to experience wide swings in semiannual coupons.[27]

Zero Coupon and Deep Discount Bonds The typical corporate bond has a coupon and maturity. In turn, the value of the bond is the present value of the stream of cash flows (interest and principal) discounted at the required yield to maturity (YTM). Alternatively, some bonds do not have any coupons or have coupons that are below the market rate at the time of issue. Such securities are referred to as *zero coupon* or *minicoupon bonds* or *original-issue discount (OID) bonds.* A zero coupon discount bond promises to pay a stipulated principal amount at a future maturity date, but it does not promise to make any interim interest payments. Therefore, the price of the bond is the present value of the principal payment at the maturity date using the required discount rate for this bond. The return on the bond is the difference between what the investor pays for the bond at the time of purchase and the principal payment at maturity.

Consider a zero coupon, $10,000 par value bond with a 20-year maturity. If the required rate of return on bonds of equal maturity and quality is 8 percent and we assume semiannual discounting, the initial selling price for this bond would be $2,082.89 because the present-value factor at 8 percent compounded semiannually for 20 years is 0.208289. From the time of purchase to the point of maturity, the investor would not receive any cash flow from the firm. Notably, the investor must pay taxes, however, on the implied interest on the bond, although no cash is received. Because an investor subject to taxes would experience severe negative cash flows during the life of these bonds, they are primarily of interest to investment accounts not subject to taxes, such as pensions, IRAs, or Keogh accounts.[28]

A modified form of zero coupon bond is the OID bond where the coupon is set substantially below the prevailing market rate, for example, a 5 percent coupon on a bond when market rates are 12 percent. As a result, the bond is issued at a deep discount from par value. Again, taxes must be paid on the implied 12 percent return rather than the nominal 5 percent, so the cash flow disadvantage of zero coupon bonds, though lessened, remains.

High-Yield Bonds A segment of the corporate bond market that has grown in size, importance, and controversy is **high-yield bonds**, also referred too as *speculative-grade bonds* and *junk bonds.* These are corporate bonds that have been assigned a bond rating as noninvestment grade, that is, they have a rating below BBB or Baa. The title of speculative-grade bonds is prob-

[27]For an extended discussion, see Richard S. Wilson, "Domestic Floating-Rate and Adjustable-Rate Debt Securities," in *The Handbook of Fixed-Income Securities,* 6th ed.

[28]These bonds will be discussed further in Chapter 19 in the section on volatility and duration and in Chapter 20 when we consider immunization.

ably the most objective because bonds that are not rated investment grade are speculative grade. The designation of *high-yield bonds* was by Drexel Burnham Lambert (DBL) as an indication of the returns available for these bonds relative to Treasury bonds and investment-grade corporate bonds. The *junk bond* designation is obviously somewhat derogatory and refers to the low credit quality of the issues.

Brief History of the High-Yield Bond Market Based on a specification that bonds rated below BBB make up the high-yield market, this segment has existed as long as there have been rating agencies. Prior to 1980, most of the high-yield bonds were referred to as *fallen angels,* which means they were bonds that were originally issued as investment-grade securities, but because of changes in the firm over time, the bonds were downgraded into the high-yield sector (BB and below).

The market changed in the early 1980s when DBL began aggressively underwriting high-yield bonds for two groups of clients: (1) small firms that did not have the financial strength to receive an investment-grade rating by the rating agencies, and (2) large and small firms that issued high-yield bonds in connection with leveraged buyouts (LBOs). As a result, the high-yield bond market went from a residual market that included fallen angels to a new-issue market where bonds were underwritten and issued with below-investment-grade ratings.

As a result, the high-yield bond market exploded in size and activity beginning in 1983. As shown in Exhibit 18.6, there were a limited number of new high-yield issues in the late 1970s, and they were not very large issues. Beginning in 1983, more large issues became common (the average size of an issue currently is over $250 million), and high-yield issues became a significant percentage of the total new-issue bond market (typically between 15 and 20 percent). As of 2002, the total outstanding high-yield debt constituted about 20 percent of outstanding corporate debt in the United States.[29]

An important point bears repeating: Although the high-yield debt market has existed for many years, its real emergence as a major component of the U.S. capital market did not occur until 1983. This is relevant when considering the liquidity and default experience for these securities.

Distribution of High-Yield Bond Ratings Exhibit 18.7 contains the distribution of ratings for all the bonds contained in the Lehman Brothers High-Yield Bond Index as of December 31, 1987–2001. As shown, the heavy concentration by market value is typically in the B class, which contains almost half of all value. There was a strong increase in the BB category that grew from 17 percent in 1987 to over 48 percent in 1995, then declined to less than 34 percent in 1999 prior to an increase to over 46 percent in 2001.

Ownership of High-Yield Bonds The major owners of high-yield bonds have been mutual funds, insurance companies, and pension funds. As of the end of 2001, over 100 mutual funds were either exclusively directed to invest in high-yield bonds or included such bonds in their portfolio. Notably, there has been a shift of ownership away from insurance companies and savings and loans toward mutual funds. This shift occurred during the late 1980s when regulators "encouraged" the insurance companies and S&Ls to reduce or eliminate high-yield bonds from their portfolios.

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[29]Almost everyone would acknowledge that the development of the high-yield debt market has had a positive impact on the capital-raising ability of the economy. For an analysis of this impact, see Kevin J. Perry and Robert A. Taggart, Jr., "The Growing Role of Junk Bonds in Corporate Finance," *Journal of Applied Corporate Finance* 1, no. 1 (Spring 1988): 37–45. An update on its characteristics is contained in 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): 85–97; Edward I. Altman, "Revisiting the High-Yield Bond Market," *Financial Management* 21, no. 2 (Summer 1992): 78–92; and Frank K. Reilly and David J. Wright, "Unique Risk-Return Characteristics of High-Yield Bonds, "*The Journal of Fixed Income* 11, no. 2 (September 2001): 65–82.

EXHIBIT 18.6 *HIGH-YIELD BONDS—NEW-ISSUE VOLUME: 1977–2001*

	PUBLIC		144A		TOTAL		
Year	Number of Issues	Principal Amount ($ Millions)	Number of Issues	Principal Amount ($ Millions)	Number of Issues	Principal Amount ($ Millions)	Average Issue Size ($ Millions)
1977	61	$ 1,040.2			61	$ 1,040.2	17.05
1978	82	1,578.5			82	1,578.5	19.25
1979	56	1,399.8			56	1,399.8	25.00
1980	45	1,429.3			45	1,429.3	31.76
1981	34	1,536.3			34	1,536.3	45.19
1982	52	2,691.5			52	2,691.5	51.76
1983	95	7,765.2			95	7,765.2	81.74
1984	131	15,238.9			131	15,238.9	116.33
1985	175	15,684.8			175	15,684.8	89.63
1986	226	33,261.8			226	33,261.8	147.18
1987	190	30,522.2			190	30,522.2	160.64
1988	160	31,095.2			160	31,095.2	194.34
1989	130	28,753.2			130	28,753.2	221.18
1990	10	1,397.0			10	1,397.0	139.70
1991	48	9,967.0			48	9,967.0	207.65
1992	245	39,755.2	29	$ 3,810.8	274	43,566.0	159.00
1993	341	57,163.7	95	15,096.8	436	72,260.5	165.74
1994	191	34,598.8	81	7,733.5	272	42,332.3	155.63
1995	152	30,139.1	94	14,242.0	246	44,381.1	180.41
1996	142	30,739.4	217	35,172.9	359	65,912.3	183.60
1997	103	19,822.0	576	98,885.0	679	118,707.0	174.83
1998	116	29,844.0	604	111,044.7	720	140,888.7	195.68
1999	60	16,520.0	357	83,157.0	417	99,677.0	239.00
2000	32	10,621.1	149	39,593.6	181	50,214.7	277.40
2001	42	14,385.6	267	69,109.6	309	83,495.2	270.20

Note: Includes nonconvertible, corporate debt rated below investment grade by Moody's or Standard & Poor's. Excludes mortgage- and asset-backed issues, as well as non-144a private placements.

Source: Merrill Lynch & Co.; Securities Data Company.

The purpose of this discussion has been to introduce you to high-yield bonds because of the growth in size and importance of this segment of the market for individual and institutional investors. We revisit this topic in Chapter 20 on bond portfolio management, where we review the historical rates of return and alternative risk factors, including the default experience for these bonds. All of this must be considered by potential investors in these securities.[30]

[30]For additional discussion of these bonds, see Edward I. Altman, ed., *The High-Yield Debt Market* (Homewood, Ill.: Dow Jones–Irwin, 1990); Frank J. Fabozzi, ed., *The New High-Yield Debt Market* (New York: Harper Business, 1990); and Martin S. Fridson, *High-Yield Bonds* (Chicago: Probus Publishing, 1989).

EXHIBIT 18.7 *HIGH YIELD INDEX COMPOSITION BY CREDIT QUALITY: 1987–2001 (PERCENTAGE OF MARKET VALUE)*

	BB	B	CCC/UNRATED
1987	17.41	68.61	13.99
1988	16.26	69.09	14.64
1989	18.02	63.53	18.46
1990	15.92	67.17	16.91
1991	21.41	56.72	21.87
1992	27.86	56.70	15.44
1993	42.78	49.37	7.85
1994	42.61	48.00	9.38
1995	48.32	44.60	7.08
1996	45.67	47.36	6.97
1997	38.19	51.07	10.74
1998	35.28	52.04	12.68
1999	33.83	55.82	10.34
2000	36.63	53.94	9.43
2001	46.04	42.35	11.61

Source: Lehman Brothers, *Global Family of Indices.* (New York: Lehman Brothers, Annual).

Japanese Corporate Bond Market The corporate bond market in Japan is made up of two components: (1) bonds issued by industrial firms or utilities and (2) bonds issued by banks to finance loans to corporations. As noted in connection with Exhibit 18.2, the pure corporate bond sector has declined in relative size over time to less than 10 percent of the total. In contrast, the dollar amount of bank debentures is over 18 percent of the total.

Japanese corporate bonds are regulated by the *Kisaikai,* a council composed of 22 bond-related banks and seven major securities companies. It operates under the authority of the Ministry of Finance (MOF) and the Bank of Japan (BOJ) to determine bond-issuing procedures, including specifying the coupons on corporate bonds in relation to coupons on long-term government bonds in order to prevent any competition with the government bond market.

Because of numerous bankruptcies during the 1930s depression, the government mandated that all corporate debt be secured. This requirement was abolished in 1988. The issuance of unsecured debt led to the birth of bond-rating agencies, which were not needed with completely secured debt. Currently, there are five major bond-rating agencies.

The Ministry of Finance specifies minimum issuing requirements and controls the issuance system that specifies who can issue bonds and when they can be issued. In addition, lead-underwriting managers are predetermined in accordance with a lead manager rotating system that ensures balance among the major securities firms in Japan.

Bank Bonds The substantial issuance of bank bonds is because of the banking system in Japan, which is segmented into the following components:

- Commercial banks (13 big-city banks and 64 regional banks)
- Long-term credit banks (3)
- Mutual loan and savings banks (6)
- Specialized financial institutions

During the post–World War II reconstruction, several banks were permitted to obtain funding by issuing medium- and long-term debentures at rates above yields on government bonds. These funds were used to make mortgage loans to firms in the industrial sector to rebuild plants and equipment. Currently, these financial institutions sell five-year coupon debentures and one-year discount debentures directly to individual and institutional investors. The long-term credit banks are not allowed to take deposits and thus depend on the debentures to obtain funds. These bonds are traded in the OTC market.[31]

German Corporate Bond Market Germany likewise has a combination sector in corporates that includes pure corporate bonds and bank bonds. Bank bonds may be issued in collateralized or uncollateralized form. For the collateralized bonds, the largest categories are mortgage bonds and commercial bonds.

German mortgage bonds are collateralized bonds of the issuing bank backed by mortgage loans. Due to the supervision of these bonds and the mortgage collateral, these bonds are very high quality. They are issued in bearer or registered form. Most registered bonds are sold to domestic institutions and cannot be listed on a stock exchange because they are not considered securities. Alternatively, the bearer bonds, which are transferred by book entry, are sold in small denominations, are traded on the exchanges, and enjoy an active secondary market.

German commercial bonds are subject to the same regulation and collateralization as mortgage bonds. The difference is that the collateral consists of loans to or guarantees by a German public-sector entity rather than a first mortgage. Possible borrowers include the federal government, its agencies (the federal railway or the post office), federal states, and agencies of the European Economic Community (EEC). The credit quality of these loans is excellent. Mortgage and commercial bonds have identical credit standing and trade at very narrow spreads.

Schuldscheindarlehen are private loan agreements between borrowers and large investors (usually a bank) who make the loans but who can (with the borrower's permission) sell them or divide the loans among several investors. These instruments are like a negotiable loan participation. All participants receive a copy of the loan agreement, and a letter of assignment gives the participant title to a share of principal and interest, although the bank acts as the agent. These loan agreements, which come in various sizes, account for a substantial proportion of all funds raised in Germany. A large volume of these private loan agreements exists, but because the market is not very liquid they typically are used for the investment of large sums to maturity.

U.K. Corporate Bond Market Corporate bonds in the United Kingdom are available in three forms: debentures, unsecured loans, and convertible bonds. The value of securities in each class are about equal. The maturity structure of the corporate bond market is fairly wide because during the 1980s, the preference of investors shifted toward long-maturity bonds. The coupon structure of corporate bonds also is broad with high-coupon bonds issued during the 1980s. The higher end of the coupon range, which goes from 10 to 14 percent, is due to the unsecured segment of this market. In contrast, convertible bonds have the low coupons. Almost all U.K. corporate bonds are callable term bonds.

Corporate bonds in the United Kingdom have been issued through both public offerings and private placements. Subsequently, primary dealers have begun trading corporate bonds directly with each other. All corporate bonds are issued in registered form.

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[31]For further discussion of this market, see Aron Viner, *Inside Japanese Financial Markets* (Homewood, Ill.: Dow Jones–Irwin, 1988), Chapters 5 and 6; and Frank J. Fabozzi, ed., *The Japanese Bond Markets* (Chicago: Probus Publishing, 1990.

International Bonds

Each country's international bond market has two components. The first, *foreign bonds,* are issues sold primarily in one country and currency by a borrower of a different nationality. An example would be U.S. dollar–denominated bonds sold in the United States by a Japanese firm. (These are referred to as *Yankee bonds.*) Second are *Eurobonds,* which are bonds underwritten by international bond syndicates and sold in several national markets. An example would be Eurodollar bonds that are securities denominated in U.S. dollars, underwritten by an international syndicate, and sold to non-U.S. investors outside the United States. The relative size of these two markets (foreign bonds versus Eurobonds) varies by country.

United States The Eurodollar bond market has been much larger than the Yankee bond market (about $635 billion versus $220 billion). However, because the Eurodollar bond market is heavily affected by changes in the value of the U.S. dollar, it has experienced slower growth during periods when the dollar was weak. Such periods have created a desire for diversification by investors.

Yankee bonds are issued by foreign firms who register with the SEC and borrow U.S. dollars, using issues underwritten by a U.S. syndicate for delivery in the United States. These bonds are traded in the United States and pay interest semiannually. Over 60 percent of Yankee bonds are issued by Canadian corporations and typically have shorter maturities and longer call protection than U.S. domestic issues. These features increase their appeal.

The Eurodollar bond market is dominated by foreign investors, and the center of trading is in London. Eurodollar bonds pay interest annually. The Eurodollar bond market currently comprises almost 40 percent of the total Eurobond market.

Japan Before 1985, the Japanese international bond market was dominated (over 90 percent) by foreign bonds (Samurai bonds) with the balance in Euroyen bonds. After the issuance requirements for Euroyen bonds were liberalized in 1985, the ratio of issuance swung heavily in favor of Euroyen bonds.

Samurai bonds are yen-denominated bonds sold by non-Japanese issuers and mainly sold in Japan. The market is fairly small and has limited liquidity. The market has experienced very little growth in terms of yen but substantial growth in U.S. dollar terms because of changes in the exchange rate.

Euroyen bonds are yen-denominated bonds sold in markets outside Japan by international syndicates. This market has grown substantially because of the liberal issue requirements. Its appeal over time is determined by the strength or weakness of the yen relative to other currencies.

Germany All deutschemark bonds of foreign issuers can be considered Eurobonds. This is because the stability of German currency reduces the importance of the distinction between foreign bonds (DM-denominated bonds sold in Germany by non-German firms) and Euro-DM bonds (DM bonds sold outside Germany). Both types of bonds share the same primary and secondary market procedures, are free of German taxes, and have similar yields; and the amount outstanding is almost equal.

United Kingdom U.K. foreign bonds, referred to as *bulldog bonds,* are sterling-denominated bonds issued by non-English firms and sold in London. Eurosterling bonds are sold in markets outside London by international syndicates.

Similar to other countries, the U.K. international bond market has become dominated by the Eurosterling bonds. As of 2001, the ratio of Eurobonds versus foreign bonds (bulldogs) had grown to 25-to-1. The procedure for issuing and trading Eurosterling bonds is similar to that of other Eurobonds.

Obtaining Information on Bond Prices

As might be expected, the price information needs of bond investors are considerably different from those of stockholders. We know that there is substantial up-to-the-minute information on numerous listed and OTC stocks based on recent transactions. In sharp contrast, almost all bond trading (in dollar volume) is done on the OTC market, and these transactions are not reported. As a result, almost all prices reported are based upon self-reporting of yield estimates by bond dealers who trade government, corporate, or municipal bonds. There was some discussion of this in Chapter 5 when we considered the creation and maintenance of bond indexes. Given this background, the following discussion considers how investors read and interpret bond price information reported in newspapers and quote sheets.

Interpreting Bond Quotes

Essentially, all bonds are quoted on the basis of either yield or price. Price quotes are always interpreted as a *percentage of par.* For example, a quote of 98½ is interpreted not as $98.50 but 98½ percent of par. The dollar price is derived from the quote, given the par value. If the par value is $5,000 on a municipal bond, then the price of an issue quoted at 98½ would be $4,925. Actually, the market follows three systems of bond pricing: one system for corporates, another for governments (both Treasury and agency obligations), and a third for municipals.

Corporate Bond Quotes Exhibit 18.8 is a listing of U.S. Exchange corporate bond quotes that appeared in *The Wall Street Journal* on February 27, 2002. The data pertain to trading activity on February 26, 2002. Several quotes have been designated for illustrative purposes. The first issue designated in Column 1 is an American Telephone and Telegraph (ATT) issue and is representative of most corporate prices. In particular, the 8⅛22 indicates the coupon and maturity of the obligation; in this case, the ATT issue carries an 8.125 percent coupon and matures in 2022. The next column provides the *current* yield of the obligation and is found by comparing the coupon to the current market price. For example, a bond with an 8.125 percent coupon selling for 99.750 would have an 8.1 percent current yield. This is *not* the YTM or even necessarily a good approximation to it. Both of these yields will be discussed in Chapter 19.

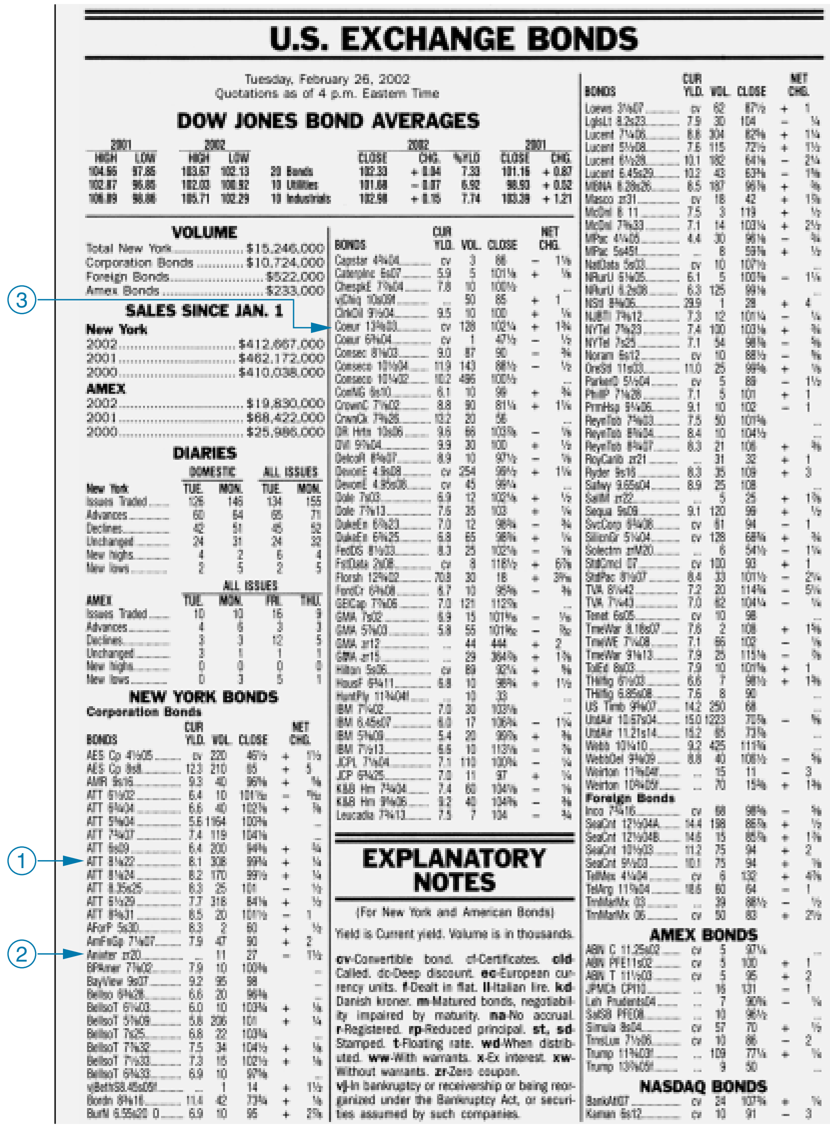
The next column gives the volume of $1,000 par value bonds traded that day (in this case, 308 bonds were traded). The next column indicates closing quotes, followed by the column for the net change in the closing price from the last day the issue was traded. In this case, ATT closed at 99.750, which was up ¼ from the prior day ($25).

The second example in Column 1 is Anixter, which refers to an Anixter Corp. zero coupon bond ("zr") due in 2020. As discussed, zero coupon securities do not pay interest but are redeemed at par at maturity. Because there is no coupon, they sell at a deep discount, which implies a yield. Again, since there are no coupon payments, they do not report a current yield.

Finally, the third example in Column 2 is a convertible ("cv") bond from Coeur that has a 13.375 percent coupon and is due in 2003. The conversion feature means that the bond is convertible into the common stock of the company. The letters "dc" before the coupon mean "deep discount" and indicate that the original coupon for this bond was set below the going rate at the time of issue. An example of such a bond would be a 5 percent coupon bond issued when market rates were 9 or 10 percent. Alternatively, "vj" in front of a bond issue means that the firm is in receivership or bankruptcy. The small letter "f" that will usually follow the maturity date of such a bond means that the issue is trading *flat,* which means the issuer is not meeting its interest payments. Therefore, the coupon of the obligation is inconsequential and there is a dash in the current yield column because there are no coupon payments. An example of such a bond in Column 1 is BethS (Bethlehem Steel).

All fixed-income obligations, with the exception of preferred stock, are traded on an *accrued interest basis.* The prices pertain to the value of all *future* cash flows from the bond and exclude

EXHIBIT 18.8 *SAMPLE CORPORATE BOND QUOTATIONS*



Source: *The Wall Street Journal,* 27 February 2002. Reprinted with permission from *The Wall Street Journal,* Dow Jones Co. Inc.

interest that has accrued to the holder since the last interest payment date. The actual price of the bond will exceed the quote listed because accrued interest must be added. Assume a bond with a 7⅛ percent coupon. If two months have elapsed since interest was paid, the current holder of the bond is entitled to 2⁄6 or one-third of the bond's semiannual interest payment that will be paid in four months. More specifically, the 7⅛ percent coupon provides semiannual interest income of $35.625. The investor who held the obligation for two months beyond the last interest payment date is entitled to one-third (⅓) of that $35.625 in the form of accrued interest. Therefore, whatever the current price of the bond, an accrued interest value of $11.87 will be added. If a bond is trading "flat" as already discussed, accrued interest would not be added.

EXHIBIT 18.9 *SAMPLE QUOTES FOR TREASURY BONDS, NOTES, AND BILLS*

TREASURY BONDS, NOTES & BILLS

Monday, March 4, 2002

Representative Over-the-Counter quotation based on transactions of $1 million or more.

Treasury bond, note and bill quotes are as of mid-afternoon. Colons in bid-and-asked quotes represent 32nds; 101:01 means 101 1/32. Net changes in 32nds. n-Treasury note. i-Inflation-Indexed issue. Treasury bill quotes in hundredths, quoted on terms of a rate of discount. Days to maturity calculated from settlement date. All yields are to maturity and based on the asked quote. Latest 13-week and 26-week bills are boldfaced. For bonds callable prior to maturity, yields are computed to the earliest call date for issues quoted above par and to the maturity date for issues below par. *-When issued.

Source: eSpeed/Cantor Fitzgerald

U.S. Treasury strips as of 3 p.m. Eastern time, also based on transactions of $1 million or more. Colons in bid-and-asked quotes represent 32nds; 99:01 means 99 1/32. Net changes in 32nds. Yields calculated on the asked quotation. ci-stripped coupon interest. bp-Treasury bond, stripped principal. np-Treasury note, stripped principal. For bonds callable prior to maturity, yields are computed to the earliest call date for issues quoted above par and to the maturity date for issues below par.

Source: Bear, Stearns & Co. via Street Software Technology Inc.

GOVT. BOND & NOTES

RATE	MATURITY MO/YR		BID	ASKED	CHG.	ASKED YLD.
6½	Mar	02n	100:10	100:11	....	1.64
6⅝	Mar	02n	100:10	100:11	– 1	1.54
6⅜	Apr	02n	100:22	100:23	– 1	1.58
6⅝	Apr	02n	100:23	100:24	– 1	1.63
7½	May	02n	101:03	101:04	....	1.71
6½	May	02n	101:04	101:05	....	1.62
6⅝	May	02n	101:04	101:05	– 1	1.67
6¼	Jun	02n	101:13	101:14	– 1	1.71
6⅜	Jun	02n	101:14	101:15	– 1	1.74
3⅝	Jul	02i	101:13	101:14	....	0.04
① 6	Jul	02n	101:22	101:23	....	1.76
6¼	Jul	02n	101:24	101:25	– 1	1.81
6⅜	Aug	02n	102:00	102:00	– 1	1.86
6⅛	Aug	02n	102:00	102:01	....	1.91
6¼	Aug	02n	102:01	102:02	– 1	1.94
5⅞	Sep	02n	102:06	102:07	– 1	1.95

RATE	MATURITY MO/YR		DID	ASKED	CHG.	ASKED YLD.
5½	Feb	08n	104:12	104:13	– 6	4.64
5⅝	May	08n	104:26	104:27	– 7	4.71
8⅜	Aug	08	107:20	107:21	– 7	n.a.
4¾	Nov	08n	99:23	99:24	– 7	4.79
8¾	Nov	08	109:06	109:07	– 2	n.a.
3⅞	Jan	09i	104:06	104:07	– 2	3.19
5½	May	09n	103:25	103:26	– 7	4.86
9⅛	May	09	111:28	111:29	– 4	n.a.
6	Aug	09n	106:20	106:21	– 8	4.92
10⅜	Nov	09	116:25	116:26	– 6	n.a.
4¼	Jan	10i	106:27	106:28	– 3	3.25
6½	Feb	10n	109:26	109:27	– 8	4.98
11¾	Feb	10	121:21	121:22	– 5	n.a.
10	May	10	117:21	117:22	– 4	n.a.
5¾	Aug	10n	104:30	104:31	– 9	5.02
12¾	Nov	10	129:03	129:04	– 6	n.a.
3½	Jan	11i	101:26	101:27	– 3	3.26
5	Feb	11n	99:22	99:23	– 8	5.04

U.S. TREASURY STRIPS

MATURITY		TYPE	BID	ASKED	CHG.	ASKED YLD.
May	02	ci	99:23	99:23	....	1.40
May	02	np	99:21	99:21	....	1.72
Aug	02	ci	99:10	99:10	....	1.55
Aug	02	np	99:06	99:06	....	1.82
Nov	02	ci	98:28	98:29	....	1.61
Feb	03	ci	97:28	97:29	– 1	2.24
Feb	03	np	97:26	97:26	– 1	2.34
May	03	ci	97:06	97:07	– 1	2.39
Jul	03	ci	96:17	96:17	– 2	2.60
Aug	03	ci	96:08	96:09	– 2	2.64
Aug	03	np	96:02	96:03	– 2	2.77
Nov	03	ci	95:22	95:23	– 2	2.60
Nov	03	np	95:03	95:04	– 2	2.97
Jan	04	ci	94:14	94:15	– 2	3.08
Feb	04	ci	94:03	94:04	– 2	3.13
Feb	04	np	94:01	94:02	– 2	3.16
May	04	ci	93:00	93:01	– 2	3.32
May	04	np	92:29	92:31	– 2	3.36
Jul	04	ci	92:12	92:13	– 2	3.37
Aug	04	ci	92:00	92:01	– 2	3.42
Aug	04	np	91:27	91:28	– 2	3.49
Nov	04	ci	90:23	90:24	– 2	3.63
Nov	04	bp	90:14	90:16	– 2	3.75
Nov	04	np	90:18	90:19	– 2	3.70
Jan	05	ci	90:01	90:02	– 2	3.69
② Feb	05	ci	89:19	89:21	– 2	3.74
Feb	05	np	89:17	89:19	– 2	3.76
May	05	ci	88:13	88:14	– 2	3.88
May	05	bp	88:05	88:06	– 2	3.97
May	05	np	88:09	88:11	– 2	3.92
May	05	np	88:12	88:14	– 2	3.88
Jul	05	ci	87:27	87:28	– 3	3.88
Aug	05	ci	87:13	87:15	– 3	3.92
Aug	05	bp	86:26	86:28	– 3	4.13
Aug	05	np	87:05	87:07	– 3	4.00
Nov	05	ci	86:22	86:24	– 3	3.88
Nov	05	np	85:29	85:31	– 3	4.13
Nov	05	np	86:00	86:02	– 3	4.10
Jan	06	ci	85:17	85:19	– 1	4.07
Feb	06	ci	85:01	85:03	– 1	4.13
Feb	06	bp	84:14	84:17	– 3	4.31
Feb	06	np	84:25	84:28	– 3	4.20

TREASURY BILLS

MATURITY	DAYS TO MAT.	BID	ASKED	CHG.	ASKED YLD.
Mar 07 '02	2	1.74	1.73	+0.01	1.75
Mar 14 '02	9	1.73	1.72	+0.01	1.74
Mar 21 '02	16	1.74	1.73	....	1.76
Mar 28 '02	23	1.74	1.73	....	1.76
Apr 04 '02	30	1.74	1.73	+0.01	1.76
Apr 11 '02	37	1.72	1.71	....	1.74
Apr 18 '02	44	1.74	1.73	+0.02	1.76
Apr 25 '02	51	1.74	1.73	+0.01	1.76
May 02 '02	58	1.75	1.74	+0.01	1.77
May 09 '02	65	1.75	1.74	+0.01	1.77
May 16 '02	72	1.75	1.74	+0.01	1.77
May 23 '02	79	1.76	1.75	+0.02	1.78
May 30 '02	**86**	**1.76**	**1.75**	**+0.01**	**1.78**
Jun 13 '02	100	1.76	1.75	+0.01	1.78
Jun 13 '02	100	1.76	1.75	+0.01	1.78
Jun 20 '02	107	1.76	1.75	....	1.78
Jun 27 '02	114	1.75	1.74	....	1.77
Jul 05 '02	122	1.77	1.76	....	1.80
Jul 11 '02	128	1.79	1.78	+0.02	1.82
Jul 18 '02	135	1.79	1.78	+0.01	1.82
Jul 25 '02	142	1.79	1.78	....	1.82
Aug 01 '02	149	1.81	1.80	....	1.84
Aug 08 '02	156	1.84	1.83	+0.01	1.87
Aug 15 '02	163	1.85	1.84	+0.02	1.88
Aug 22 '02	170	1.85	1.84	....	1.88
Aug 29 '02	**177**	**1.86**	**1.85**	**....**	**1.89**

INFLATION-INDEXED TREASURY SECURITIES

RATE	MAT.	BID/ASKED	CHG.	*YLD.	ACCR. PRIN.
3.625	07/02	101-13/14	....	0.040	1104
3.375	01/07	102-16/17	– 2	2.814	1116 ③
3.625	01/08	103-05/06	– 2	3.027	1094
3.875	01/09	104-06/07	– 2	3.185	1081
4.250	01/10	106-27/28	– 3	3.252	1054
3.500	01/11	101-26/27	– 3	3.258	1015
3.375	01/12	100-29/30	– 3	3.262	995
3.625	04/28	103-16/17	– 4	3.419	1093
3.875	04/29	108-00/01	– 4	3.418	1079
3.375	04/32	100-30/31	– 4	3.324	999

*-Yld. to maturity on accrued principal.

Source: *The Wall Street Journal,* 5 March 2002. Reprinted with permission from *The Wall Street Journal,* Dow Jones Co. Inc.

Treasury and Agency Bond Quotes Exhibit 18.9 illustrates the quote system for Treasury and agency issues. These quotes resemble those used for OTC securities because they contain both bid and ask prices rather than high, low, and close. For U.S. Treasury bond quotes, a small "n" behind the maturity date indicates that the obligation is a Treasury *note.* A small "p" indicates it is a Treasury note on which nonresident aliens are exempt from withholding taxes on the interest.

All other obligations in this section are Treasury bonds. The security identification is different because it is not necessary to list the issuer. Instead, the usual listing indicates the coupon, the month and year of maturity, and information on a call feature of the obligation. For example, if a quote carried a maturity of 2005–2010, this would mean that the issue has a deferred call feature until 2005 (and is thereafter freely callable) and a (final) maturity date of 2010. The bid-ask figures provided are stated as a percentage of par. The yield figure provided is yield to maturity, or *promised* yield based on the asking price. This system is used for Treasuries, agencies, and municipals.

Quote 1 is a 6 percent obligation of 2002 that demonstrates the basic difference in the price system of government bonds (i.e., Treasuries and agencies). The bid quote is 101:22, and the ask is 101:23. Governments are traded in thirty-seconds of a point (rather than eighths), and the figures to the right of the colons indicate the number of thirty-seconds in the fractional bid or ask. In this case, the bid price is actually 101.6875 percent of par. These quotes also are notable in terms of the bid-ask spread, which typically is 1 or 2 thirty-seconds, or about one-half the size of the spread for most stocks. This small spread reflects the outstanding liquidity and low transaction costs for Treasury securities.

The third column contains quotes for U.S. Treasury securities that have been "stripped." Specifically, the typical bond promises a series of coupon payments and its principal at maturity. A "stripped" security is created by dividing into separate units each coupon payment and principal payment, which are treated like a zero coupon bond that matures on that date. The security labeled ② was originally a coupon that was to be paid in February 2005. The asking yield (3.74) is referred to as the spot rate for this maturity (spot rate will be discussed in Chapter 19). The coupon interest payment with no principal is designated as "ci" (stripped coupon interest), while the other strip for February 2005 containing only the principal payment is designated "np" (Treasury note, stripped principal).

The securities listed in the Treasury strip and Treasury bill section only report dates and days to maturity and no coupons. This is because these are pure discount securities, that is, the return is the difference between the price you pay and par at maturity.[32]

The final section contains Treasury Inflation Protection Securities (TIPS) discussed earlier. Notice the accrued principal in the last column that reflects the inflation since the bond was issued. The bond designated ③ was the original bond issued in January 1997, so it has the highest accrued principal value of 1,116, and its yield to maturity is computed using this as the principal amount to be paid at maturity.

Municipal Bond Quotes Exhibit 18.10 contains municipal bond quotes from *The Blue List of Current Municipal Offerings.* These are ordered according to states and then alphabetically within states. Each issue gives the amount of bonds being offered (in thousands of dollars), the name of the security, the purpose or description of the issue, the coupon rate, the maturity (which includes month, day, and year), the yield or price, and the dealer offering the bonds. Bond quote 1 is for $200,000 of Indiana State Office Building bonds. The letters MBIA indicate that the bonds are guaranteed by the Municipal Bond Insurance Association (MBIA). These are zero (0.000) coupon bonds due July 1, 2005. In this instance, the yield to maturity is given (5.60 percent). To determine the price, compute the discount value or look up in a yield book the price of a zero coupon bond, due in 2005 to yield 5.60 percent. The dealer offering the bonds is Bearster. A list in the back of the publication gives the name and phone number of the firm.

The second bond is for $115,000 of Indiana State Toll Road bonds with a 9 percent coupon. These bonds have an M/S/F (mandatory sinking fund) that becomes effective in 2011, although the bond matures in 2015. The letters ETM mean that the sinking fund is put into "escrow till

[32]For a discussion of calculating yields, see Bruce D. Fielitz, "Calculating the Bond Equivalent Yield for T-Bills." *Journal of Portfolio Management* 9, no. 3 (Spring 1983): 58–60.

EXHIBIT 18.10 *QUOTES FOR MUNICIPALS*

INDIANA

No. of Bonds Offered	Municipal Issuer	Special Characteristics	Coupon	Maturity	Price/YTM	Broker
100	INDIANA BD BK REV (Hoosier) EQUIP	*B/E*	4.300	01/01/96N/C	100	NORWESMN
550	INDIANA HEALTH FAC FING AUTH	METHODIST	5.625	09/01/02N/C	101	PRUBACG
45	INDIANA HEALTH FAC FING AUTH	P/R @ 102	7.750	08/15/20C00	5.25	EQUITSEC
200	INDIANA PORT COMMN PORT REV		6.750	07/01/10	993/4	NOYESDAV
3115	INDIANA ST OFFICE BLDG COMMN	P/R @ 102	8.200	07/01/01C97	4.60	MORGANNT
200	INDIANA ST OFFICE BLDG COMMN	MBIA	0.000	07/01/05	5.60	BEARSTER ←①
335	INDIANA ST RECREATIONAL DEV		6.050	07/01/14	6.45	SMITHBCH
115	INDIANA ST TOLL RD COMMN TOLL	M/S/F 11	9.000	01/01/15ETM	6.30	DRIZOS ←②
95	INDIANA ST TOLL RD COMMN TOLL		9.000	01/01/15ETM	6.30	EMMET
1000	INDIANA ST TOLL RD COMMN TOLL	N/C S/F 11	9.000	01/01/15ETM	6.00	WILLIAMA
100	ELKHART CNTY IND HOSP AUTH REV (ELKHART GEN HOSP)	*B/E* RFDG	6.200	07/01/01N/C	5.40	BLAIRWM
45	FORT WAYNE IND HOSP AUTH HOSP	S/F 97	6.875	01/01/02ETM	5.85	EMMET
100	FORT WAYNE IND HOSP AUTH HOSP	P/R @ 102	9.125	07/01/15C95	3.80	GABRIELE
55	GOSHEN IND CMNTY SCHS		6.600	07/01/97	4.75	NBDBKIND
10	INDIANAPOLIS IND ARPT AUTH REV (CA @ 102.01)	US AIR	7.500	07/01/09C97	100	HSH ←③
15	INDIANAPOLIS IND ARPT AUTH REV	US AIR	7.500	07/01/19	8.25	STERLING
500	INDIANAPOLIS IND GAS UTIL REV		4.300	06/01/98	5.00	CITYSEC
60	INDIANAPOLIS IND LOC PUB IMPT		0.000	08/01/07N/C	8.10	SAPNY
25	INDIANAPOLIS IND LOC PUB IMPT		6.750	02/01/20	100	COUGHLIN
200	LAKE CENTRAL IND MULTI-		6.000	01/15/02ETM	5.25	CREWASSC
300	MICHIGAN CITY IND SEW WKS REV		5.200	08/01/07	5.70	NOYESDAV
	Thursday May 28, 1994				PAGE 15.A	

Source: *The Blue List of Current Municipal Offerings,* 28 May 1994, 15A. The Blue List Division of Standard & Poor's, New York. Reprinted with permission.

maturity." The market yield on these bonds is 6.30 percent, which means the bond would be selling at a premium.

Bond quote 3 refers to $10,000 of Indianapolis, Indiana, Airport Authority revenue bonds that are backed by a contract with US Air. Although the bonds mature in 2009, they are callable beginning in 1997 (C97) at 102 of par. The coupon is 7.50 percent and, in this case, the price of the bond is listed (100), which means its market yield also is 7.50 percent. Such bonds are called *dollar bonds.*

The "+" in the far left column indicates a new item since the prior issue of *The Blue List.* A "#" in the column prior to the yield to maturity or the price indicates that the price or yield has changed since the last issue. It is always necessary to call the dealer to determine the current yield/price because these quotes are at least one day old when they are published.

The Internet *Investments Online*

This chapter discusses some of the basics of bonds—terminology, ratings, and the differences between corporate and municipal bonds. Bonds are much simpler to evaluate than stocks, since they are debt, not ownership claims, and they (usually) have a fixed time to maturity and known cash flows to the investor (barring default). But bonds are an important part of many individual and institutional portfolios, and here are some helpful Web sites for bond information:

http://www.bonds-online.com This Web site covers the gamut of bonds. It offers information and price quotes on a wide variety of instruments, including treasuries, savings bonds, corporates, munis, inflation-indexed bonds, and zero coupon bonds. It features a "bond professor" that answers queries about fixed income securities, and site visitors can submit their own questions. Other information includes a capital markets commentary and a savings bond calculator.

http://www.prudential.com Prudential Securities' Market Commentaries is one of the brokerage house's sites that focuses on bonds. It features daily market commentaries on topics such as the financial markets, including treasuries, corporates, and the stock market. Some commentaries span the trading day, starting with pre-opening thoughts, a mid-day update, and after-the-close summary of what happened during the day.

Three bond ratings firms with interesting Web sites are Fitch's Investor's Service LP (**http://www.fitchinv.com**), Moody's Investor Services (**http://www.moodys.com**), and **http://www.standardandpoors.com/ratings.** These sites feature ratings, research, products and services. Moody's includes economic commentary, a discussion of its rating track record, and an overview of its rating process. In addition to featuring bond ratings, Moody's site also offers country sovereign risk ratings. Standard & Poor's site offers selected research reports, ratings, and their rating criteria.

http://www.bradynet.com This is a good information source for emerging markets' fixed income securities. This site features bond prices and indexes as well as analysis and research.

http://www.bondmarkets.com This is an issues and information-oriented site. It has information and updates on legislative and regulatory issues affecting the bond market, including sectors such as corporate, mortgage, and municipal bond markets.

Summary

- We considered the basic features of bonds: interest, principal, and maturity. Certain key relationships affect price behavior. Price is essentially a function of coupon, maturity, and prevailing market interest rates. Bond price volatility depends on coupon and maturity. As will be demonstrated in Chapter 19, bonds with longer maturities and/or lower coupons respond most vigorously to a given change in market rates.
- Each bond has unique intrinsic characteristics and can be differentiated by type of issue and indenture provisions. Major benefits to bond investors include high returns for nominal risk, the potential for capital gains, certain tax advantages, and possibly additional returns from active trading of bonds. Aggressive bond investors must consider market liquidity, investment risks, and interest rate behavior. We considered high-yield (junk) bonds because of the growth in size and status of this segment of the bond market.
- The global bond market includes numerous countries. The non-U.S. markets have experienced strong relative growth, whereas the U.S. market has been stable and constitutes about half the world bond market. The four major bond markets (the United States, Japan, Germany, and the United Kingdom) have a different makeup in terms of the proportion of governments, agencies, municipals, corporates,

and international issues. The various market sectors also are unique in terms of liquidity, yield spreads, tax implications, and operating features.

- To gauge default risk, most bond investors rely on agency ratings. For additional information on the bond market, prevailing economic conditions, and intrinsic bond features, individual and institutional investors rely on a host of readily available publications. Although extensive up-to-date quotes are available on Treasury bonds and notes, trading and price information for corporates and municipals is relatively difficult to find and is expensive.
- The world bond market is large and is continuing to grow due to government deficits around the world and the need for capital by corporations. It is also very diverse in terms of country alternatives and issuers within countries. This chapter provides the fundamentals that will allow us to consider the valuation of individual bonds in Chapter 19 and the alternative bond portfolio techniques in Chapter 20.

Questions

1. Explain the difference between calling a bond and a bond refunding.
2. Identify the three most important determinants of the price of a bond. Describe the effect of each.
3. Given a change in the level of interest rates, discuss how two major factors will influence the relative change in price for individual bonds.
4. Briefly describe two indenture provisions that can affect the maturity of a bond.
5. Explain the differences in taxation of income from municipal bonds, from U.S. Treasury bonds, and from corporate bonds.
6. For several institutional participants in the bond market, explain what type of bond each is likely to purchase and why.
7. Why should investors be aware of the trading volume for bonds in their portfolio?
8. What is the purpose of bond ratings?
9. Based on the data in Exhibit 18.1, which is the fastest-growing bond market in the world? Which markets are losing market share?
10. Based on the data in Exhibit 18.2, discuss the makeup of the German bond market and how and why it differs from the U.S. market.
11. Discuss the positives and negatives of investing in a government agency issue rather than a straight Treasury bond.
12. Discuss the difference between a foreign bond (e.g., a Samurai) and a Eurobond (e.g., a Euroyen issue).
13. CFA® *CFA Examination Level I*
    List *three* differences between Eurodollar and Yankee bonds.

Problems

1. An investor in the 28 percent tax bracket is trying to decide which of two bonds to purchase. One is a corporate bond carrying an 8 percent coupon and selling at par. The other is a municipal bond with a 5½ percent coupon, and it, too, sells at par. Assuming all other relevant factors are equal, which bond should the investor select?
2. What would be the initial offering price for the following bonds (assume semiannual compounding):
   a. A 15-year zero coupon bond with a yield to maturity (YTM) of 12 percent.
   b. A 20-year zero coupon bond with a YTM of 10 percent.
3. An 8.4 percent coupon bond issued by the state of Indiana sells for $1,000. What coupon rate on a corporate bond selling at its $1,000 par value would produce the same after-tax return to the investor as the municipal bond if the investor is in
   a. the 15 percent marginal tax bracket?
   b. the 25 percent marginal tax bracket?
   c. the 35 percent marginal tax bracket?

4. The Shamrock Corporation has just issued a $1,000 par value zero coupon bond with an 8 percent yield to maturity, due to mature 15 years from today (assume semiannual compounding).
   a. What is the market price of the bond?
   b. If interest rates remain constant, what will be the price of the bond in three years?
   c. If interest rates rise to 10 percent, what will be the price of the bond in three years?
5. Complete the information requested for each of the following $1,000 face value, zero coupon bonds, assuming semiannual compounding.

Bond	Maturity (Years)	Yield (Percent)	Price ($)
A	20	12	?
B	?	8	601
C	9	?	350

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Chapter 19 The Analysis and Valuation of Bonds

After you read this chapter, you should be able to answer the following questions:

- How do you determine the value of a bond based on the present value formula?
- What are the alternative bond yields that are important to investors?
- How do you compute the following major yields on bonds: current yield, yield to maturity, yield to call, and compound realized (horizon) yield?
- What are spot rates and forward rates and how do you calculate these rates from a yield to maturity curve?
- What are the spot rate yield curve and the forward rate curve?
- How and why do you use the spot rate curve to determine the value of a bond?
- What are the alternative theories that attempt to explain the shape of the term structure of interest rates?
- What factors affect the level of bond yields at a point in time?
- What economic forces cause changes in bond yields over time?
- When yields change, what characteristics of a bond cause differential percentage price changes for individual bonds?
- What is meant by the duration of a bond, how do you compute it, and what factors affect it?
- What is modified duration and what is the relationship between a bond's modified duration and its price volatility?
- What is the convexity for a bond, how do you compute it, and what factors affect it?
- Under what conditions is it necessary to consider both modified duration and convexity when estimating a bond's price volatility?
- What happens to the duration and convexity of bonds that have embedded call options?
- What are effective duration and effective convexity and when are they useful?
- What is empirical duration and how is it used with common stocks and other assets?
- What are the static yield spread and the option-adjusted spread?

In this chapter, we apply the valuation principles that were introduced in Chapter 11 to the valuation of bonds. This chapter is concerned with how one goes about finding the value of bonds using the traditional single yield to maturity rate and using multiple spot rates. We will also come to understand the several measures of yields for bonds. It is important to understand why these bond values and yields change over time. To do this, we begin with a review of value estimation for bonds using the present value model introduced in Chapter 11. This background on valuation allows us to understand and compute the expected rates of return on bonds.

After mastering the measurement of bond yields, we consider what factors influence the level of bond yields and what economic forces cause changes in yields over time. This is followed by a consideration of the alternative shapes of the yield curve and the alternative theories that explain changes in its shape. We discuss the effects of various characteristics and indenture provisions that affect the required returns and, therefore, the value of specific bond issues. This includes such factors as time to maturity, coupon, callability, and sinking funds.

We return to the consideration of bond value and acknowledge that, when yields change, all bond prices do not change in the same way. An understanding of the factors that affect the price changes for bonds has become more important because the price volatility of bonds has increased substantially. Before 1950, the yields on bonds were fairly low and both yields and prices were stable. In this environment, bonds were considered a very safe investment and most investors in bonds intended to hold them to maturity. During the last several decades, however, the level of interest rates has increased substantially because of inflation, and interest rates have also become more volatile because of changes in the rate of inflation and monetary policy. As a result, bond prices and rates of return on bonds have been much more volatile and the rates of return on bond investments have increased. Although this increase in interest rate volatility has affected all bonds, the impact is more significant on bonds with embedded options, such as call features.

THE FUNDAMENTALS OF BOND VALUATION

The value of bonds can be described in terms of dollar values or the rates of return they promise under some set of assumptions. In this section, we describe both the present value model, which computes a specific value for the bond using a single discount value, and the yield model, which computes the promised rate of return based on the bond's current price.

The Present Value Model

In our introduction to valuation theory in Chapter 11, we saw that the value of a bond (or any asset) equals the present value of its expected cash flows. The cash flows from a bond are the periodic interest payments to the bondholder and the repayment of principal at the maturity of the bond. Therefore, the value of a bond is the present value of the semiannual interest payments plus the present value of the principal payment. Notably, the standard technique is to use a single interest rate discount factor, which is the required rate of return on the bond. We can express this in the following present value formula that assumes semiannual compounding.[1]

➤19.1
$$P_m = \sum_{t=1}^{2n} \frac{C_i/2}{(1+i/2)^t} + \frac{P_p}{(1+i/2)^{2n}}$$

where:

P_m = the current market price of the bond
n = the number of years to maturity
C_i = the annual coupon payment for bond i
i = the prevailing yield to maturity for this bond issue
P_p = the par value of the bond

The value computed indicates what an investor would be willing to pay for this bond to realize a rate of return that takes into account expectations regarding the *RFR,* the expected rate of inflation, and the risk of the bond. The standard valuation technique assumes holding the bond to the maturity of the obligation. In this case, the number of periods would be the number of years to the maturity of the bond (referred to as its *term to maturity*). In such a case, the cash flows would include all the periodic interest payments and the payment of the bond's par value at the maturity of the bond.

[1]Almost all U.S. bonds pay interest semiannually so it is appropriate to use semiannual compounding wherein you cut the annual coupon rate in half and double the number of periods. To be consistent, you should also use semiannual compounding when discounting the principal payment of a coupon bond or even a zero coupon bond. All our present value calculations assume semiannual compounding.

We can demonstrate this formula using an 8 percent coupon bond that matures in 20 years with a par value of $1,000. This calculation implies that an investor who holds this bond to maturity will receive $40 every 6 months (one half of the $80 coupon) for 20 years (40 periods) and $1,000 at the maturity of the bond in 20 years. If we assume a prevailing yield to maturity for this bond of 10 percent (the market's required rate of return on the bond), the value for the bond using Equation 19.1 would be:

$$P_m = \sum_{t=1}^{40} \frac{80/2}{(1+.10/2)^t} + \frac{\$1,000}{(1+.10/2)^{40}}$$

We know that the first term is the present value of an annuity of $40 every 6 months for 40 periods at 5 percent, while the second term is the present value of $1,000 to be received in 40 periods at 5 percent. This can be summarized as follows:

Present value of interest payments		
$40 × 17.1591	=	$686.36
Present value of principal payment		
$1,000 × 0.1420	=	142.00
Total value of bond at 10%		$828.36

As expected, the bond will be priced at a discount to its par value because the market's required rate of return of 10 percent is greater than the bond's coupon rate, that is $828.36 or 82.836 percent of par.

Alternatively, if the market's required rate was 6 percent, the value would be computed the same way except we would compute the present value of the annuity at 3 percent for 40 periods and the present value of the principal at 3 percent for 40 periods as follows:

Present value of interest payments		
$40 × 23.1148	=	$ 924.59
Present value of principal payment		
$1,000 × 0.3066	=	306.60
Total value of bond at 6%		$1,231.19

Because the bond's discount rate is lower than its coupon, the bond would sell at a premium above par value—that is, $1,231.19 or 123.119 of par.

The Price-Yield Curve When you know the basic characteristics of a bond in terms of its coupon, maturity, and par value, the only factor that determines its value (price) is the market discount rate—its required rate of return. As has been shown, as we increase the required rate, the price declines. It is possible to demonstrate the specific relationship between the price of a bond and its yield by computing the bond's price at a range of yields as shown in Exhibit 19.1.

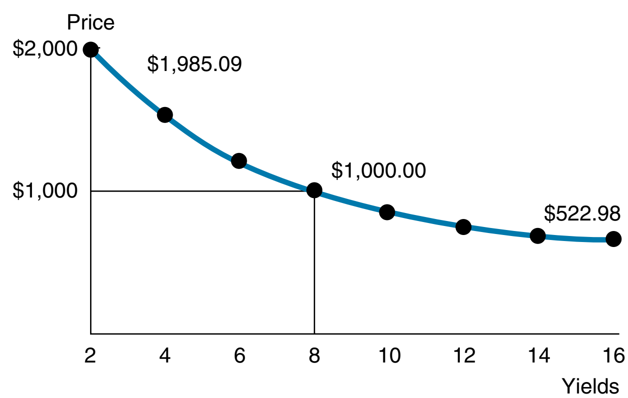
A graph of this relationship between the required return (yield) on the bond and its price is referred to as the price-yield curve, as shown in Exhibit 19.2. Besides demonstrating that price moves inverse to yield, it shows three other important points:

1. When the yield is below the coupon rate, the bond will be priced at a **premium** to its par value.

EXHIBIT 19.1 *PRICE-YIELD RELATIONSHIP FOR A 20-YEAR, 8 PERCENT COUPON BOND ($1,000 PAR VALUE)*

Required Yield	Price of Bond
2	$1,985.09
4	1,547.12
6	1,231.19
8	1,000.00
10	828.36
12	699.05
14	600.07
16	522.98

EXHIBIT 19.2 *THE PRICE-YIELD CURVE FOR A 20-YEAR, 8 PERCENT COUPON BOND*



2. When the yield is above the coupon rate, the bond will be priced at a **discount** to its par value.
3. The price-yield relationship is not a straight line; rather, it is *convex.* As yields decline, the price increases at an increasing rate; and, as the yield increases, the price declines at a declining rate. This concept of a convex price-yield curve is referred to as *convexity* and will be discussed further in a later section.

The Yield Model

Instead of determining the value of a bond in dollar terms, investors often price bonds in terms of **yields**—the promised rates of return on bonds under certain assumptions. Thus far, we have used cash flows and our required rate of return to compute an estimated value for the bond. To compute an expected yield, we use the current market price (P_m) and the expected cash flows to *compute the expected yield on the bond.* We can express this approach using the same present value model. The difference is that in Equation 19.1, it was assumed that we knew the appropriate discount rate (the required rate of return), and we computed the estimated value (price) of the bond. In this case, we still use equation 19.1, but it is assumed that we know the price of the bond and we compute the discount rate (yield) that will give us the current market price (P_m).

$$P_m = \sum_{t=1}^{2n} \frac{C_i/2}{(1+i/2)^t} + \frac{P_p}{(1+i/2)^{2n}}$$

where the variables are the same as previously, except

i = the discount rate that will discount the expected cash flows to equal the current market price of the bond

This i value gives the expected ("promised") yield of the bond under various assumptions to be noted, assuming you pay the price P_m. In the next section, we will discuss several types of bond yields that arise from the assumptions of the valuation model.

Approaching the investment decision stating the bond's value as a yield figure rather than a dollar amount, you consider the relationship of the computed bond yield to your required rate of return on this bond. If the computed promised bond yield is equal to or greater than your required rate of return, you should buy the bond; if the computed promised yield is less than your required rate of return, you should not buy the bond.

These approaches to pricing bonds and making investment decisions are similar to the two alternative approaches by which firms make investment decisions. We referred to one approach, the **net present value (NPV)** method, in Chapter 11. With the NPV approach, you compute the present value of the net cash flows from the proposed investment at your cost of capital and subtract the present value cost of the investment to get the net present value (NPV) of the project. If this NPV is positive, you consider accepting the investment; if it is negative, you reject it. This is basically the way we compared the value of an investment to its market price.

The second approach is to compute the **internal rate of return (IRR)** on a proposed investment project. The IRR is the discount rate that equates the present value of cash outflows for an investment with the present value of its cash inflows. You compare this discount rate, or IRR (which is also the estimated rate of return on the project), to your cost of capital, and accept any investment proposal with an IRR equal to or greater than your cost of capital. We do the same thing when we price bonds on the basis of yield. If the estimated ("promised") yield on the bond (yield to maturity, yield to call, or horizon yield) is equal to or exceeds your required rate of return on the bond, you should invest in it; if the estimated yield is less than your required rate of return on the bond, you should not invest in it.

Computing Bond Yields

Bond investors traditionally have used five yield measures for the following purposes:

Yield Measure	Purpose
Nominal yield	Measures the coupon rate.
Current yield	Measures the current income rate.
Promised yield to maturity	Measures the estimated rate of return for bond held to maturity.
Promised yield to call	Measures the estimated rate of return for bond held to first call date.
Realized (horizon) yield	Measures the estimated rate of return for a bond likely to be sold prior to maturity. It considers specific reinvestment assumptions and an estimated sales price. It also can measure the actual rate of return on a bond during some past period of time.

Nominal and current yields are mainly descriptive and contribute little to investment decision making. The last three yields are all derived from the present value model as described previously.

To measure an estimated realized yield (also referred to as the horizon yield or total return), a bond investor must estimate a bond's future selling price. Following our presentation of bond yields, we present the procedure for finding these prices. We conclude the valuation segment with a demonstration of valuing bonds using spot rates, which is becoming more prevalent.

Nominal Yield

Nominal yield is the coupon rate of a particular issue. A bond with an 8 percent coupon has an 8 percent nominal yield. This provides a convenient way of describing the coupon characteristics of an issue.

Current Yield

Current yield is to bonds what dividend yield is to stocks. It is computed as

➤19.2 $$CY = C_i / P_m$$

where:

CY = the current yield on a bond
C_i = the annual coupon payment of bond i
P_m = the current market price of the bond

Because this yield measures the current income from the bond as a percentage of its price, it is important to income-oriented investors who want current cash flow from their investment portfolios. An example of such an investor would be a retired person who lives on this investment income. Current yield has little use for investors who are interested in total return because it excludes the important capital gain or loss component.

Promised Yield to Maturity

Promised yield to maturity is the most widely used bond yield figure because it indicates the fully compounded rate of return promised to an investor who buys the bond at prevailing prices, *if two assumptions hold true.* Specifically, the *promised* yield to maturity will be equal to the investor's *realized* yield *if* these assumptions are met. The first assumption is that the investor holds the bond to maturity. This assumption gives this value its shortened name, *yield to maturity* (YTM). The second assumption is implicit in the present value method of computation. Referring to Equation 19.1, recall that it related the current market price of the bond to the present value of all cash flows as follows:

$$P_m = \sum_{t=1}^{2n} \frac{C_i/2}{(1+i/2)^t} + \frac{P_p}{(1+i/2)^{2n}}$$

To compute the YTM for a bond, we solve for the rate i that will equate the current price (P_m) to all cash flows from the bond to maturity. As noted, this resembles the computation of the internal rate of return (IRR) on an investment project. Because it is a present value–based computation, it implies a reinvestment rate assumption because it discounts the cash flows. That is, the equation assumes that *all interim cash flows (interest payments) are reinvested at the computed YTM*. This is referred to as a *promised* YTM because the bond will provide this computed YTM *only if* you meet its conditions:

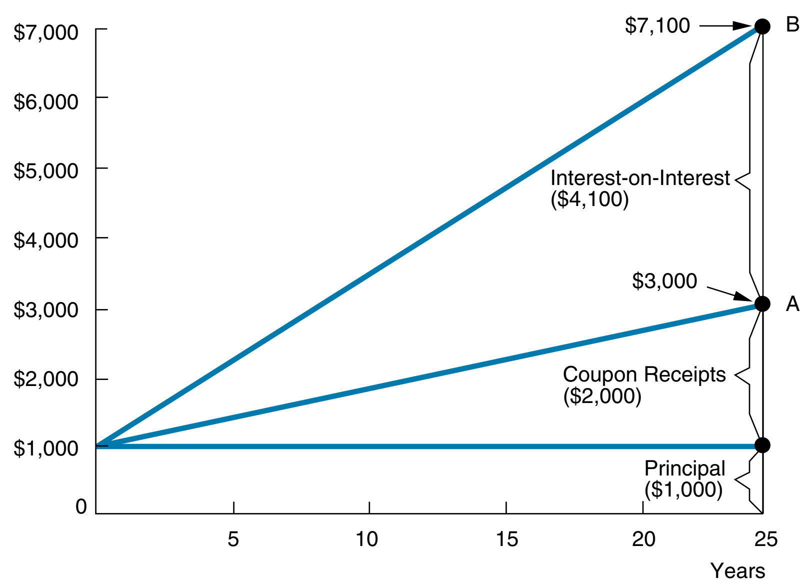
1. You hold the bond to maturity.
2. You reinvest all the interim cash flows at the computed YTM rate.

If a bond promises an 8 percent YTM, you must reinvest coupon income at 8 percent to realize that promised return. If you spend (do not reinvest) the coupon payments or if you cannot find opportunities to reinvest these coupon payments at rates as high as its promised YTM, then the actual realized yield you earn will be less than the promised yield to maturity. As will be demonstrated in the section on realized return, if you can reinvest cash flows at rates above the YTM, your realized (horizon) return will be greater than the promised YTM. The income earned on this reinvestment of the interim interest payments is referred to as **interest-on-interest**.[2]

The impact of the reinvestment assumption (i.e., the interest-on-interest earnings) on the actual return from a bond varies directly with the bond's coupon and maturity. A higher coupon and/or a longer term to maturity will increase the loss in value from failure to reinvest the coupon cash flow at the YTM. Put another way, a higher coupon or a longer maturity makes the reinvestment assumption more important.

Exhibit 19.3 illustrates the impact of interest-on-interest for an 8 percent, 25-year bond bought at par to yield 8 percent. If you invested $1,000 today at 8 percent for 25 years and reinvested all the coupon payments at 8 percent, you would have approximately $7,100 at the end of 25 years. We will refer to this money that you have at the end of your investment horizon as your **ending-wealth value**. To prove that you would have an ending-wealth value of $7,100, look up the compound interest factor for 8 percent for 25 years (6.8493) or 4 percent for 50 periods (which assumes semiannual compounding and is 7.1073). In the case of U.S. bonds, the semiannual compounding is the appropriate procedure because almost all U.S. bonds pay interest every six months.

EXHIBIT 19.3 *THE EFFECT OF INTEREST-ON-INTEREST ON TOTAL REALIZED RETURN*



Promised yield at time of purchase: 8.00%
Realized yield over the 25-year investment horizon with no coupon reinvestment (A): 4.50%
Realized yield over the 25-year horizon with coupons reinvested at 8% (B): 8.00%

[2]This concept is developed in Sidney Homer and Martin L. Leibowitz. *Inside the Yield Book* (Englewood Cliffs, N.J.: Prentice-Hall, 1972), Chapter 1.

Exhibit 19.3 shows that this \$7,100 is made up of \$1,000 principal return, \$2,000 of coupon payments over the 25 years (\$80 a year for 25 years), and \$4,100 in interest earned on the semiannual coupon payments reinvested at 4 percent semiannually. If you never reinvested any of the coupon payments, you would have an ending-wealth value of only \$3,000. This ending-wealth value of \$3,000 derived from the beginning investment of \$1,000 gives you an actual (realized) yield to maturity of only 4.5 percent. That is, the rate that will discount \$3,000 back to \$1,000 in 25 years is 4.5 percent. Reinvesting the coupon payments at some rate between 0 and 8 percent would cause your ending-wealth position to be above \$3,000 and below \$7,100; therefore, your actual rate of return would be somewhere between 4.5 percent and 8 percent. Alternatively, if you managed to reinvest the coupon payments at rates consistently above 8 percent, your ending-wealth position would be above \$7,100, and your realized (horizon) rate of return would be above 8 percent.

Interestingly, during periods of very high interest rates, you often hear investors talk about "locking in" high yields. Many of these people are subject to **yield illusion** because they do not realize that attaining the high *promised* yield requires that they reinvest all the coupon payments at the very high *promised* yields. For example, if you buy a 20-year bond with a promised yield to maturity of 15 percent, you will actually realize the promised 15 percent yield *only* if you are able to reinvest all the coupon payments at 15 percent over the next 20 years.

Computing the Promised Yield to Maturity The promised yield to maturity can be computed by using the present value model with semiannual compounding. The present value model gives the investor an accurate result and is the technique used by investment professionals.

The present value model equation—Equation 19.1—shows the promised yield valuation model:

$$P_m = \sum_{t=1}^{2n} \frac{C_i/2}{(1+i/2)^t} + \frac{P_p}{(1+i/2)^{2n}}$$

All variables are as described previously. This model is somewhat complex because the solution requires iteration. As noted, the present value equation is a variation of the internal rate of return (IRR) calculation where we want to find the discount rate, *i*, that will equate the present value of the cash flows to the market price of the bond (P_m). Using the prior example of an 8 percent, 20-year bond, priced at \$900, the equation gives us a semiannual promised yield to maturity of 4.545 percent, which implies an annual promised YTM of 9.09 percent.[3]

$$\begin{aligned} 900 &= 40\sum_{t=1}^{40}\left(\frac{1}{(1.04545)^t}\right) + 1000\left(\frac{1}{(1.04545)^{40}}\right) \\ &= 40(18.2574) + 1,000(0.1702) \\ &= 900 \end{aligned}$$

The values for $1/(1 + i)$ were taken from the present value interest factor tables in the appendix at the back of the book using interpolation.

[3]You will recall from your corporate finance course that you start with one rate (e.g., 9 percent or 4.5 percent semiannual) and compute the value of the stream. In this example, the value would exceed \$900, so you would select a higher rate until you had a present value for the stream of cash flows of less than \$900. Given the discount rates above and below the true rate, you would do further calculations or interpolate between the two rates to arrive at the correct discount rate that would give you a value of \$900.

YTM for a Zero Coupon Bond In several instances, we have discussed the existence of zero coupon bonds that only have the one cash inflow at maturity. This single cash flow means that the calculation of YTM is substantially easier as shown by the following example.

Assume a zero coupon bond maturing in 10 years with a maturity value of $1,000 selling for $311.80. Because you are dealing with a zero coupon bond, there is only the one cash flow from the principal payment at maturity. Therefore, you simply need to determine what the discount rate is that will discount $1,000 to equal the current market price of $311.80 in 20 periods (10 years of semiannual payments). The equation is as follows:

$$\$311.80 = \frac{\$1000}{(1+i)^{20}}$$

You will see that $i = 6$ percent, which implies an annual rate of 12 percent. For future reference, this yield also is referred to as the 10-year spot rate, which is the discount rate for a single cash flow to be received in 10 years.

Promised Yield to Call

Although investors use promised YTM to value most bonds, they must estimate the return on certain callable bonds with a different measure—the **promised yield to call (YTC)**. Whenever a bond with a call feature is selling for a price above par (that is, at a premium) equal to or greater than its call price, a bond investor should consider valuing the bond in terms of YTC rather than YTM. This is because the marketplace uses the lowest, most conservative yield measure in pricing a bond. When bonds are trading at or above a specified **crossover price**, which is approximately the bond's call price plus a small premium that increases with time to call, the yield to call will provide the lowest yield measure.[4] The crossover price is important because at this price the YTM and the YTC are equal—this is the *crossover yield.* When the bond rises to this price above par, the computed YTM becomes low enough that it would be profitable for the issuer to call the bond and finance the call by selling a new bond at this prevailing market interest rate.[5] Therefore, the YTC measures the promised rate of return the investor will receive from holding this bond until it is retired at the first available call date, that is, at the end of the deferred call period. Note that if an issue has multiple call dates at different prices (the call price will decline for later call dates), it will be necessary to compute which of these scenarios provides the *lowest* yield—this is referred to as computing **yield to worst**. Investors must consider computing the YTC for their bonds after a period when numerous high-yielding, high-coupon bonds have been issued. Following such a period, interest rates will decline, bond prices will rise, and the high-coupon bonds will subsequently have a high probability of being called—that is, their yields will fall below the crossover yield.

Computing Promised Yield to Call Again, the present value method assumes that you hold the bond until the first call date and that you reinvest all coupon payments at the YTC rate.

[4]For a discussion of the crossover price and yield, see Homer and Leibowitz, *Inside the Yield Book,* Chapter 4.

[5]Extensive literature exists on the refunding of bond issues, including W. M. Boyce and A. J. Kalotay, "Optimum Bond Calling and Refunding," *Interfaces* (November 1979): 36–49; R. S. Harris, "The Refunding of Discounted Debt: An Adjusted Present Value Analysis," *Financial Management* 9, no. 4 (Winter 1980): 7–12; A. J. Kalotay, "On the Structure and Valuation of Debt Refundings," *Financial Management* 11, no. 1 (Spring 1982): 41–42; and John D. Finnerty, "Evaluating the Economics of Refunding High-Coupon Sinking-Fund Debt." *Financial Management* 12, no. 1 (Spring 1983): 5–10.

Yield to call is calculated using a variation of Equation 19.1. To compute the YTC by the present value method, we would adjust the semiannual present value equation to give

➤19.3
$$P_m = \sum_{t=1}^{2nc} \frac{C_i/2}{(1+i/2)^t} + \frac{p_c}{(1+i/2)^{2nc}}$$

where

P_m = the current market price of the bond
C_i = the annual coupon payment of bond i
nc = the number of years to first call date
P_c = the call price of the bond

Following the present value method, we solve for *i,* which typically requires several computations or interpolations to get the exact yield.

Realized (Horizon) Yield

The final measure of bond yield, **realized yield** or **horizon yield** (i.e., the actual return over a horizon period) measures the expected rate of return of a bond that you expect to sell prior to its maturity. In terms of the equation, the investor has a holding period *(hp)* or investment horizon that is less than *n.* Realized (horizon) yield can be used to estimate rates of return attainable from various trading strategies. Although it is a very useful measure, it requires several additional estimates not required by the other yield measures. Specifically, the investor must estimate the expected future selling price of the bond at the end of the holding period. Also, this measure requires a specific estimate of the reinvestment rate for the coupon flows prior to the liquidation of the bond. This technique also can be used by investors to measure their actual yields after selling bonds.

Computing Realized (Horizon) Yield

The realized yields over a horizon holding period are variations on the promised yield equations. The substitution of P_f and *hp* into the present value model (Equation 19.1) provides the following realized yield model:

➤19.4
$$P_m = \sum_{t=1}^{2hp} \frac{C_t/2}{(1+i/2)^t} + \frac{P_f}{(1+i/2)^{2hp}}$$

Again, this present value model requires you to solve for the *i* that equates the expected cash flows from coupon payments and the estimated selling price to the current market price.

You will note from the present value realized yield formula in Equation 19.4 that the coupon flows are implicitly discounted at the computed realized (horizon) yield. In many cases, this is an inappropriate assumption because available market rates might be very different from the computed realized (horizon) yield. Therefore, to derive a realistic estimate of the estimated realized yield, you also need to *estimate your expected reinvestment rate during the investment horizon.* We will demonstrate this in a subsequent subsection.

Therefore, to complete your understanding of computing estimated realized yield for alternative investment strategies, the next section considers the calculation of future bond prices. This is followed by a section on calculating a realized (horizon) return with different reinvestment rates.

CALCULATING FUTURE BOND PRICES

Dollar bond prices need to be calculated in two instances: (1) when computing realized (horizon) yield, you must determine the future selling price (P_f) of a bond if it is to be sold before maturity or first call, and (2) when issues are quoted on a promised yield basis, as with municipals. You can easily convert a yield-based quote to a dollar price by using Equation 19.1, which does not require iteration. (You need only solve for P_m.) The coupon (C_i) is given, as is par value (P_p) and the promised YTM, which is used as the discount rate.

Consider a 10 percent, 25-year bond with a promised YTM of 12 percent. You would compute the price of this issue as

$$\begin{aligned} P_m &= 100/2 \sum_{t=1}^{50} \frac{1}{\left(1+\frac{0.120}{2}\right)^t} + 1{,}000 \frac{1}{\left(1+\frac{0.120}{2}\right)^{50}} \\ &= 50(15.7619) + 1{,}000(0.0543) \\ &= \$842.40 \end{aligned}$$

In this instance, we are determining the prevailing market price of the bond based on the current market YTM. These market figures indicate the consensus of all investors regarding the value of this bond. An investor with a required rate of return on this bond that differs from the market YTM would estimate a different value for the bond.

In contrast to the current market price, you will need to compute a future price (P_f) when estimating the expected realized (horizon) yield performance of alternative bonds. Investors or portfolio managers who consistently trade bonds for capital gains need to compute expected realized (horizon) yield rather than promised yield. They would compute P_f through the following variation of the realized yield equation:

➤19.5
$$P_f = \sum_{t=1}^{2n-2hp} \frac{C_i/2}{(1+i/2)^t} + \frac{P_p}{(1+i/2)^{2n-2hp}}$$

where:

P_f = the future selling price of the bond
P_p = the par value of the bond
n = the number of years to maturity
hp = the holding period of the bond (in years)
C_i = the annual coupon payment of bond i
i = the expected market YTM at the end of the holding period

This equation is a version of the present value model that is used to calculate the expected price of the bond at the end of the holding period *(hp)*. The term $2n - 2hp$ equals the bond's remaining term to maturity at the end of the investor's holding period, that is, the number of six-month periods remaining after the bond is sold. Therefore, the determination of P_f is based on four variables: two that are known and two that must be estimated by the investor.

Specifically, the coupon (C_i) and the par value (P_p) are given. The investor must forecast the length of the holding period and, therefore, the number of years remaining to maturity at the time the bond is sold ($n - hp$). The investor also must forecast the expected market YTM at the time of sale *(i)*. With this information, you can calculate the future price of the bond. The real difficulty (and the potential source of error) in estimating P_f lies in predicting *hp* and *i*.

Assume you bought the 10 percent, 25-year bond just discussed at $842, giving it a promised YTM of 12 percent. Based on an analysis of the economy and the capital market, you expect this bond's market YTM to decline to 8 percent in five years. Therefore, you want to compute its future price (P_f) at the end of year 5 to estimate your expected rate of return, assuming you are correct in your assessment of the decline in overall market interest rates. As noted, you estimate the holding period (5 years), which implies a remaining life of 20 years, and the market YTM of 8 percent. Using Equation 19.5 gives a future price:

$$\begin{aligned} P_f &= 50\sum_{t=1}^{40}\frac{1}{(1.04)^t} + 1{,}000\frac{1}{(1.04)^{40}} \\ &= 50(19.7928) + 1{,}000(0.2083) \\ &= 989.64 + 208.30 \\ &= \$1{,}197.94 \end{aligned}$$

Subsequently, we will use this estimate of the selling price in our calculation of the realized (horizon) yield on this investment.

Realized (Horizon) Yield with Differential Reinvestment Rates

The realized yield equation—Equation 19.4—is the standard present value formula with the changes in holding period and ending price. As such, it includes the implicit reinvestment rate assumption that all cash flows are reinvested at the computed *i* rate. There may be instances where such an implicit assumption is not appropriate, given your expectations for future interest rates. Assume that current market interest rates are very high and you invest in a long-term bond (e.g., a 20-year, 14 percent coupon) to take advantage of an expected decline in rates from 14 percent to 10 percent over a 2-year period. Computing the future price (equal to $1,330.95) and using the realized yield equation to estimate the realized (horizon) yield, we will get the following fairly high realized rate of return:

$$\begin{aligned} P_m &= \$1{,}000 \\ hp &= 2 \text{ Years} \\ P_f &= \sum_{t=1}^{36} 70/(1+0.05)^t + \$1{,}000/(1.05)^{36} \\ &= \$1{,}158.30 + \$172.65 \\ &= \$1{,}330.95 \end{aligned}$$

$$\$1{,}000 = \sum_{t=1}^{4}\frac{70}{(1+i/2)^t} + \frac{1{,}330.95}{(1+i/2)^4}$$

$$i = 27.5\%$$

As noted, this calculation assumes that all cash flows are reinvested at the computed *i* (27.5 percent). However, it is unlikely that during a period when market rates are going from 14 percent to 10 percent, you could reinvest the coupon at 27.5 percent. It is more appropriate and realistic to *explicitly estimate the reinvestment rates* and calculate the realized yields based on your *ending-wealth position.* This procedure is more precise and realistic, and it is easier because it does not require iteration.

The basic technique calculates the value of all cash flows at the end of the holding period, which is the investor's ending-wealth value. We compare this ending-wealth value to our *beginning-wealth value* to determine the *compound rate of return that equalizes these two values.* Adding to our prior example, assume we have the following cash flows:

P_m = \$1,000
i = Interest Payments of \$70 in 6, 12, 18, and 24 Months
P_f = \$1,330.95 (the Ending Market Value of the Bond)

The ending value of the four interest payments is determined by our assumptions regarding specific reinvestment rates. Assume each payment is reinvested at a different declining rate that holds for its time period (that is, the first three interest payments are reinvested at progressively lower rates and the fourth interest payment is received at the end of the holding period).

$$
\begin{aligned}
i_1 \text{ at } 13\% \text{ for 18 Months} &= \$70 \times (1 + 0.065)^3 = \$\ \ 84.55 \\
i_2 \text{ at } 12\% \text{ for 12 Months} &= \$70 \times (1 + 0.06)^2 \ \ = \ \ 78.65 \\
i_3 \text{ at } 11\% \text{ for 6 Months} &= \$70 \times (1 + 0.055) \ \ = \ \ 73.85 \\
i_4 \text{ Not Reinvested} &= \$70 \times (1.0) \qquad\ \ = \ \ 70.00 \\
\text{Future Value of Interest Payments} &= \$307.05
\end{aligned}
$$

Therefore, our total ending-wealth value is

$$\$1{,}330.95 + \$307.05 = \$1{,}638.00$$

The compound realized (horizon) rate of return is calculated by comparing our ending-wealth value (\$1,638) to our beginning-wealth value (\$1,000) and determining what interest rate would equalize these two values over a two-year holding period. To find this, compute the ratio of ending wealth to beginning wealth (1.638). Find this ratio in a compound value table for four periods (assuming semiannual compounding). Table C.3 at the end of the book indicates that the realized rate is somewhere between 12 percent (1.5735) and 14 percent (1.6890). Interpolation gives an estimated semiannual rate of 13.16 percent, which indicates an annual rate of 26.32 percent. Using a calculator or computer, it is equal to $(1.638)^{1/4} - 1$. This compares to an estimate of 27.5 percent when we assume an implicit reinvestment rate of 27.5 percent.

This realized (horizon) yield computation specifically states the expected reinvestment rates as contrasted to assuming the reinvestment rate is equal to the computed realized yield. The actual assumption regarding the reinvestment rate can be very important.

The steps to calculate an expected realized (horizon) yield can be summarized as follows:

1. Calculate the future value at the horizon date of all coupon payments reinvested at estimated rates.
2. Calculate the expected sales price of the bond at your expected horizon date based on your estimate of the required yield to maturity at that time.
3. Sum the values in (1) and (2) to arrive at the total ending-wealth value.
4. Calculate the ratio of the ending-wealth value to the beginning value (the purchase price of the bond). Given this ratio and the time horizon, compute the compound rate of interest that will grow to this ratio over this time horizon.

$$\left(\frac{\text{Ending - Wealth Value}}{\text{Beginning Value}}\right)\frac{1}{2n} - 1$$

5. If all calculations assume semiannual compounding, double the interest rate derived from (4).

Price and Yield Determination on Noninterest Dates

So far, we have assumed that the investor buys (or sells) a bond precisely on the date that interest is due, so the measures are accurate only when the issues are traded on coupon payment dates.

However, when the semiannual model is used, and when more accuracy is necessary, another version of the price and yield model must be used for transactions on noninterest payment dates. Fortunately, the basic models need be extended only one more step because the value of an issue that trades X years, Y months, and so many days from maturity is found by extrapolating the bond value (price or yield) for the month before and the month after the day of transaction. Thus, the valuation process involves full months to maturity rather than years or semiannual periods.[6]

Accrued Interest Having computed a value for the bond at a noninterest payment date, it is also necessary to consider the notion of *accrued interest.* Because the interest payment on a bond, which is paid every six months, is a contractual promise by the issuer, the bond investor has the right to receive a portion of the semiannual interest payment if he/she held the bond for some part of the six-month period. For example, assume an 8 percent, $1,000 par value bond that pays $40 every six months. If you sold the bond two months after the prior interest payment, you have held it for one-third of the six-month period and would have the right to one-third of the $40 ($13.33). This is referred to as the accrued interest on the bond. Therefore, when you sell the bond, there is a calculation of the bond's remaining value until maturity, that is, its price. What you receive is this price *plus* the accrued interest ($13.33).

Yield Adjustments for Tax-Exempt Bonds

Municipal bonds, Treasury issues, and many agency obligations possess one common characteristic: Their interest income is partially or fully tax-exempt. This tax-exempt status affects the valuation of taxable versus nontaxable bonds. Although you could adjust each present value equation for the tax effects, it is not necessary for our purposes. We can envision the approximate impact of such an adjustment, however, by computing the fully taxable equivalent yield, which is one of the most often cited measures of performance for municipal bonds.

The **fully taxable equivalent yield (FTEY)** adjusts the promised yield computation for the bond's tax-exempt status. To compute the FTEY, we determine the promised yield on a tax-exempt bond using one of the yield formulas and then adjust the computed yield to reflect the rate of return that must be earned on a fully taxable issue. It is measured as

➤19.6
$$\text{FTEY} = \frac{i}{1 - T}$$

where:

i = the promised yield on the tax-exempt bond
T = the amount and type of tax exemption. (i.e., the investor's marginal tax rate)

For example, if the promised yield on the tax-exempt bond is 6 percent and the investor's marginal tax rate is 30 percent, the taxable equivalent yield would be

$$\text{FTEY} = \frac{0.06}{1 - 0.30} = \frac{0.06}{0.70} = 0.0857$$
$$= 8.57\%$$

[6]For a detailed discussion of these calculations, see Chapter 4 in Frank J. Fabozzi, ed., *The Handbook of Fixed-Income Securities,* 6th ed. (New York: McGraw-Hill, 2001).

The FTEY equation has some limitations. It is applicable only to par bonds or current coupon obligations, such as new issues, because the measure considers only interest income, ignoring capital gains, which are not tax-exempt. Therefore, we cannot use it for issues trading at a significant variation from par value (premium or discount).

Bond Yield Books

Bond value tables, commonly known as *bond books* or *yield books,* can eliminate most of the calculations for bond valuation. A bond yield table is like a present value interest factor table in that it provides a matrix of bond prices for a stated coupon rate, various terms to maturity (on the horizontal axis), and promised yields (on the vertical axis). Such a table allows you to determine either the promised yield or the price of a bond.

As might be expected, access to sophisticated calculators or computers has substantially reduced the need for and use of yield books. In addition, to truly understand alternative yield measures, you must master the present value model and its variations that generate values for promised YTM, promised YTC, realized (horizon) yield, and bond prices.

BOND VALUATION USING SPOT RATES

Thus far, we have used the valuation model, which assumes that we discount all cash flows by one common yield, reflecting the overall required rate of return for the bond. Similarly, we compute the yield on the bond (YTM, YTC, horizon yield) as the single interest rate that would discount all the flows from the bond to equal the current market price of the bond. It was noted in the YTM calculations that this was a "promised" yield that depended on two assumptions: holding the bond to maturity and reinvesting all cash flows at the computed YTM (the IRR assumption). Notably, this second assumption often is very unrealistic because it requires a flat, constant yield curve. We know that it is extremely rare for the yield curve to be flat, much less remain constant for any period of time. The yield curve typically is upward sloping for several reasons, which we discuss in a later section. Investors at any point in time require *a different rate of return for flows at different times.* For example, if investors are buying alternative zero coupon bonds (promising a single cash flow at maturity), they will almost always require different rates of return if they are offered a bond that matures in 2 years, 5 years, or 10 years.

As mentioned earlier, the rates used to discount a cash flow at a point in time are called spot rates. It is possible to demonstrate the desire for different rates by examining the rates on government discount notes with different maturities (i.e., spot rates) as of early 2002 as shown in Exhibit 19.4. These rates indicate that investors require 2.91 percent for a cash flow in 2 years, 4.28 percent for the cash flow in 5 years, and 4.85 percent for the cash flow in 10 years. These differences in required rates for alternative maturities are very noticeable. The difference in yield between the 1-year bond (2.14 percent) and the 30-year bond (5.40 percent) (referred to as the *maturity spread*) was 326 basis points in early 2002, which is a very large spread historically.

Because of these differences in spot rates across maturities, bond analysts and bond portfolio managers recognize that it is inappropriate to discount all the flows for a bond at one single rate where the rate used is often based on the yield to maturity for a government bond with a single maturity. For example, when asked about the value of a particular 20-year bond rated AA, a bond trader typically will respond that the bond should trade a certain number of basis points higher than comparable maturity Treasury bonds (e.g., "plus 70 basis points"). This means that if 20-year Treasury bonds are currently yielding 5.58 percent, this AA-rated bond should trade at about a 6.28 percent yield. Notably, this rate would determine the price for the bond with no con-

EXHIBIT 19.4 *YIELDS ON U.S. TREASURY STRIPS WITH ALTERNATIVE MATURITIES*

MATURITY	YIELD
1 Year	2.14
2 Years	2.91
3 Years	3.53
4 Years	4.01
5 Years	4.28
6 Years	4.48
7 Years	4.65
8 Years	4.82
9 Years	4.88
10 Years	4.85
12 Years	5.25
14 Years	5.39
16 Years	5.47
18 Years	5.54
20 Years	5.58
25 Years	5.60
30 Years	5.40

Source: *The Wall Street Journal,* 6 March 2002. Reprinted with permission from *The Wall Street Journal,* Dow Jones Co. Inc.

sideration given to the specific cash flows of this security (i.e., high or low coupon). Therefore, there is a growing awareness that the valuation formula should be specified such that *all cash flows should be discounted at spot rates consistent with the timing of the flows* as follows:

19.7
$$P_m = \sum_{t=1}^{2n} \frac{C_t}{(1+i_t/2)^t}$$

where:

P_m = the market price for the bond
C_t = the cash flow at time t
n = the number of years
i_t = the spot rate for Treasury securities at maturity t

Note that this valuation model requires a different discount rate for each flow so it is not possible to use the annuity concept. Also, the principal payment at the end of the year n is no different from the interest coupon flow at year n.

To demonstrate the effect of this procedure, consider the following hypothetical spot rate curve for the next five years (in Exhibit 19.5) and three example bonds with equal maturities of five years, but with very different cash flows.

Beyond the differences in value because of the differences in cash flows and the rising spot rate curve, a significant comparison is the value that would be derived using a single discount

EXHIBIT 19.5 *DEMONSTRATION OF DIFFERENT VALUATION OF ALTERNATIVE FIVE-YEAR MATURITY BONDS WITH UNIQUE CASH FLOWS, DISCOUNTED USING THE SPOT RATE CURVE*

			CASH FLOWS					
			BOND A		BOND B		BOND C	
Maturity (Years)	Spot Rate	Discount Factor	$	PV	$	PV	$	PV
0.5	5.00	0.9756	60	$ 58.536	30	$ 29.268	—	—
1.0	5.20	0.9499	60	56.994	30	28.497	—	—
1.5	5.50	0.9218	60	55.308	30	27.654	—	—
2.0	5.70	0.8937	60	53.622	30	26.811	—	—
2.5	5.80	0.8668	60	52.008	30	26.004	—	—
3.0	5.90	0.8399	60	50.394	30	25.197	—	—
3.5	6.10	0.8103	60	48.618	30	24.309	—	—
4.0	6.30	0.7803	60	46.818	30	23.409	—	—
4.5	6.40	0.7532	60	45.192	30	22.596	—	—
5.0	6.50	0.7270	1,060	770.620	1,030	748.810	1,000	727.00
Total present value				$1,238.110		$982.555		$727.00

rate based on the five-year maturity of all three bonds. If we assume two alternative yields to maturity of 6 percent and 6.5 percent for five-year bonds, the values for the three bonds are:

	6%	6.5%
Bond A	$ 60 × 8.5302 = $ 511.81	$ 60 × 8.4254 = $ 505.52
	$1,000 × 0.7441 = 744.10	$1,000 × 0.7270 = 727.00
	Total Value = $1,255.91	= $1,232.52
Bond B	$ 30 × 8.5302 = $ 255.90	$ 30 × 8.4254 = $ 252.76
	$1,000 × 0.7441 = 744.10	$1,000 × 0.7270 = 727.00
	Total Value = $1,000.00	= $ 979.76
Bond C	$1,000 × 0.7441 = $ 744.10	$1,000 × 0.7270 = $ 727.00
	Total Value = $ 744.10	= $ 727.00

Because there is a rising spot-yield curve, we know the YTM would be somewhere between these two values. The point is, under these conditions valuing the bonds with a single high rate tends to generate a value that is lower than that derived from the spot rate curve. This implies that a single-rate valuation technique would typically misvalue these bonds relative to the more appropriate technique that considers each flow as a single bond discounted by its own spot rate.

What Determines Interest Rates?

Now that we have learned to calculate various yields on bonds and to determine the value of bonds using yields and spot rates, the question arises as to what causes differences and changes in yields over time. Market interest rates cause these effects because the interest rates reported in the media are simply the prevailing YTMs for the bonds being discussed. For example, when you hear that the interest rate on long-term government bonds declined from 6.80 percent to 6.70 percent, this means that the price of this particular bond increased such that the computed YTM at the former price was 6.80 percent, but the computed YTM at the new, higher price is 6.70 percent. Yields and interest rates are the same. They are different terms for the same concept.

We have discussed the inverse relationship between bond prices and interest rates. When interest rates decline, the prices of bonds increase; when interest rates rise, there is a decline in bond prices. It is natural to ask which of these is the driving force—bond prices or bond interest rates? It is a simultaneous change, and you can envision either factor causing it. Most practitioners probably envision the changes in interest rates as causes because they constantly use interest rates to describe changes. They use interest rates because they are comparable across bonds, whereas the price of a bond depends not only on the interest rate but also on the bond's specific characteristics, including its coupon and maturity. The point is, as demonstrated in Exhibit 19.1 and Exhibit 19.2, when you change the interest rate (yield) on a bond, you simultaneously change its price in the opposite direction. Later in the chapter we will discuss the specific price-yield relationship for individual bonds and demonstrate that this price-yield relationship differs among bonds based on their particular coupon and maturity.

Understanding interest rates and what makes them change is necessary for an investor who hopes to maximize returns from investing in bonds. Therefore, in this section we review our prior discussion of the following topics: what causes overall market interest rates to rise and fall, why alternative bonds have different interest rates, and why the difference in rates (i.e., the yield spread) between alternative bonds changes over time. To accomplish this, we begin with a general discussion of what influences interest rates and then consider the **term structure of interest rates** (shown by yield curves), which relates the interest rates on a set of comparable bonds to their terms to maturity. The term structure is important because it implies a set of spot rates that can be used in the valuation of bonds. In addition, it reflects what investors expect to happen to interest rates in the future and it dictates their current risk attitude. In this section, we specifically consider the calculation of spot rates and forward rates from the reported yield curve. Finally, we turn to the concept of *yield spreads,* which measure the differences in yields between alternative bonds. We describe various yield spreads and explore changes in them over time.

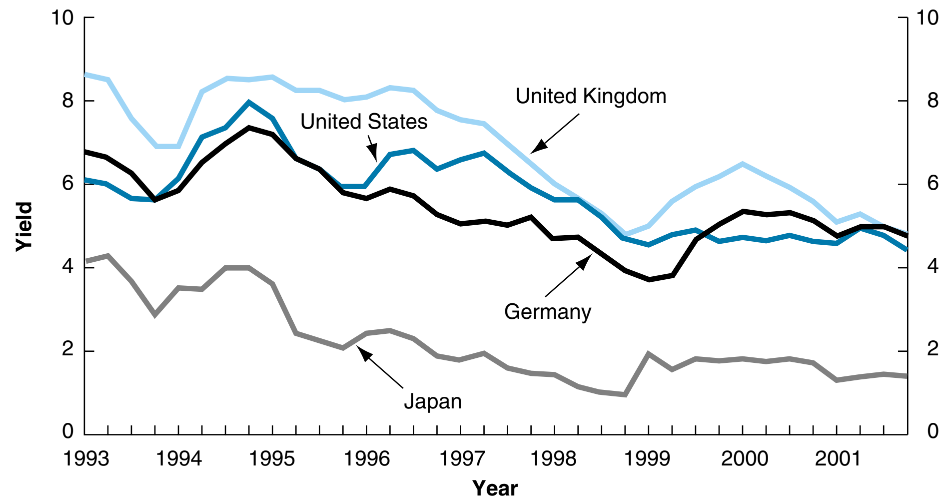
Forecasting Interest Rates

As discussed, the ability to forecast interest rates and changes in these rates is critical to successful bond investing. Later, we consider the major determinants of interest rates, but for now you should keep in mind that interest rates *are the price for loanable funds.* Like any price, they are determined by the supply and demand for these funds. On the one side, investors are willing to provide funds (the supply) at prices based on their required rates of return for a particular borrower. On the other side, borrowers need funds (the demand) to support budget deficits (government), to invest in capital projects (corporations), or to acquire durable goods (cars, appliances) or homes (individuals).

Although lenders and borrowers have some fundamental factors that determine supply and demand curves, the prices for these funds (interest rates) also are affected for short periods by events that shift the curves. Examples include major government bond issues that affect demand for funds, or significant changes in Federal Reserve monetary policy that affect the supply of money.

Our treatment of interest rate forecasting recognizes that you must be aware of the basic determinants of interest rates and monitor these factors. We also recognize that detailed forecasting of interest rates is a very complex task that is best left to professional economists. Therefore, our goal as bond investors and bond portfolio managers is to monitor current and expected interest rate behavior. We should attempt to continuously assess the major factors that affect interest rate behavior but also rely on others—such as economic consulting firms, banks, or investment

EXHIBIT 19.6 *YIELDS OF INTERNATIONAL LONG-TERM GOVERNMENT BONDS: QUARTERLY 1993–2001*



Source: International Monetary Fund, *International Financial Statistics.*

banking firms—for detailed insights on such topics as the real *RFR* and the expected rate of inflation.[7] This is precisely the way most bond portfolio managers operate.

Fundamental Determinants of Interest Rates

As shown in Exhibit 19.6, average interest rates (yields) for long-term (10-year) U.S. government bonds during the period from 1993 through 2001, went from about 6.20 percent to less than 5 percent. These results were midway between those of the United Kingdom and Germany. U.K. bonds went from about 8.70 percent to almost 4 percent, while the rate on Japanese government bonds declined from 4 percent to 1.5 percent. As a bond investor, you should understand *why* these differences exist and *why* interest rates changed.

As you know from your knowledge of bond pricing, bond prices increased dramatically during periods when market interest rates dropped, and some bond investors experienced very attractive returns. In contrast, some investors experienced substantial losses during periods when interest rates increased. A casual analysis of this chart, which covers about nine years, indicates the need for monitoring interest rates. Essentially, the factors causing interest rates *(i)* to rise or fall are described by the following model:

$$i = RFR + I + RP \tag{19.8}$$

where:

RFR = the real risk-free rate of interest
I = the expected rate of inflation
RP = the risk premium

[7]Sources of information on the bond market and interest rate forecasts would include Merrill Lynch's *Fixed Income Weekly* and *World Bond Market Monitor;* Goldman Sach's *Financial Market Perspectives* and *The Pocket Chartroom;* and the Federal Reserve Bank of St. Louis, *Monetary Trends.*

The relationship shown in this equation should be familiar from our presentations in Chapter 1 and Chapter 11. It is a simple but complete statement of interest rate behavior. The more difficult task is estimating the *future* behavior of such variables as real growth, expected inflation, and economic uncertainty. In this regard, interest rates, like stock prices, are extremely difficult to forecast with any degree of accuracy.[8] Alternatively, we can visualize the source of changes in interest rates in terms of the economic conditions and issue characteristics that determine the rate of return on a bond:

➤19.9
$$\begin{aligned} i &= f\,(\text{Economic Forces} + \text{Issue Characteristics}) \\ &= (RFR + I) + RP \end{aligned}$$

This rearranged version of the previous equation helps isolate the determinants of interest rates.[9]

Effect of Economic Factors The real risk-free rate of interest *(RFR)* is the economic cost of money, that is, the opportunity cost necessary to compensate individuals for forgoing consumption. It is determined by the real growth rate of the economy with short-run effects due to ease or tightness in the capital market.

The expected rate of inflation is the other economic influence on interest rates. We add the expected level of inflation *(I)* to the real risk-free rate *(RFR)* to specify the nominal *RFR,* which is a market rate like the current rate on government T-bills. Given the stability of the real *RFR,* it is clear that the wide swings in nominal risk-free interest rates during the years covered by Exhibit 19.6 occurred because of expected inflation.[10] Besides the unique country and exchange rate risk that we discuss in the section on risk premiums, differences in the rates of inflation between countries have a major impact on their level of interest rates.

To sum up, one way to estimate the nominal *RFR* is to begin with the real growth rate of the economy, adjust for short-run ease or tightness in the capital market, and then adjust this real rate of interest for the expected rate of inflation.

Another approach to estimating the nominal rate or changes in the rate is the macroeconomic view, where the supply and demand for loanable funds are the fundamental economic determinants of *i.* As the supply of loanable funds increases, the level of interest rates declines, other things being equal. Several factors influence the supply of funds. Government monetary policies imposed by the Federal Reserve have a significant impact on the supply of money. The savings patterns of U.S. and non-U.S. investors also affect the supply of funds. Non-U.S. investors have become a stronger influence on the U.S. supply of loanable funds during recent years, as shown by the significant purchases of U.S. securities by non-U.S. investors. It is widely acknowledged that this foreign supply of funds to the U.S. bond market has been very beneficial to the United States because it has helped reduce interest rates and the cost of capital.

Interest rates increase when the demand for loanable funds increases. The demand for loanable funds is affected by the capital and operating needs of the U.S. government, federal agencies, state and local governments, corporations, institutions, and individuals. Federal budget deficits increase the Treasury's demand for loanable funds. Likewise, the level of consumer demand for funds to buy houses, autos, and appliances affects rates, as does corporate demand

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[8]For an overview of interest rate forecasting, see Frank J. Fabozzi, "The Structure of Interest Rates," in *The Handbook of Fixed-Income Securities,* 6th ed., ed. Frank J. Fabozzi (New York: McGraw-Hill, 2001).

[9]For an extensive exploration of interest rates and interest rate behavior, see James C. Van Horne, *Financial Market Rates and Flows,* 5th ed. (Englewood Cliffs, N.J.: Prentice-Hall, 1998).

[10]In this regard, see C. Alan Garner, "How Useful Are Leading Indicators of Inflation?" Federal Reserve Bank of Kansas City *Economic Review* 80, no. 2 (Second Quarter 1995): 5–18.

for funds to pursue investment opportunities. The total of all groups determines the aggregate demand and supply of loanable funds and the level of the nominal *RFR*.[11]

The Impact of Bond Characteristics The interest rate of a specific bond issue is influenced not only by all the factors that affect the nominal *RFR* but also by the unique issue characteristics of the bond. These issue characteristics influence the bond's risk premium *(RP)*. The economic forces that determine the nominal *RFR* affect all securities, whereas issue characteristics are unique to individual securities, market sectors, or countries. Thus, the differences in the yields of corporate and Treasury bonds are caused not by economic forces but, rather, by different issue characteristics that cause differences in the risk premiums.

Bond investors separate the risk premium into four components:

1. The quality of the issue as determined by its risk of default relative to other bonds
2. The term to maturity of the issue, which can affect price volatility
3. Indenture provisions, including collateral, call features, and sinking-fund provisions
4. Foreign bond risk, including exchange rate risk and country risk

Of the four factors, quality and maturity have the greatest impact on the risk premium for domestic bonds, while exchange rate risk and country risk are important components of risk for non-U.S. bonds.

The credit quality of a bond reflects the ability of the issuer to service outstanding debt obligations. This information is largely captured in the ratings issued by the bond rating firms. As a result, bonds with different ratings have different yields. For example, AAA-rated obligations possess lower risk of default than BBB obligations, so they can provide lower yield.

Notably, the risk premium differences between bonds of different quality levels have changed dramatically over time, depending on prevailing economic conditions. When the economy experiences a recession or a period of economic uncertainty, the desire for quality increases, and investors bid up prices of higher-rated bonds, which reduces their yields. This difference in yield is referred to as the *quality spread.* It also has been suggested by Dialynas and Edington that this yield spread is influenced by the volatility of interest rates.[12] This variability in the risk premium over time was demonstrated and discussed in Chapter 1 and Chapter 11. The U.S. market experienced dramatic demonstrations of short-run risk premium explosions in August 1998 in response to Russia defaulting on its debt and following the terrorist attacks on September 11, 2001.

Term to maturity also influences the risk premium because it affects the price volatility of the bond. In the section on the term structure of interest rates, we will discuss the typical positive relationship between the term to maturity of a bond issue and its interest rate.

As discussed in Chapter 18, indenture provisions indicate the collateral pledged for a bond, its callability, and its sinking-fund provisions. Collateral gives protection to the investor if the issuer defaults on the bond because the investor has a specific claim on some assets in case of liquidation.

Call features indicate when an issuer can buy back the bond prior to its maturity. A bond is called by an issuer when interest rates have declined, so it is not to the advantage of the investor who must reinvest the proceeds at a lower interest rate. Obviously, an investor will charge the

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[11]For an example of an estimate of the supply and demand for funds in the economy, see *Prospects for Financial Markets in 1999* (New York: Salomon Bros. Smith Barney, 1998). This is an annual publication of Salomon Brothers Smith Barney that gives an estimate of the flow of funds in the economy and discusses its effect on various currencies and interest rates.

[12]Chris P. Dialynas and David H. Edington, "Bond Yield Spreads: A Postmodern View," *Journal of Portfolio Management* 19, no. 1 (Fall 1992): 68–75.

issuer for including the call option, and the cost of the option (which is a higher yield) will increase with the level of interest rates. Therefore, more protection against having the bond called reduces the risk premium. The significance (value) of call protection increases during periods of high interest rates. The point is, when you buy a bond with a high coupon, you want protection from having it called away when rates decline.[13]

A sinking fund reduces the investor's risk and causes a lower yield for several reasons. First, a sinking fund reduces default risk because it requires the issuer to reduce the outstanding issue systematically. Second, purchases of the bond by the issuer to satisfy sinking-fund requirements provide price support for the bond because of the added demand. These purchases by the issuer also contribute to a more liquid secondary market for the bond because of the increased trading. Finally, sinking-fund provisions require that the issuer retire a bond before its stated maturity, which causes a reduction in the issue's average maturity. The decline in average maturity tends to reduce the risk premium of the bond much as a shorter maturity would reduce yield.[14]

We know that foreign currency exchange rates change over time and that this increases the risk of global investing. The variability of exchange rates vary among countries because the trade balances and rates of inflation differ. Volatile trade balances, and inflation rates make exchange rates more volatile, which adds to the uncertainty of future exchange rates and increases the exchange rate risk premium.

In addition to changes in exchange rates, investors also are concerned with the political and economic stability of a country. If investors are unsure about the political environment or the economic system in a country, they will increase the required risk premium to reflect this country risk.[15]

Term Structure of Interest Rates

The term structure of interest rates (or the *yield curve,* as it is more popularly known) is a static function that relates the term to maturity to the yield to maturity for a sample of bonds at *a given point in time.*[16] Thus, it represents a cross section of yields for a category of bonds that are comparable in all respects but maturity. Specifically, the quality of the issues should be constant, and ideally you should have issues with similar coupons and call features within a single industry category. You can construct different yield curves for Treasuries, government agencies, prime-grade municipals, AAA utilities, and so on. The accuracy of the yield curve will depend on the comparability of the bonds in the sample.

As an example, Exhibit 19.7 shows yield curves for a sample of U.S. Treasury obligations. It is based on the yield to maturity information for a set of comparable Treasury issues from a publication such as the *Federal Reserve Bulletin* or *The Wall Street Journal.* These promised yields were plotted on the graph, and a yield curve was drawn that represents the general configuration of rates. These data represent yield curves at four different points in time to demonstrate the changes in yield levels and in the shape of the yield curve over time.

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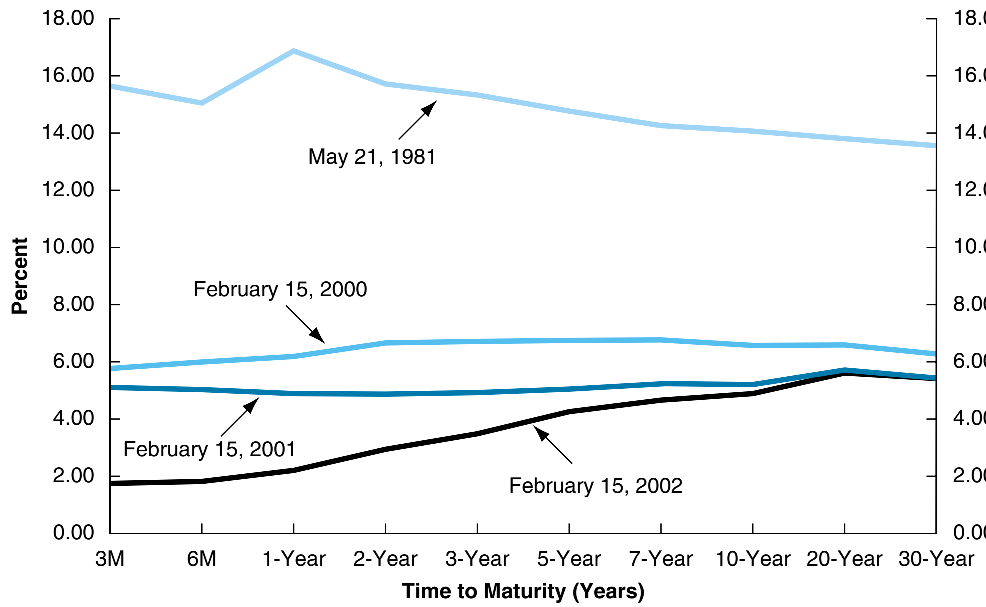
[13]William Marshall and Jess B. Yawitz, "Optimal Terms of the Call Provision on a Corporate Bond," *Journal of Financial Research* 3, no. 3 (Fall 1980): 203–211; Bryan Stanhouse and Duane Stock, "How Changes in Bond Call Features Affect Coupon Rates," *Journal of Applied Corporate Finance* 12, no. 1 (Spring 1999): 92–99.

[14]For a further discussion of sinking funds, see A. J. Kalotay, "On the Management of Sinking Funds," *Financial Management* 10, no. 2 (Summer 1981): 34–40; and A. J. Kalotay, "Sinking Funds and the Realized Cost of Debt," *Financial Management* 11, no. 1 (Spring 1982): 43–54.

[15]In this regard, see Allen A. Vine, "High-Yield Analysis of Emerging Markets Debt," in *The Handbook of Fixed-Income Securities,* 6th ed.

[16]For a discussion of the theory and empirical evidence, see Suresh Sundaresan, *Fixed-Income Markets and Their Derivatives,* 2d ed. (Cincinnati, Ohio: South-Western, 2002), Chapter 6.

EXHIBIT 19.7 *YIELD ON U.S. TREASURY STRIPS WITH ALTERNATIVE MATURITIES*



Source: Federal Reserve System Statistics.

All yield curves, of course, do not have the same shape as those in Exhibit 19.7. Although individual yield curves are static, their behavior over time is quite fluid. As shown, the level of the curve decreased from May 1981 to February 2000 and then declined further by February 2001, and the short end of the curve declined further by February 2002. Also, the shape of the yield curve can undergo dramatic alterations, following one of the four patterns shown in Exhibit 19.8. The rising yield curve is the most common and tends to prevail when interest rates are at low or modest levels. The declining yield curve tends to occur when rates are relatively high. The flat yield curve rarely exists for any period of time. The humped yield curve prevails when extremely high rates are expected to decline to more normal levels. Note that the slope of the yield curve tends to level off after 15 years.

Why does the term structure assume different shapes? Three major theories attempt to explain this: the expectations hypothesis, the liquidity preference hypothesis, and the segmented market hypothesis.

Before we discuss these three alternative hypotheses, we must first discuss two previously noted rates that not only are an integral part of the term structure but also are important in the valuation of bonds. The next two subsections will deal with the specification and computation of *spot rates* and *forward rates.* Earlier, we discussed and used spot rates to value bonds with the idea that any coupon bond can be viewed as a collection of zero coupon securities.

Creating the Theoretical Spot Rate Curve[17] Earlier in the chapter, we discussed the notion that the yield on a zero coupon bond for a given maturity is the spot rate for the maturity.

[17]This discussion of the theoretical spot rate curve and the subsequent presentation on calculating forward rates draw heavily from Frank J. Fabozzi, "The Structure of Interest Rates," in *The Handbook of Fixed-Income Securities,* 6th ed.

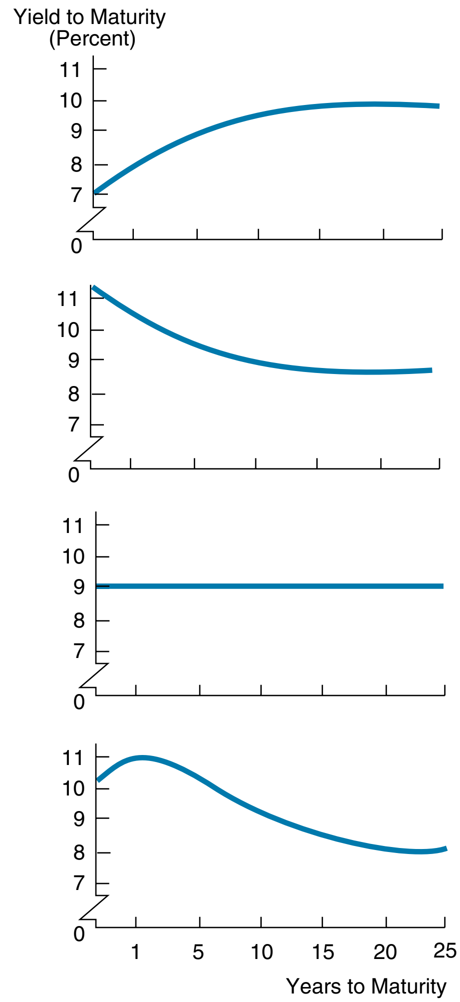
EXHIBIT 19.8 *TYPES OF YIELD CURVES*

A rising yield curve is formed when the yields on short-term issues are low and rise consistently with longer maturities and flatten out at the extremes.

A declining yield curve is formed when the yields on short-term issues are high and yields on subsequently longer maturities decline consistently.

A flat yield curve has approximately equal yields on short-term and long-term issues.

A humped yield curve is formed when yields on intermediate-term issues are above those on short-term issues and the rates on long-term issues decline to levels below those for the short term and then level out.



Specifically, the **spot rate** is defined as the discount rate for a cash flow at a specific maturity. At that time, we used the rates on a series of zero coupon government bonds created by stripping coupon government bonds.

In this case, we will construct a theoretical spot rate curve from the observable yield curve that is based on the existing yields of Treasury bills and the most recent Treasury coupon securities (referred to as *on-the-run* Treasury issues). One might expect the theoretical spot rate curve and the spot rate curve derived from the stripped zero coupon bonds used earlier to be the same. The fact is, while they are close, they will not be exactly the same because the stripped zero coupon bonds will not be as liquid as the on-the-run issues. In addition, there are instances where institutions will have a strong desire for a particular spot maturity and this preference will distort the term structure relationship. Therefore, while it is possible to use the stripped zero coupon curve for a general indication, if you are going to use the spot rates for significant valuation, you would want to use the theoretical spot rate curve.

EXHIBIT 19.9 *MATURITY AND YIELD TO MATURITY FOR HYPOTHETICAL TREASURY SECURITIES*

Maturity (Years)	Coupon Rate	Price	Yield to Maturity
0.50	0.0000	96.15	0.0800
1.00	0.0000	92.19	0.0830
1.50	0.0850	99.45	0.0890
2.00	0.0900	99.64	0.0920
2.50	0.1100	103.49	0.0940
3.00	0.0950	99.49	0.0970

Sources: Federal Reserve Bulletin; Mergent Bond Record. Reprinted with permission.

The process of creating a theoretical spot rate curve from coupon securities is called *bootstrapping* wherein it is assumed that the value of the Treasury coupon security should be equal to the value of the package of zero coupon securities that duplicates the coupon bond's cash flow. Exhibit 19.9 lists the maturity and YTM for six hypothetical Treasury bonds that will be used to calculate the initial spot rates.

Consider the six-month Treasury bill in Exhibit 19.9. As discussed earlier, a Treasury bill is a zero coupon instrument so its annualized yield of 8 percent is equal to the spot rate. Similarly, for the one-year Treasury bill, the cited yield of 8.3 percent is equal to 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 for this 1.5-year security should equal the present value of three cash flows from an actual 1.5-year coupon Treasury, where the yield used for discounting a specific coupon payment is the spot rate corresponding to the cash flow.

Using $100 as par, the *cash flow* for the 1.5-year, 8.50 percent coupon Treasury is as follows:

0.5 years	$0.085 \times \$100 \times 0.5$	=	$ 4.25
1.0 years	$0.085 \times \$100 \times 0.5$	=	$ 4.25
1.5 years	$0.085 \times \$100 \times 0.5 + \$100$	=	$104.25

The present value of the cash flows discounted at the appropriate spot rates 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 percent and 8.3 percent, respectively, we know that

$$z_1 = 0.04 \qquad \textit{and} \qquad z_2 = 0.0415$$

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 19.9) 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:

$$99.45 = 4.08654 + 3.91805 + \frac{104.25}{(1+z_3)^3}$$

$$91.44541 = \frac{104.25}{(1+z_3)^3}$$

$$\frac{104.25}{91.44541} = (1+z_3)^3$$

$$(1+z_3)^3 = 1.140024$$

$$z_3 = 0.04465$$

Doubling this yield, we obtain the bond-equivalent yield of 0.0893 or 8.93 percent, which is the theoretical 1.5-year spot rate. That rate is the rate that the market would apply to a 1.5-year zero coupon Treasury, if such a security existed.

Given the theoretical 1.5-year spot rate, we can obtain the theoretical 2-year spot rate. The cash flow for the 2-year, 9.0 percent coupon Treasury in Exhibit 19.9 is

0.5 years	$0.090 \times \$100 \times 0.5$	=	\$ 4.50
1.0 years	$0.090 \times \$100 \times 0.5$	=	\$ 4.50
1.5 years	$0.090 \times \$100 \times 0.5$	=	\$ 4.50
2.0 years	$0.090 \times \$100 \times 0.5 + 100$	=	\$104.50

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 6-month, 1-year, and 1.5-year spot rates are 8 percent, 8.3 percent, and 8.93 percent, respectively, then

$$z_1 = 0.04 \quad z_2 = 0.0415 \qquad \textit{and} \qquad z_3 = 0.04465$$

EXHIBIT 19.10 *THEORETICAL SPOT RATES*

Maturity (Years)	Yield to Maturity	Theoretical Spot Rate
0.50	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

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, 9.0 percent 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 percent.

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, z_4 (the 6-month, 1-year, 1.5-year, and 2-year spot rates), and the price and the coupon of the bond with a maturity of 2.5 years. Subsequently, one could derive the theoretical spot rate for three years. The spot rates thus obtained are shown in Exhibit 19.10. They represent the term structure of spot interest rates for maturities up to three years, based on the prevailing bond price quotations.

As shown, with a rising YTM curve, the theoretical spot rate will increase at a faster rate such that the difference increases with maturity (i.e., the theoretical spot rate curve will be above a positively sloped YTM curve).

CALCULATING FORWARD RATES FROM THE SPOT RATE CURVE

Now that we have derived the theoretical spot rate curve, it is possible to determine what this curve implies regarding the market's expectation of *future* short-term rates, which are referred to as *forward rates.* The following illustrates the process of extrapolating this information about expected future interest 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 on 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 six months from now. The yield on a six-month Treasury bill six months from now is called a **forward rate**. Given the spot rate for the six-month Treasury bill and the one-year bill, we can determine the forward rate on a six-month Treasury bill *that will make the investor indifferent between the two alternatives.*

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 = one-half the bond-equivalent yield of the theoretical one-year spot rate

Second, suppose 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 = one-half the bond-equivalent yield of the theoretical six-month spot rate

Let ${}_{t+0.5}r_{0.5}$ represent one-half the forward rate (expressed as a bond-equivalent yield) on a six-month Treasury bill (0.5) available six months from now ($t + 0.5$). If the investor were to renew her investment by purchasing that bill at that time, then the future dollars available at the end of the year from the \$X investment would be

$$X(1 + z_1)(1 + {}_{t+0.5}r_{0.5}) = 100$$

Third, it is easy to use that formula to find out how many dollars the investor must invest in order to get \$100 one year from now. This can be found as follows:

$$X(1 + z_1)(1 + {}_{t+0.5}r_{0.5}) = 100$$

which gives us

$$X = \frac{100}{(1+z_1)(1+{}_{t+0.5}r_{0.5})}$$

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

$$\frac{100}{(1+z_2)^2} = \frac{100}{(1+z_1)(1+{}_{t+0.5}r_{0.5})}$$

Solving for ${}_{t\,+\,0.5}\,r_{0.5}$ we get

$${}_{t+0.5}r_{0.5} = \frac{(1+z_2)^2}{(1+z_1)} - 1$$

Doubling r 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 19.10. From that table, we know that

Six-month bill spot rate = 0.080 so z_1 = 0.0400
One-year bill spot rate = 0.083 so z_2 = 0.0415

Substituting into the formula, we have

$$\begin{aligned} {}_{t+0.5}r_{0.5} &= \frac{(1.0415)^2}{(1.0400)} - 1 \\ &= 0.043 \end{aligned}$$

Therefore, the forward rate six months from now (t + 0.5) on a six-month Treasury security, quoted annually, is 8.6 percent (0.043 × 2). Let us confirm our results. The price of a one-year Treasury bill with \$100 maturity is

$$\frac{100}{(1.0415)^2} = 92.19$$

If \$92.19 is invested for six months at the six-month spot rate of 8 percent, 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 bill offering 4.3 percent for six months (8.6 percent 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 percent (8.6 percent on a bond-equivalent basis). This means that, if an investor is guaranteed a 4.3 percent yield 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 called the *implied forward rate.*

It is possible to use the yield curve to calculate the implied forward rate for any time in the future for any investment horizon. This would include six-month or one-year forward rates for each year in the future. The one-year forward rates would be designated as follows:

$_{t+1}r_1$ = the one-year forward rate, one year from now ($t + 1$)
$_{t+2}r_1$ = the one-year forward rate, two years from now ($t + 2$)
$_{t+3}r_1$ = the one-year forward rate, three years from now ($t + 3$)

Given the calculations, it is clear that with a rising spot rate curve, the forward rate curve would be above the spot rate curve. From Exhibit 19.10, we have the following one-year spot rates, which imply the following one-year forward rates:

MATURITY (YEARS)	SPOT RATES	ONE–YEAR FORWARD RATES
1.0	0.08300	
2.0	0.09247	0.1020
3.0	0.09787	0.1087

Therefore:

$$_{t+1}r_1 = \frac{(1.09247)^2}{(1.08300)} - 1 = \frac{1.19349}{1.08300} - 1 = 0.1020$$

$$_{t+2}r_1 = \frac{(1.09787)^3}{(1.09247)^2} - 1 = \frac{1.32328}{1.19349} - 1 = 0.1087$$

Specifically, the one–year forward rate that is expected one year from now ($_{t+1}r_1$) is 10.20 percent, while the one-year forward rate that is expected two years from now ($_{t+2}r_1$) is 10.87 percent.

TERM-STRUCTURE THEORIES

Expectations Hypothesis

According to the expectations hypothesis, the shape of the yield curve results from the interest rate expectations of market participants. More specifically, it holds that *any long-term interest rate simply represents the geometric mean of current and future one-year interest rates expected to prevail over the maturity of the issue.* In essence, the term structure involves a series of intermediate and long-term interest rates, each of which is a reflection of the geometric average of current and expected one-year interest rates. Under such conditions, the equilibrium long-term rate is the rate the long-term bond investor would expect to earn through successive investments in short-term bonds over the term to maturity of the long-term bond.

Generally, this relationship can be formalized as follows:

19.10
$$(1 + {_t}R_n) = [(1 + {_t}R_1)(1 + {_{t+1}}r_1) \ldots (1 + {_{t+n-1}}r_1)]^{1/N}$$

where:

R_n = the actual long-term rate
N = the term to maturity (in years) of long issue
R = the current one-year rate
$_{t+i}r_1$ = the expected one-year yield during some future period, $t + i$ (these future one-year rates are referred to as *forward rates*)

Given the relationship set forth in this equation, the formula for computing the one-period forward rate beginning at time $t + n$ and implied in the term structure at time t is

$$1 + {}_{t+n}r_{1t} = \frac{(1 + {}_tR_{1t})(1 + {}_{t+1}r_{1t})(1 + {}_{t+2}r_{1t})\ldots(1 + {}_{t+n-1}r_{1t})(1 + {}_{t+n}r_{1t})}{(1 + {}_tR_{1t})(1 + {}_{t+1}r_{1t})\ldots(1 + {}_{t+n-1}r_{1t})}$$

$$= \frac{(1 + {}_tR_{n+1})^{n+1}}{(1 + {}_tR_n)^n}$$

➤19.11

$${}_{t+n}r_{1t} = \frac{(1 + {}_tR_{n+1})^{n+1}}{(1 + {}_tR_n)^n} - 1$$

where ${}_{t+n}r_{1t}$ is the one-year forward rate prevailing at $t + n$, using the term structure at time t.

Assume that the five-year spot rate is 10 percent (${}_tR_5 = 0.10$) and the four-year spot rate is 9 percent (${}_tR_4 = 0.09$). The forward one-year rate four years from now implied by these spot rates can be calculated as follows:

$$\begin{aligned}{}_{t+4}r_{1t} &= \frac{(1 + {}_tR_5)^5}{(1 + {}_tR_4)^4} - 1 \\ &= \frac{(1 + 0.10)^5}{(1 + 0.09)^4} - 1 \\ &= \frac{1.6105}{1.4116} - 1 \\ &= 1.1409 - 1 = 0.1409 = 14.09\%\end{aligned}$$

The term structure at time t implies that the one-year spot rate four years from now (during Year 5) will be 14.09 percent. This concept and formula can be used to derive future rates for multiple years. Thus, the two-year spot rate that will prevail three years from now could be calculated using the three-year spot rate and the five-year spot rate. The general formula for computing the j-period forward rate beginning at time $t + n$ as of time t is

➤19.12

$${}_{t+n}r_{jt} = \sqrt[j]{\frac{(1 + {}_tR_{n+j})^{n+j}}{(1 + {}_tR_n)^n}} - 1$$

As a practical approximation of Equation 19.10, it is possible to use the *arithmetic* average of one-year rates to generate long-term yields.

The expectations theory can explain any shape of yield curve. Expectations for rising short-term rates in the future cause a rising yield curve; expectations for falling short-term rates in the future will cause long-term rates to lie below current short-term rates, and the yield curve will decline. Similar explanations account for flat and humped yield curves.

Consider the following explanation by the expectations hypothesis of the shape of the term structure of interest rates using arithmetic averages:

${}_tR_1$ = 5½ percent the one-year rate of interest prevailing now (period t)
${}_{t+1}r_1$ = 6 percent the one-year rate of interest expected to prevail next year (period $t + 1$)
${}_{t+2}r_1$ = 7½ percent the one-year rate of interest expected to prevail two years from now (period $t + 2$)
${}_{t+3}r_1$ = 8½ percent the one-year rate of interest expected to prevail three years from now (period $t + 3$)

Using these values and the known rate on a one-year bond, we compute rates on two-, three-, or four-year bonds (designated R_2, R_3, and R_4) as follows:

$_tR_1$ = 5½ percent
$_tR_2 = (0.055 + 0.06)/2 = 5.75$ percent
$_tR_3 = (0.055 + 0.06 + 0.075)/3 = 6.33$ percent
$_tR_4 = (0.055 + 0.06 + 0.075 + 0.085)/4 = 6.88$ percent

In this illustration (which uses the arithmetic average as an approximation of the geometric mean), the yield curve is upward sloping because, at present, investors expect future short-term rates to be above current short-term rates. This is not the formal method for constructing the yield curve. Rather, the yield curve is constructed on the basis of the prevailing promised yields for bonds with different maturities.

The expectations hypothesis attempts to explain *why* the yield curve is upward sloping, downward sloping, humped, or flat by explaining the expectations implicit in yield curves with different shapes. The evidence is fairly substantial and convincing that the expectations hypothesis is a workable explanation of the term structure. Because of the supporting evidence, its relative simplicity, and the intuitive appeal of the theory, the expectations hypothesis of the term structure of interest rates is rather widely accepted.

Consistent Investor Actions Besides the theory and empirical support, it is also possible to present a scenario wherein investor actions will cause the yield curve postulated by the theory. The expectations hypothesis predicts a declining yield curve when interest rates are expected to fall in the future rather than rise. In a case of expected falling rates, long-term bonds would be considered attractive investments because investors would want to lock in prevailing higher yields (which are not expected to be as high in the future) or they would want to capture the increase in bond prices (as capital gains) that will accompany a decline in rates. By the same reasoning, investors will avoid short-term bonds or sell them and reinvest the funds in long-term bonds that will experience larger price increases if rates decline. The point is, investor expectations will reinforce the declining shape of the yield curve as they bid up the prices of long-maturity bonds (forcing yields to decline) and short-term bond issues are avoided or sold (so prices decline and yields rise). At the same time, there is confirming action by suppliers of bonds. Specifically, government or corporate issuers will avoid selling long bonds at the current high rates, waiting until the rates decline. In the meantime, they will issue short-term bonds, if needed, while waiting for lower rates. Therefore, in the long-term market, you will have an increase in demand and a decline in the supply and vice versa in the short-term market. These shifts between long- and short-term maturities will continue until equilibrium occurs or expectations change.

Liquidity Preference Hypothesis

The theory of liquidity preference holds that long-term securities should provide higher returns than short-term obligations because investors are willing to sacrifice some yields to invest in short-maturity obligations to avoid the higher price volatility of long-maturity bonds. Another way to interpret the liquidity preference hypothesis is to say that lenders prefer short-term loans, and, to induce them to lend long term, it is necessary to offer higher yields.

The liquidity preference theory contends that uncertainty and volatility cause investors to favor short-term issues over bonds with longer maturities because short-term bonds are less volatile and can easily be converted into predictable amounts of cash should unforeseen events occur. This theory argues that the yield curve should slope upward and that any other shape should be viewed as a temporary aberration.

This theory can be considered an extension of the expectations hypothesis because the formal liquidity preference position contends that the liquidity premium inherent in the yields for longer maturity bonds should be added to the expected future rate in arriving at long-term yields. Specifically, the liquidity premium *(L)* compensates the investor in long-term bonds for the added volatility inherent in long-term bonds compared to short-maturity securities. Because the liquidity premium *(L)* is provided to compensate the long-term investor, it is simply a variation of Equation 19.10 as follows:

$$(1 + {}_tR_N) = [(1 + {}_tR_1)(1 + {}_{t+1}r_1 + L_2) \ldots (1 + {}_{t+N-1}r_1 + L_n)]^{1/N}$$

In this specification, the *L*s are not the same but would be expected to increase with maturity because the price volatility increases with maturity. The liquidity preference theory has been found to possess some strong empirical support.[18]

To see how the liquidity preference theory predicts future yields and how it compares with the pure expectations hypothesis, let us predict future long-term rates from a single set of one-year rates: 6 percent, 7.5 percent, and 8.5 percent. The liquidity preference theory suggests that investors add increasing liquidity premiums to successive rates to derive actual market rates. As an example, they might arrive at rates of 6.3 percent, 7.9 percent, and 9.0 percent.

As a matter of historical fact, the yield curve shows an upward bias, which implies that some combination of the expectations theory and the liquidity preference theory will more accurately explain the shape of the yield curve than either of them alone. Specifically, actual long-term rates consistently tend to be above what is envisioned from the price expectations hypothesis. This tendency implies the existence of a liquidity premium.

Segmented Market Hypothesis

Despite meager empirical support, a third theory for the shape of the yield curve is the segmented market hypothesis, which enjoys wide acceptance among market practitioners. Also known as the *preferred habitat,* the *institutional theory,* or the *hedging pressure theory,* it asserts that different institutional investors have different maturity needs that lead them to confine their security selections to specific maturity segments. That is, investors supposedly focus on short-, intermediate-, or long-term securities. This theory contends that the shape of the yield curve ultimately is a function of these investment policies of major financial institutions.

As noted in Chapter 18, financial institutions tend to structure their investment policies in line with such factors as their tax liabilities, the types and maturity structure of their liabilities, and the level of earnings demanded by depositors. For example, because commercial banks are subject to normal corporate tax rates and their liabilities are generally short- to intermediate-term time and demand deposits, they consistently invest in short- to intermediate-term municipal bonds.

The segmented market theory contends that the business environment, along with legal and regulatory limitations, tends to direct each type of financial institution to allocate its resources to particular types of bonds with specific maturity characteristics. In its strongest form, the segmented market theory holds that the maturity preferences of investors and borrowers are so strong that investors never purchase securities outside their preferred maturity range to take advantage of yield differentials. As a result, the short- and long-maturity portions of the bond market are effectively segmented, and yields for a segment depend on the supply and demand *within* that maturity segment.

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[18]See Reuben A. Kessel, "The Cyclical Behavior of the Term Structure of Interest Rates," Occasional Paper 91, National Bureau of Economic Research, 1965; Phillip Cagan, *Essays on Interest Rates* (New York: Columbia University Press for the National Bureau of Economic Research, 1969); and J. Huston McCulloch, "An Estimate of the Liquidity Premium," *Journal of Political Economy* 83, no. 1 (January–February 1975): 95–119.

Trading Implications of the Term Structure

Information on maturity yields can help you formulate yield expectations by simply observing the shape of the yield curve. If the yield curve is declining sharply, historical evidence suggests that interest rates will probably decline. Expectations theorists would suggest that you need to examine only the prevailing yield curve to predict the direction of interest rates in the future.

Based on these theories, bond investors use the prevailing yield curve to predict the shapes of future yield curves. Using this prediction and knowledge of current interest rates, investors can determine expected yield volatility by maturity sector. In turn, the maturity segments that are expected to experience the greatest yield changes give the investor the largest potential price change opportunities.[19]

Yield Spreads

Another technique that helps bond investors make profitable trades is the analysis of *yield spreads*—the differences in promised yields between bond issues or segments of the market at any point in time. Such differences are specific to the particular issues or segments of the bond market. Thus they add to the rates determined by the basic economic forces ($RFR + I$).

There are four major yield spreads:

1. Different *segments* of the bond market may have different yields. For example, pure government bonds will have lower yields than government agency bonds, and government bonds have much lower yields than corporate bonds.
2. Bonds in different *sectors* of the same market segment may have different yields. For example, prime-grade municipal bonds will have lower yields than good-grade municipal bonds; you will find spreads between AA utilities and BBB utilities, or between AAA industrial bonds and AAA public utility bonds.
3. Different *coupons* or *seasoning* within a given market segment or sector may cause yield spreads. Examples include current coupon government bonds versus deep-discount governments or recently issued AA industrials versus seasoned AA industrials.
4. Different *maturities* within a given market segment or sector also cause differences in yields. You will see yield spreads between short-term agency issues and long-term agency issues, or between 3-year prime municipals and 25-year prime municipals.

The differences among these bonds cause yield spreads that may be either positive or negative. More important, *the magnitude or the direction of a spread can change over time.* These changes in size or direction of yield spreads offer profit opportunities. We say that the spread narrows whenever the differences in yield become smaller; it widens as the differences increase. Exhibit 19.11 contains data on a variety of past yield spreads that have changed over time.

As a bond investor, you should evaluate yield spread changes because these changes influence bond price behavior and comparative return performance. You should attempt to identify (1) any normal yield spread that is expected to become abnormally wide or narrow in response to an anticipated swing in market interest rates, or (2) an abnormally wide or narrow yield spread that is expected to become normal.

Economic and market analyses will help you develop expectations regarding the potential for yield spreads to change. Taking advantage of these changes requires a knowledge of historical spreads, an ability to *predict* future total market changes, and an understanding of why and when specific spreads will change.[20]

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[19]Gikas A. Hourdouvelis, "The Predictive Power of the Term Structure during Recent Monetary Regimes," *Journal of Finance* 43, no. 2 (June 1988): 339–356.

[20]An article that identifies four determinants of relative market spreads and suggests scenarios when they will change is Chris P. Dialynas and David H. Edington, "Bond Yield Spreads: A Postmodern View," *Journal of Portfolio Management* 19, no. 1 (Fall 1992): 68–75.

EXHIBIT 19.11 *SELECTED MEAN YIELD SPREADS (REPORTED IN BASIS POINTS)*

Comparisons	1995	1996	1997	1998	1999	2000	2001
1. Long Governments – Short Governments	80	89	37	67	109	–6	201
2. Long Aaa Corporates – Long Governments	79	45	72	95	118	168	159
3. Long Aaa Corporates – Long Aaa Municipals	132	169	167	160	177	204	257
4. Long Baa Municipals – Long Aaa Municipals	26	30	14	21	42	61	73
5. Utilities – Industrials	15	13	7	–1	8	1	4
6. Industrials – Financials	29	38	24	20	27	31	34
7. Long CCC Corporates – Long BB Corporates	720	624	573	682	898	1,343	1,250

Note: Yield spreads are equal to the yield on the first bond minus the yield on the second bond—for example, the yield on long governments minus the yield on short governments.

Sources: *Federal Reserve Bulletin;* Lehman Brothers Fixed Income Research, *Global Family of Indices;* Merrill Lynch Fixed Income Research.

What Determines the Price Volatility for Bonds?

In this chapter, we have learned about alternative bond yields, how to calculate them, what determines bond yields (interest rates), and what causes them to change. Now that we understand why yields change, we can logically ask, What is the effect of these yield changes on the prices and rates of return for different bonds? We have discussed the inverse relationship between changes in yields and the price of bonds, so we can now discuss *the specific factors that affect the amount of price change for a yield change* in different bonds. This can also be referred to as the *interest rate sensitivity* of a bond. This section lists the specific factors that affect bond price changes for a given change in interest rates (i.e., the interest rate sensitivity of a bond) and demonstrates the effect for different bonds.

A given change in interest rates can cause vastly different percentage price changes for alternative bonds, which implies different interest rate sensitivity. This section will help you understand what causes these differences in interest rate sensitivity. To maximize your rate of return from an expected decline in interest rates, for example, you need to know which bonds will benefit the most from the yield change. This section helps you make this bond selection decision.

Throughout this section, we talk about bond price changes or bond price volatility interchangeably. A bond price change is measured as the percentage change in the price of the bond, computed as follows:

$$\frac{\text{EPB}}{\text{BPB}} - 1$$

where:

EPB = the ending price of the bond
BPB = the beginning price of the bond

Bond price volatility also is measured in terms of percentage changes in bond prices. A bond with high price volatility or high interest rate sensitivity is one that experiences a relatively large percentage price change for a give change in yields.

Bond price volatility is influenced by more than yield behavior alone. Malkiel used the bond valuation model to demonstrate that the market price of a bond is a function of four factors: (1) its par value, (2) its coupon, (3) the number of years to its maturity, and (4) the prevailing

EXHIBIT 19.12 *EFFECT OF MATURITY ON BOND PRICE VOLATILITY*

	PRESENT VALUE OF AN 8 PERCENT BOND ($1,000 PAR VALUE)							
TERM TO MATURITY	1 YEAR		10 YEARS		20 YEARS		30 YEARS	
Discount rate (YTM)	7%	10%	7%	10%	7%	10%	7%	10%
Present value of interest	$ 75	$ 73	$ 569	$498	$ 858	$686	$1,005	$757
Present value of principal	934	907	505	377	257	142	132	54
Total value of bond	$1,009	$980	$1,074	$875	$1,115	$828	$1,137	$811
Percentage change in total value	–2.9		–18.5		–25.7		–28.7	

market interest rate.[21] Malkiel's mathematical proofs showed the following relationships between yield (interest rate) changes and bond price behavior:

1. Bond prices move inversely to bond yields (interest rates).
2. For a given change in yields (interest rates), longer-maturity bonds post larger price changes; thus, bond price volatility is *directly* related to term to maturity.
3. Bond price volatility (percentage of price change) increases at a diminishing rate as term to maturity increases.
4. Bond price movements resulting from equal absolute increases or decreases in yield are *not* symmetrical. A decrease in yield raises bond prices by more than an increase in yield of the same amount lowers prices.
5. Higher coupon issues show smaller percentage price fluctuation for a given change in yield; thus, bond price volatility is *inversely* related to coupon.

Homer and Leibowitz showed that the absolute level of market yields also affects bond price volatility.[22] As the level of prevailing yields rises, the price volatility of bonds increases, *assuming a constant percentage change in market yields.* It is important to note that if you assume a constant percentage change in yield, the basis-point change will be greater when rates are high. For example, a 25 percent change in interest rates when rates are at 4 percent will be 100 basis points; the same 25 percent change when rates are at 8 percent will be a 200 basis-point change. In the discussion of bond duration, we will see that this difference in basis point change is important.

Exhibit 19.12, Exhibit 19.13, and Exhibit 19.14 demonstrate these relationships assuming semiannual compounding. Exhibit 19.12 demonstrates the effect of maturity on price volatility. In all four maturity classes, we assume a bond with an 8 percent coupon and assume that the discount rate (YTM) changes from 7 percent to 10 percent. The only difference among the four cases is the maturities of the bonds. The demonstration involves computing the value of each bond at a 7 percent yield and at a 10 percent yield and noting the percentage change in price. As shown, this change in yield caused the price of the one-year bond to decline by only 2.9 percent; the 30-year bond declined by almost 29 percent. Clearly, the longer-maturity bond experienced the greater price volatility.

Also, price volatility increased at a decreasing rate with maturity. When maturity doubled from 10 years to 20 years, the percent change in price increased by less than 50 percent (from

[21]Burton G. Malkiel, "Expectations, Bond Prices, and the Term Structure of Interest Rates," *Quarterly Journal of Economics* 76, no. 2 (May 1962): 197–218.

[22]Sidney Homer and Martin L. Leibowitz, *Inside the Yield Book* (Englewood Cliffs, N.J.: Prentice-Hall, 1972).

EXHIBIT 19.13 *EFFECT OF COUPON ON BOND PRICE VOLATILITY*

	PRESENT VALUE OF 20-YEAR BOND ($1,000 PAR VALUE)							
	0 PERCENT COUPON		3 PERCENT COUPON		8 PERCENT COUPON		12 PERCENT COUPON	
Discount rate (YTM)	7%	10%	7%	10%	7%	10%	7%	10%
Present value of interest	$ 0	$ 0	$322	$257	$ 858	$686	$1,287	$1030
Present value of principal	257	142	257	142	257	142	257	142
Total value of bond	$257	$142	$579	$399	$1,115	$828	$1,544	$1,172
Percentage change in total value	–44.7		–31.1		–25.7		–24.1	

EXHIBIT 19.14 *EFFECT OF YIELD LEVEL ON BOND PRICE VOLATILITY*

	PRESENT VALUE OF 20-YEAR, 4 PERCENT BOND ($1,000 PAR VALUE)							
	(1) LOW YIELDS		(2) INTERMEDIATE YIELDS		(3) HIGH YIELDS		(4) 100 BASIS-POINT CHANGE AT HIGH YIELDS	
Discount rate (YTM)	3%	4%	6%	8%	9%	12%	9%	10%
Present value of interest	$ 602	$ 547	$ 462	$396	$370	$301	$370	$343
Present value of principal	562	453	307	208	175	97	175	142
Total value of bond	$1,164	$1,000	$ 769	$604	$545	$398	$545	$485
Percentage change in total value	–14.1		–21.5		–27.0		–11.0	

18.5 percent to 25.7 percent). A similar change occurred when going from 20 years to 30 years. Therefore, Exhibit 19.12 demonstrates the first three of our price-yield relationships: (1) bond price is inversely related to yields, (2) bond price volatility is positively related to term to maturity, and (3) bond price volatility increases at a decreasing rate with maturity.

It also is possible to demonstrate the fourth relationship with this exhibit. Using the 20-year bond for demonstration purposes, if you computed the percentage change in price related to an *increase* in rates (e.g., from 7 percent to 10 percent), you would get the answer reported—a 25.7 percent decrease. In contrast, if you computed the effect on price of a *decrease* in yields from 10 percent to 7 percent, you would get a 34.7 percent increase in price (from $828 to $1,115). This demonstrates that prices change more in response to a decrease in rates (from 10 percent to 7 percent) than to a comparable increase in rates (from 7 percent to 10 percent).

Exhibit 19.13 demonstrates the coupon effect. In this set of examples, all the bonds have equal maturity (20 years) and experience the same change in YTM (from 7 percent to 10 percent). The exhibit shows the *inverse* relationship between coupon rate and price volatility: The smallest coupon bond (the zero) experienced the largest percentage price change (almost 45 percent) versus a 24 percent change for the 12 percent coupon bond.

Exhibit 19.14 demonstrates the yield level effect. In these examples, all the bonds have the same 20-year maturity and the same 4 percent coupon. In the first three cases, the YTM changed by a constant 33.3 percent (i.e., from 3 percent to 4 percent, from 6 percent to 8 percent, and from 9 percent to 12 percent). Note that the first change is 100 basis points, the second is 200 basis points, and the third is 300 basis points. The results in the first three columns confirm the statement that when rates change by a *constant percentage,* the change in the bond price is larger when the rates are at a higher level.

The fourth column shows that if you assume a *constant basis-point change in yields,* you get the opposite results. Specifically, a 100 basis-point change in yields from 3 percent to 4 percent provides a price change of 14.1 percent, while the same 100 basis-point change from 9 percent to 10 percent results in a price change of only 11 percent. Therefore, the yield level effect can differ, depending on whether the yield change is specified as a constant percentage change or a constant basis-point change.

Thus, the price volatility of a bond for a given change in yield (i.e., its interest rate sensitivity) is affected by the bond's coupon, its term to maturity, the level of yields (depending on what kind of change in yield), and the direction of the yield change. However, although both the level and direction of change in yields affect price volatility, they cannot be used for trading strategies. When yields change, the two variables that have a dramatic effect on a bond's interest rate sensitivity are coupon and maturity.

Trading Strategies

Knowing that coupon and maturity are the major variables that influence a bond's interest rate sensitivity, we can develop some strategies for maximizing rates of return when interest rates change. Specifically, if you expect a major *decline* in interest rates, you know that bond prices will increase, so you want a portfolio of bonds with the *maximum interest rate sensitivity* so that you will enjoy maximum price changes (capital gains) from the change in interest rates. In this situation, the previous discussion regarding the effect of maturity and coupon indicates that you should attempt to build a portfolio of long-maturity bonds with low coupons (ideally a long-term zero coupon bond). A portfolio of such bonds should experience the maximum price appreciation for a given decline in market interest rates.

In contrast, if you expect an *increase* in market interest rates, you know that bond prices will decline, and you want a portfolio with *minimum interest rate sensitivity* to minimize the capital losses caused by the increase in rates. Therefore, you would want to change your portfolio to short-maturity bonds with high coupons. This combination should provide minimal price volatility for a change in market interest rates.

Duration Measures

Because the price volatility (interest rate sensitivity) of a bond varies inversely with its coupon and directly with its term to maturity, it is necessary to determine the best combination of these two variables to achieve your objective. This effort would benefit from a composite measure that considered both coupon and maturity.

A composite measure of the interest rate sensitivity of a bond is referred to as **duration**. This concept and its development as a tool in bond analysis and portfolio management have existed for over 60 years. Notably, several specifications of duration have been derived over the past 20 years. First, **Macaulay duration**, developed over 60 years ago by Frederick Macaulay, is a measure of the time flow of cash from a bond.[23] A modified version of Macaulay duration can be used under certain conditions to indicate the price volatility of a bond in response to interest rate changes. Second, **modified duration** is derived by making a small adjustment (modification) to the Macaulay duration value. As already noted, under certain restrictive conditions (most important, there are no embedded options), modified duration can provide an approximation to the interest rate sensitivity of a bond (or any financial asset). Third, **effective duration** is a direct measure of the interest rate sensitivity of a bond (or any financial instrument) in cases where it is possible to estimate price changes for an asset using a valuation model. Finally,

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[23]Frederick R. Macaulay, *Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields, and Stock Prices in the United States since 1856* (New York: National Bureau of Economic Research, 1938).

empirical duration measures directly the percentage price change of an asset for an actual change in interest rates. This measure can be used as an estimate for an asset when there is no exact valuation model available. Because of the development of many new financial instruments, which have very unique cash flows *that change with interest rates,* effective duration and empirical duration have become widely used because of their flexibility and ability to provide a useful measure of interest rate sensitivity—the primary goal of duration. Therefore, in this section, we discuss and demonstrate these four duration measures, including their limitations.

Macaulay Duration Macaulay showed that the duration of a bond was a more appropriate measure of time characteristics than the term to maturity of the bond because duration considers both the repayment of capital at maturity and the size and timing of coupon payments prior to final maturity. Using annual compounding, duration *(D)* is

➤19.13
$$D = \frac{\sum_{t=1}^{n} \frac{C_t(t)}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

where:

t = the time period in which the coupon or principal payment occurs
C_t = the interest or principal payment that occurs in period t
i = the yield to maturity on the bond

The denominator in this equation is the price of a bond as determined by the present value model. The numerator is the present value of all cash flows *weighted according to the time to cash receipt.* The following example, which demonstrates the specific computations for two bonds, shows the procedure and highlights some of the properties of Macaulay duration. Consider the following two sample bonds:

	Bond A	Bond B
Face value	$1,000	$1,000
Maturity	10 years	10 years
Coupon	4%	8%

Assuming annual interest payments and an 8 percent yield to maturity on the bonds, duration is computed as shown in Exhibit 19.15.[24] If duration is computed by discounting flows using the yield to maturity of the bond, it is called *Macaulay duration.*

Characteristics of Macaulay Duration This example illustrates several characteristics of Macaulay duration. First, the Macaulay duration of a bond with coupon payments always will be less than its term to maturity because duration gives weight to these interim interest payments.

Second, there is *an inverse relationship between coupon and duration.* A bond with a larger coupon will have a shorter duration because more of the total cash flows come earlier in the form

[24]We assume annual interest payments to reduce the space requirements and computations. In practice you would assume semiannual payments that would cause a slightly shorter duration since you receive half the payments earlier.

EXHIBIT 19.15 *COMPUTATION OF MACAULAY DURATION (ASSUMING 8 PERCENT MARKET YIELD)*

BOND A

(1) Year	(2) Cash Flow	(3) PV at 8%	(4) PV of Flow	(5) PV as % of Price	(6) (1) × (5)
1	$ 40	0.9259	$ 37.04	0.0506	0.0506
2	40	0.8573	34.29	0.0469	0.0938
3	40	0.7938	31.75	0.0434	0.1302
4	40	0.7350	29.40	0.0402	0.1608
5	40	0.6806	27.22	0.0372	0.1860
6	40	0.6302	25.21	0.0345	0.2070
7	40	0.5835	23.34	0.0319	0.2233
8	40	0.5403	21.61	0.0295	0.2360
9	40	0.5002	20.01	0.0274	0.2466
10	1,040	0.4632	481.73	0.6585	6.5850
Sum			$ 731.58	1.0000	8.1193
Duration = 8.12 Years					

BOND B

(1) Year	(2) Cash Flow	(3) PV at 8%	(4) PV of Flow	(5) PV as % of Price	(6) (1) × (5)
1	$ 80	0.9259	$ 74.07	0.0741	0.0741
2	80	0.8573	68.59	0.0686	0.1372
3	80	0.7938	63.50	0.0635	0.1906
4	80	0.7350	58.80	0.0588	0.1906
5	80	0.6806	54.44	0.0544	0.2720
6	80	0.6302	50.42	0.0504	0.3024
7	80	0.5835	46.68	0.0467	0.3269
8	80	0.5403	43.22	0.0432	0.3456
9	80	0.5002	40.02	0.0400	0.3600
10	1,080	0.4632	500.26	0.5003	5.0030
Sum			$1,000.00	1.0000	7.2470
Duration = 7.25 Years					

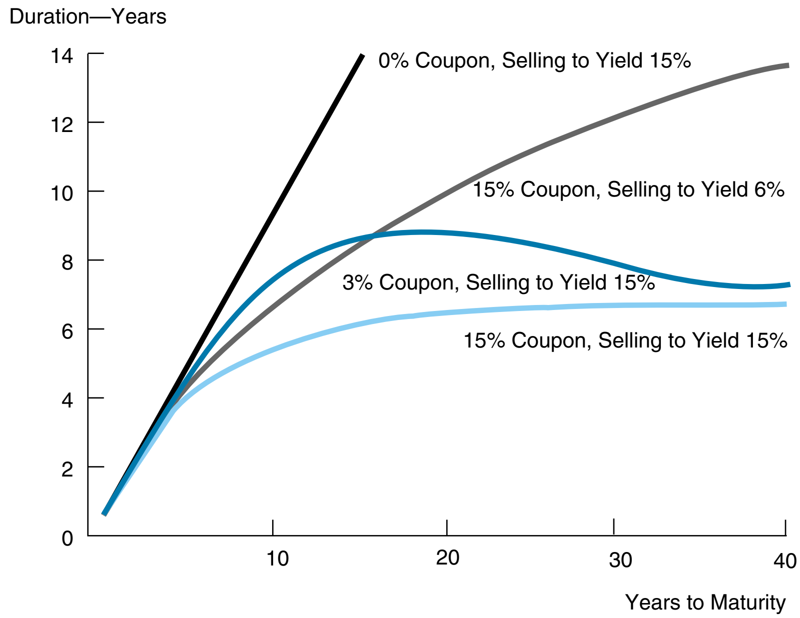
of interest payments. As shown in Exhibit 19.15, the 8 percent coupon bond has a shorter duration than the 4 percent coupon bond.

A zero coupon bond or a pure discount bond, such as a Treasury bill, will have *duration equal to its term to maturity.* In Exhibit 19.15, if you assume a single payment at maturity, duration will equal term to maturity because the only cash flow comes in the final (maturity) year—that is, you receive 100 percent of cash flows in year *n.*

Third, there is *generally a positive relationship between term to maturity and Macaulay duration,* but duration increases at a decreasing rate with maturity. Therefore, a bond with longer term to maturity almost always will have a higher duration. The relationship is not direct because as maturity increases the present value of the principal declines in value.

As shown in Exhibit 19.16, the shape of the duration-maturity curve depends on the coupon and the yield to maturity. The curve for a zero coupon bond is a straight line, indicating that duration equals term to maturity. In contrast, the curve for a low-coupon bond selling at a deep

EXHIBIT 19.16 *DURATION VERSUS MATURITY*



discount (due to a high YTM) will turn down at long maturities, which means that under these conditions, the longer-maturity bond will have lower duration because the discounted value of the principal payment becomes insignificant, which shifts the weight to the early interest payments, causing a decline in Macaulay duration.

Fourth, all else the same, there is an *inverse relationship between YTM and duration.* A higher yield to maturity of a bond reduces its duration. As an example, in Exhibit 19.15, if the yield to maturity had been 12 percent rather than 8 percent, the duration for the 4 percent bond would have gone from 8.12 to 7.75, and the duration of the 8 percent bond would have gone from 7.25 to 6.80.[25] The combined effect of the inverse relationships between duration and both coupon and yield can be seen with the curve for the 15 percent coupon and yield bond where the duration tops out at about six years. The real-world example of such a bond would be a high-yield bond.

Finally, sinking funds and call provisions can have a dramatic effect on a bond's duration. They can change the total cash flows for a bond and, therefore, significantly change its duration. Between these two factors, the characteristic that causes the greatest uncertainty is the call feature—it is difficult to estimate when the call option will be exercised since it is a function of changes in interest rates. We consider this further when we discuss the effect of embedded options on the duration and convexity of a bond.

A summary of Macaulay duration characteristics is as follows:

- The duration of a zero coupon bond will *equal* its term to maturity.
- The duration of a coupon bond always will be less than its term to maturity.
- There is an *inverse* relationship between coupon and duration.

[25]These properties are discussed and demonstrated in Frank K. Reilly and Rupinder Sidhu, "The Many Uses of Bond Duration," *Financial Analysts Journal* 36, no. 4 (July–August 1980): 58–72; and Frank J. Fabozzi, Gerald W. Buetow, and Robert R. Johnson, "Measuring Interest Rate Risk," in *The Handbook of Fixed-Income Securities,* 6th ed.

- There is generally a *positive* relationship between term to maturity and duration. Note that the duration of a coupon bond increases at a decreasing rate with maturity and the shape of the duration/maturity curve will depend on the coupon and YTM of the bond. Also, the duration of a deep discount bond will decline at very long maturities (over 20 years).
- There is an *inverse* relationship between yield to maturity and duration.
- Sinking funds and call provisions can cause a dramatic change in the duration of a bond. The effect of embedded options is discussed in a subsequent section.

Modified Duration and Bond Price Volatility

An adjusted measure of duration called *modified duration* can be used to approximate the interest rate sensitivity of an option-free (straight) bond. Modified duration equals Macaulay duration (computed in Exhibit 19.15) divided by 1 plus the current yield to maturity divided by the number of payments in a year. As an example, a bond with a Macaulay duration of 10 years, a yield to maturity *(i)* of 8 percent, and semiannual payments would have a modified duration of

$$D_{mod} = 10/\left(1+\frac{0.08}{2}\right)$$
$$= 10/(1.04) = 9.62$$

It has been shown, both theoretically and empirically, that price movements of option-free bonds *will vary proportionally* with modified duration for *small changes in yields.*[26] Specifically, as shown in the following equation, an estimate of the percentage change in bond price equals the change in yield times modified duration:

19.14
$$\frac{\Delta P}{P} \times 100 = -D_{mod} \times \Delta i$$

where:

ΔP = the change in price for the bond
P = the beginning price for the bond
$-D_{mod}$ = the modified duration of the bond
Δi = the yield change in basis points divided by 100. For example, if interest rates go from 8.00 to 8.50 percent, $\Delta i = 50/100 = 0.50$.

Consider a bond with Macaulay $D = 8$ years and $i = 0.10$. Assume that you expect the bond's YTM to decline by 75 basis points (e.g., from 10 percent to 9.25 percent). The first step is to compute the bond's modified duration as follows:

$$D_{mod} = 8/\left(1+\frac{0.10}{2}\right)$$
$$= 8/(1.05) = 7.62$$

[26]A generalized proof of this is contained in Michael H. Hopewell and George Kaufman, "Bond Price Volatility and Term to Maturity: A Generalized Respecification," *American Economic Review* 63, no. 4 (September 1973): 749–753. The importance of the specification "for small changes in yields" will become clear when we discuss convexity in the next section. Because modified duration is an approximate measure of interest rate sensitivity, the "years" label is not appropriate.

EXHIBIT 19.17 *BOND DURATION IN YEARS FOR BOND YIELDING 6 PERCENT UNDER DIFFERENT TERMS*

	COUPON RATES			
Years to Maturity	0.02	0.04	0.06	0.08
1	0.995	0.990	0.985	0.981
2	4.756	4.558	4.393	4.254
10	8.891	8.169	7.662	7.286
20	14.981	12.980	11.904	11.232
50	19.452	17.129	16.273	15.829
100	17.567	17.232	17.120	17.064
∞	17.167	17.167	17.167	17.167

Source: L. Fisher and R. L. Weil, "Coping with the Risk of Interest Rate Fluctuations: Returns to Bondholders from Naive and Final Strategies," *Journal of Business* 44, no. 4 (October 1971): University of Chicago Press. Reprinted by permission of The University of Chicago Press.

The estimated percentage change in the price of the bond using Equation 19.14 is:

$$\begin{aligned}\%\Delta P &= -(7.62)\times\frac{-75}{100}\\ &= (-7.62)\times(-0.75)\\ &= 5.72\end{aligned}$$

This indicates that the bond price should increase by approximately 5.72 percent in response to the 75 basis-point decline in YTM. If the price of the bond before the decline in interest rates was \$900, the price after the decline in interest rates should be approximately \$900 × 1.0572 = \$951.48.

The modified duration is always a negative value for a noncallable bond because of the inverse relationship between yield changes and bond price changes. Also, remember that this formulation provides an *estimate* or *approximation* of the percent change in the price of the bond. The following section on convexity shows that this formula that uses only modified duration provides an exact estimate of the percentage price change only for very small changes in yields of option-free securities.

Trading Strategies Using Modified Duration We know that the longest duration security provides the maximum price variation. Exhibit 19.17 demonstrates that numerous ways exist to achieve a given level of duration. The following discussion indicates that an active bond investor who wants to adjust his/her portfolio for anticipated interest rate changes can use this measure of interest rate sensitivity to structure a portfolio to take advantage of changes in market yields.

If you expect a *decline* in interest rates, you should *increase* the average modified duration of your bond portfolio to experience maximum price volatility. If you expect an *increase* in interest rates, you should *reduce* the average modified duration of your portfolio to minimize your price decline. Note that the modified duration of your portfolio is the market-value-weighted average of the modified durations of the individual bonds in the portfolio.

Bond Convexity

Modified duration allows us to estimate bond price changes for a change in interest rates. However, the equation we used to make this calculation (Equation 19.14) is accurate only for *very small changes* in market yields. We will see that the accuracy of the estimate of the price change

EXHIBIT 19.18 *PRICE-YIELD RELATIONSHIPS FOR ALTERNATIVE BONDS*

A. 12 PERCENT, 20 YEAR		B. 12 PERCENT, 3 YEAR		C. ZERO COUPON, 30 YEAR	
YIELD	PRICE	YIELD	PRICE	YIELD	PRICE
1.0%	$2,989.47	1.0%	$1,324.30	1.0%	$741.37
2.0	2,641.73	2.0	1,289.77	2.0	550.45
3.0	2,346.21	3.0	1,256.37	3.0	409.30
4.0	2,094.22	4.0	1,224.06	4.0	304.78
5.0	1,878.60	5.0	1,192.78	5.0	227.28
6.0	1,693.44	6.0	1,162.52	6.0	169.73
7.0	1,533.88	7.0	1,133.21	7.0	126.93
8.0	1,395.86	8.0	1,104.84	8.0	95.06
9.0	1,276.02	9.0	1,077.37	9.0	71.29
10.0	1,171.59	10.0	1,050.76	10.0	53.54
11.0	1,080.23	11.0	1,024.98	11.0	40.26
12.0	1,000.00	12.0	1,000.00	12.0	30.31

deteriorates with larger changes in yields because the modified duration calculation is a *linear* approximation of a bond price change that follows a *curvilinear* (convex) function. To understand the effect of this **convexity**, we must consider the price-yield relationship for alternative bonds.[27]

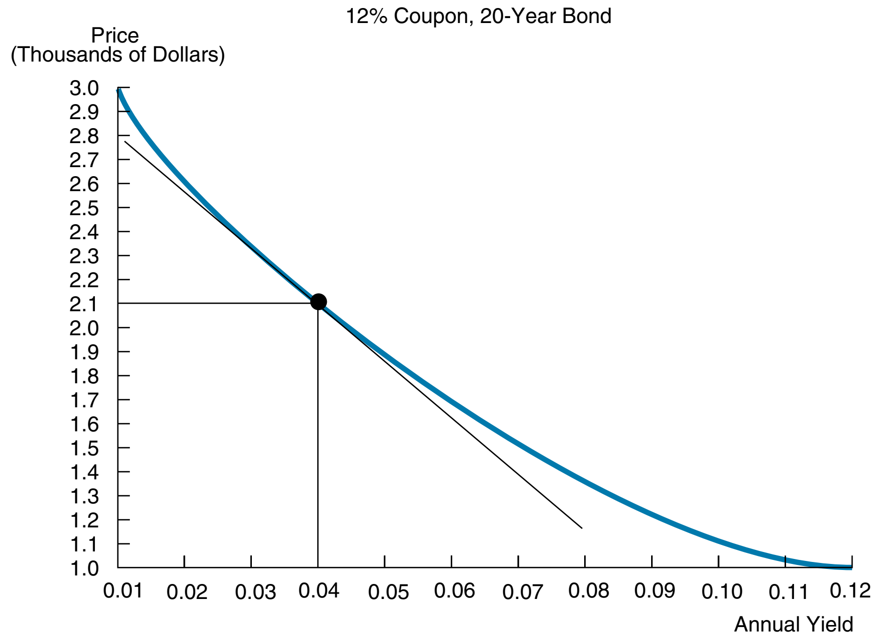
The Price-Yield Relationship for Bonds Because the price of a bond is the present value of its cash flows at a particular discount rate, if you are given the coupon, maturity, and a yield for a bond, you can calculate its price at a point in time. The price-yield curve provides a set of prices for a specific maturity/coupon bond at a point in time using a range of yields to maturity (discount rates). As an example, Exhibit 19.18 lists the computed prices for a 12 percent, 20-year bond assuming yields from 1 percent to 12 percent. The exhibit shows that if you discount the flows from this bond at a yield of 1 percent, you would get a price of $2,989.47; discounting these same flows at 10 percent gives a price of $1,171.59. The graph of these prices relative to the yields that produced them (Exhibit 19.19) indicates that the price-yield relationship for this bond is not a straight line but a curvilinear relationship. That is, it is convex.

Two points are important about the price-yield relationship:

1. This relationship can be applied to a single bond, a portfolio of bonds, or any stream of future cash flows.
2. The convex price-yield relationship will differ among bonds or other cash flow streams, depending on the nature of the cash flow stream, that is, its coupon and maturity. For example, the price-yield relationship for a high-coupon, short-term security will be almost a straight line because the price does not change as much for a change in yields (e.g., the 12 percent, three-year bond in Exhibit 19.18). In contrast, the price-yield relationship for a low-coupon, long-term bond will curve radically (i.e., be very convex), as shown by the

[27]For a further discussion of this topic, see Mark L. Dunetz and James M. Mahoney, "Using Duration and Convexity in the Analysis of Callable Bonds," *Financial Analysts Journal* 44, no. 3 (May–June 1988): 53–73; and Fabozzi, Buetow, and Johnson," Measuring Interest Rate Risk," in *The Handbook of Fixed-Income Securities,* 6th ed.

EXHIBIT 19.19 *PRICE-YIELD RELATIONSHIP AND MODIFIED DURATION AT 4 PERCENT YIELD*



zero coupon, 30-year bond in Exhibit 19.18. These differences in convexity are shown graphically in Exhibit 19.20. The curved nature of the price-yield relationship is referred to as the bond's *convexity.*

The Desirability of Convexity As shown by the graph in Exhibit 19.20, because of the convexity of the price-yield relationship, as yield increases, the rate at which the price of the bond declines becomes slower. Similarly, when yields decline, the rate at which the price of the bond increases becomes faster. Therefore, convexity is considered a desirable trait. Specifically, if you have two bonds with equal duration but one has greater convexity, you would want the bond with greater convexity because it would have better price performance whether yields rise (the bond price declines less) or yields fall (the bond price increases more).

Given this price-yield curve, modified duration is the percentage change in price for a nominal change in yield as follows:[28]

19.15
$$D_{mod} = \frac{\frac{dP}{di}}{P}$$

Notice that the *dP/di* line is tangent to the price-yield curve *at a given yield* as shown in Exhibit 19.21. For *small* changes in yields (i.e., from y^* to either y_1 or y_2), this tangent straight line gives a good estimate of the actual price changes. In contrast, for larger changes in yields (i.e., from y^* to either y_3 or y_4), the straight line will estimate the new price of the bond at less

[28]In mathematical terms, modified duration is the first differential of this price-yield relationship with respect to yield.

EXHIBIT 19.20 *PRICE-YIELD CURVES FOR ALTERNATIVE BONDS*

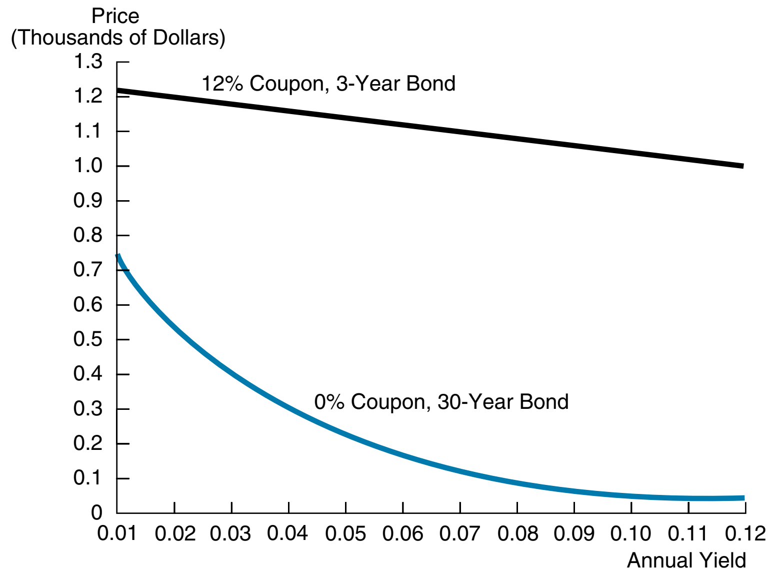
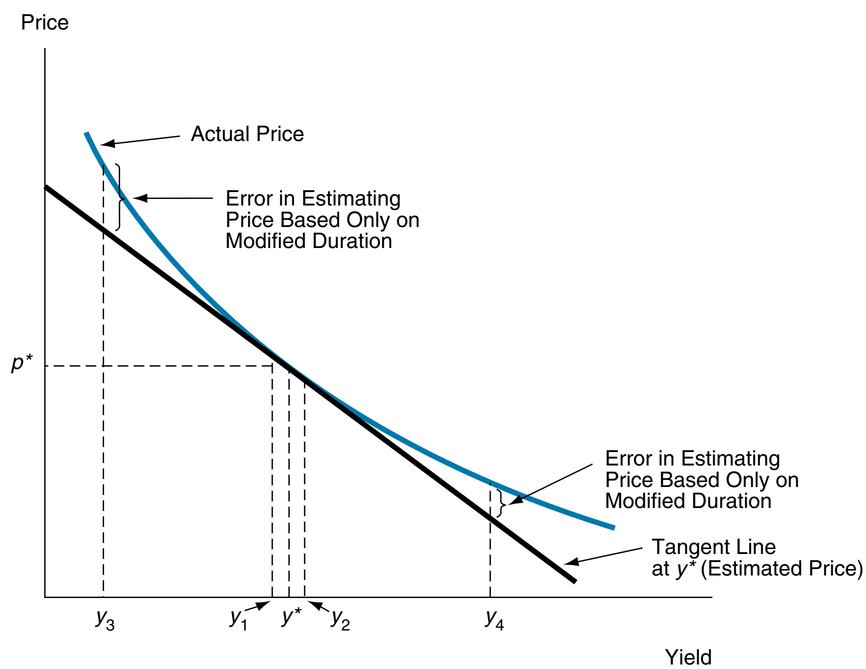


EXHIBIT 19.21 *PRICE APPROXIMATION USING MODIFIED DURATION*



Source: Frank J. Fabozzi, Gerald Buetow, and Robert R. Johnson, "Measuring Interest Rate Risk" in the *Handbook of Fixed-Income Securities,* 6th ed. (New York: McGraw-Hill, 2001). Reproduced with permission from The McGraw-Hill Companies.

than the actual price shown by the price-yield curve. This misestimate arises because the modified-duration line is a linear estimate of a curvilinear relationship. Specifically, the estimate using only modified duration will *underestimate* the actual price *increase* caused by a yield decline and *overestimate* the actual price *decline* caused by an increase in yields. This graph, which demonstrates the convexity effect, also shows that price changes are *not* symmetric when yields increase or decrease. As shown, when rates decline, there is a larger price error than when rates increase because, due to convexity, when yields decline prices rise at an *increasing* rate, while prices decline at a *decreasing* rate when yields rise.

Determinants of Convexity Convexity is a measure of the curvature of the price-yield relationship. In turn, because modified duration is the slope of the curve at a given yield, convexity indicates changes in duration. Mathematically, convexity is the second derivative of price with respect to yield (d^2P/di^2) divided by price. Specifically, convexity is the percentage change in dP/di for a given change in yield:

➤19.16
$$\text{Convexity} = \frac{\dfrac{d^2P}{di^2}}{P}$$

Convexity is a measure of how much a bond's price-yield curve deviates from the linear approximation of that curve. As indicated by Exhibit 19.19 and Exhibit 19.21 for *noncallable* bonds, convexity always is a positive number, implying that the price-yield curve lies above the modified-duration (tangent) line. Exhibit 19.20 illustrates the price-yield relationship for two bonds with very different coupons and maturities. (The yields and prices are contained in Exhibit 19.18)

These graphs demonstrate the following relationship between these factors and the convexity of a bond:

- There is an *inverse* relationship between coupon and convexity (yield and maturity constant)—that is, lower coupon, higher convexity.
- There is a *direct* relationship between maturity and convexity (yield and coupon constant)—that is, longer maturity, higher convexity.
- There is an *inverse* relationship between yield and convexity (coupon and maturity constant). This means that the price–yield curve is more convex at its lower-yield (upper left) segment.

Therefore, a short-term, high-coupon bond, such as the 12 percent coupon, three-year bond in Exhibit 19.20, has very low convexity—it is almost a straight line. In contrast, the zero-coupon, 30-year bond has high convexity.

Notably, the determinants of duration and convexity for option-free bonds are very similar. Specifically, the three factors are the same—maturity, coupon, and yield—and the direction of impact is the same—that is, maturity is direct and both coupon and yield are inverse. Therefore, high-duration bonds have high convexity.

The Modified-Duration–Convexity Effects In summary, the change in a bond's price resulting from a change in yield can be attributed to two sources: the bond's modified duration and its convexity. The relative effect of these two factors on the price change will depend on the characteristics of the bond (i.e., its convexity) and the size of the yield change. For example, if you are estimating the price change for a 300 basis-point change in yield for a zero coupon, 30-year bond, the convexity effect would be fairly large because this bond would have high convexity, and a 300 basis-point change in yield is relatively large. In contrast, if you are dealing with only a 10 basis-point change in yields, the convexity effect would be minimal because it is a small change in yield. Similarly, the convexity effect would likewise be small even if you assume a larger yield change if you are dealing with a bond with small convexity (i.e., a high-coupon, short-maturity bond) because the price-yield curve for such a bond is almost a straight line.

In conclusion, modified duration can help you derive an *approximate* percentage bond price change for a given change in interest rates, but you must remember that it is only a good estimate when you are considering small yield changes. The point is, you must also consider the convexity effect on price change when you are dealing with large yield changes and/or when the securities or cash flows have high convexity.

Computation of Convexity Again, the formula for computing the convexity of a stream of cash flows looks fairly complex, but it can be broken down into manageable steps. You will recall from our convexity equation (19.16) that

$$\text{Convexity} = \frac{\frac{d^2P}{di^2}}{P}$$

In turn,

19.17
$$\frac{d^2P}{di^2} = \frac{1}{(1+i)^2}\left[\sum_{t=1}^{n}\frac{CF_t}{(1+i)}(t^2+t)\right]$$

Exhibit 19.22 contains the computations related to this calculation for a three-year bond with a 12 percent coupon and 9 percent YTM assuming annual flows.

The convexity for this bond is very low because it has a short maturity, high coupon, and high yield. Note that the *convexity of a security will vary along the price-yield curve.* You will get a

EXHIBIT 19.22 *COMPUTATION OF CONVEXITY*

$$\text{Convexity} = \frac{d^2P/di^2}{PV \text{ of Cash Flows}} = \frac{d^2P/di^2}{\text{Price}}$$

$$\frac{d^2P}{di^2} = \frac{1}{(1+i)^2}\left[\sum_{t=1}^{n}(t^2+t)\frac{CF_t}{(1+i)^t}\right]$$

$$\text{Convexity} = \frac{d^2P/di^2}{\text{Price}}$$

Example: 3-Year Bond, 12% Coupon, 9% YTM

(1) Year	(2) CF_T	(3) PV @ 9%	(4) PV CF	(5) t^2+t	(4) × (5)
1	120	0.9174	$ 110.09	2	$ 220.18
2	120	0.8417	101.00	6	606.00
3	120	0.7722	92.66	12	1,111.92
3	1,000	0.7722	772.20	12	9,266.40
			Price = $1,075.95		$11,204.50

$$\frac{1}{(1+i)^2} = \frac{1}{(1.09)^2} = \frac{1}{1.19} = 0.84$$

$$\$11,204.50 \times 0.84 = \$9,411.78$$

$$\text{Convexity} = \frac{9,411.78}{1,075.95} = 8.75$$

different convexity at a 3 percent yield that at a 12 percent yield. In terms of the computation, the maturity and coupon will be the same, but you will use a different discount rate that reflects where you are on the curve. This is similar to the earlier observation that *you will get a different modified duration at different points on the price-yield curve* because the slope varies along the curve. You also can see this mathematically because, depending on where you are on the curve, you will be using a different market yield, and the Macaulay and modified durations are inverse to the discount rate.[29]

To compute the price change attributable to the convexity effect after you know the bond's convexity, use this equation:

➤19.18 Price Change Due to Convexity = ½ × Price × Convexity × (Δ in Yield)^2

Exhibit 19.23 shows the change in bond price considering the duration effect and the convexity effect for an 18-year bond with a 12 percent coupon and 9 percent YTM. For demonstration purposes, we assumed a decline of 100 and 300 basis points (BP) in rates (i.e., 9 percent to 8 percent and 9 percent to 6 percent).

With the 300 BP change, if you considered only the modified-duration effect, you would have *estimated* that the bond went from 126.50 to 158.30 (a 25.14 percent increase), when, in fact, the actual price is closer to 164.41, which is about a *30 percent increase.*

Duration and Convexity for Callable Bonds

The discussion and presentation thus far regarding Macaulay and modified durations and convexity have been concerned with option-free bonds. A callable bond is different because it provides the issuer with an option to call the bond under certain conditions and pay it off with funds from a new issue sold at a lower yield. Observers refer to this as a bond with an *embedded option.* We noted earlier that the duration of a bond can be seriously affected by an embedded call option if interest rates decline substantially below a bond's coupon rate. In such a case, the issuer will likely call the bond, which will dramatically change the maturity and the duration of the bond. For example, assume a firm issues a 30-year bond with a 9 percent coupon with a deferred call provision whereby the bond can be called in six years at 109 percent of par. If the bond is issued at par, its original *duration to maturity* will be about 11 years. A year later, if rates decline to about 7 percent, its duration to maturity will still be over *10 years* because duration is inversely related to yield and yields have declined. Notably, at a yield of 7 percent, this bond will probably trade at *yield to call* because at a 7 percent yield the firm will likely exercise its option and call the bond in five years. Notably, the bond's *duration to first call* would be about *four years.* Clearly, there is a significant difference between duration to maturity (over 10 years) and duration to first call (about 4 years).

To understand the impact of the call feature on the duration and convexity of a bond, it is important to consider what determines the price of a callable bond. A callable bond is a combination of a noncallable bond plus a *call option* that was *sold to the issuer,* which allows the issuer to call the bond under the conditions discussed earlier. Because the call option is owned by the issuer, it has negative value for the investor in the bond. Thus the bondholder's position is

➤19.19 Long a Callable Bond = Long a Noncallable Bond + A Short Position in a Call Option

Therefore, the value (price) of a callable bond is equal to

➤19.20 Callable Bond Price = Noncallable Bond Price – Call Option Price

[29]Exhibit 19A.1 in the appendix to this chapter is a table that combines the computation of Macaulay and modified duration and convexity using semiannual cash flows.

EXHIBIT 19.23 *ANALYSIS OF BOND PRICE CHANGE CONSIDERING DURATION AND CONVEXITY*

Example: 18-Year Bond, 12% Coupon, 9% YTM
Price: 126.50
Modified Duration:8.38 (D^*)
Convexity: 107.70
Estimate of Price Change Using duration:
Percent Δ Price = D^* (Δ in YLD/100)
Estimate of Price change from Convexity:
Price Change = ½ × Price × Convexity × (Δ in YLD)²

A. Change in Yield: –100 BP

Duration Change: $$-8.38 + \left(\frac{-100}{100}\right) = +8.38\%$$
$$+8.38\% \times 126.50 = +10.60$$

Convexity Change: $$\frac{1}{2} \times (126.50) \times 107.70 \times (0.01)^2$$
$$= 63.25 \times 107.70 \times 0.0001$$
$$= 6,812.03 \times 0.0001 = 0.68$$

Combined Effect:

126.50	
+ 10.60	(Duration)
137.10	
+ 0.68	(Convexity)
137.78	

B. Change in Yield: –300 BP

Duration Change: $$-8.38 \times \left(\frac{-300}{100}\right) = +25.14\%$$
$$126.50 \times 1.2514 = 158.30(+31.80)$$

Convexity Effect: $$\frac{1}{2} \times (126.50) \times 107.70 \times (0.03)^2$$
$$6,812.03 \times 0.0009 = 6.11$$

Combined Effect:

126.50	
+ 31.80	(Duration)
158.30	
+ 6.11	(Convexity)
164.41	

Given this valuation, anything that increases the value of the call option will reduce the value of the callable bond.[30] The point is, when interest rates decline, the right-hand side of this equation experiences a conflict between the value of the noncallable bond that increases in value, and the negative effect of the call option that also increases. Notably, if the value of the call option increases faster than the value of the noncallable bond, the overall value of the callable bond will *decline* when interest rates decline and this is referred to as *negative duration*—that is, in

[30]For a further discussion of the effect of these embedded options, see Frank J. Fabozzi, Gerald W. Buetow, and Robert R. Johnson," Measuring Interest Rate Risk"; and Frank J. Fabozzi, Andrew J. Kalotay, and George O. Williams, "Valuation of Bonds with Embedded Options." Both are in *The Handbook of Fixed-Income Securities,* 6th ed. Also see Kurt Winkelmann, "Uses and Abuses of Duration and Convexity," *Financial Analysts Journal* 45, no. 5 (September–October 1989): 72–75.

contrast to the usual inverse relationship between yield changes and bond price changes, in this case yield changes and price changes both decline.

Option-Adjusted Duration[31] Given these two extreme values of (1) duration to maturity and (2) duration to first call, the investment community derives a duration estimate that is referred to as an option-adjusted or call-adjusted duration based on *the probability that the issuing firm will exercise its call option* for the bond when the bond becomes freely callable. This option-adjusted duration will be somewhere between these two extreme values. Specifically, when interest rates are substantially above the coupon rate, the probability of the bond being called is very small (i.e., the call option has very little value) and the option-adjusted duration will approach the duration to maturity. In contrast, if interest rates decline to levels substantially below the coupon rate, the probability of the bond being called at the first opportunity is very high (i.e., the call option is very valuable and will probably be exercised) and the option-adjusted duration will approach the duration to first call. In summary, the bond's option-adjusted duration will be somewhere between these two extremes with the exact option-adjusted duration depending on the level of interest rates relative to the bond's coupon rate.

The option-adjusted duration can also be envisioned or computed based on the duration of the two components, as follows:

➤**19.21** Option-Adjusted Duration = Duration of the Noncallable Bond – Duration of the Call Option

If one conceives of duration as interest rate sensitivity, we know that at high interest rates a change in yield will have little if any impact on the value of the option. Thus the duration (i.e., interest rate sensitivity) of the option would be close to zero and the option-adjusted duration would equal that of a noncallable bond. In contrast, when yields decline below the coupon yield, the call option will be very interest rate sensitive since the option will experience a large increase in value at low yields. Thus, the duration (i.e., the interest rate sensitivity) of the option will be fairly high and have a large impact on the callable bond's option-adjusted duration—it will drive the duration of the callable bond toward the duration to first call. In fact, it is possible to conceive of an option that is very leveraged such that it is extremely interest rate sensitive (i.e., has a very large duration that exceeds the duration of the noncallable bond) resulting in a *negative option-adjusted duration.* An example is a mortgage-backed security that might *decline* in price when there is a *decline* in interest rates.

Convexity of Callable Bonds Exhibit 19.24 shows what happens to the price of a callable bond versus the value of a noncallable bond when interest rates increase or decline. Starting from yield y^* (which is close to the par value yield), if interest *rates increase,* the value of the call option declines because, at market interest rates that are substantially above the coupon rate, it is unlikely the issuer will want to call the issue. Therefore, the call option has very little value and the price of the callable bond will be similar to the price of a noncallable bond. In contrast, when interest rates *decline* below y^*, there is an increase in the probability that the issuer will want to use the call option—that is, the value of the call option increases. As a result, the value of the callable bond will deviate from the value of the noncallable bond—that is, the price of the callable bond will initially not increase as fast as the noncallable bond price and eventually will not increase at all. This is what is shown in curve *a–b.*

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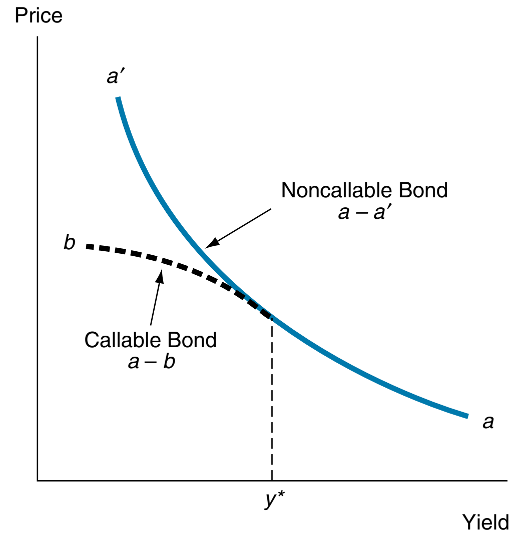
[31]The discussion in this subsection will consider the option-adjusted duration on a conceptual and intuitive basis. For a detailed mathematical treatment, see Dunetz and Mahoney, "Using Duration and Convexity in the Analysis of Callable Bonds."

EXHIBIT 19.24 *NONCALLABLE AND CALLABLE BOND PRICE-YIELD RELATIONSHIP*



Source: Frank J. Fabozzi, Gerald W. Buetow, and Robert R. Johnson, "Measuring Interest Rate Risk," in the *Handbook of Fixed-Income Securities,* 6th ed. (New York: McGraw-Hill, 2001). Reprinted by permission of the McGraw-Hill Companies.

In the case of the noncallable bond, we indicated that it had *positive convexity* because as yields declined, the price of the bond increased at a *faster* rate. With the callable bond, when rates decline, the price increases at a *slower* rate and eventually does not change at all. This pattern of price-yield change for a callable bond when yields decline is referred to as *negative convexity.*

Needless to say, this price pattern (negative convexity) is one of the risks of a callable bond versus a noncallable bond when interest rates decline.

Limitations of Macaulay and Modified Duration

It is important to understand Macaulay and modified duration because of the perspective they provide regarding factors that affect the volatility and interest rate sensitivity of bonds. However, it also is important for bond analysts and portfolio managers to recognize the serious limitations of these measures in the real world. The major limitations are as follows.

First, as noted in the discussion of convexity, the percent change estimates using modified duration are good only for small-yield changes. This was demonstrated in Exhibit 19.21. As a result, two bonds with equal duration may experience different price changes for large-yield changes—depending on *differences in the convexity* of the bonds.

Second, it is difficult to determine the interest rate sensitivity of a portfolio of bonds when there is a change in interest rates and the yield curve experiences a *nonparallel shift.* It was noted earlier that the duration of a portfolio is the weighted average of the durations of the bonds in the portfolio. Everything works well as long as all yields change by the same amount—that is, there is a parallel shift of the yield curve. However, when yields change, the yield curve *seldom* experiences a parallel shift. Assuming a nonparallel shift, which yield do you use to describe the change—the short-, intermediate-, or long-maturity yield? Two portfolios that begin the period with the same duration can have different ending durations and perform very differently, depending on how the yield curve changed (i.e., did it steepen or flatten?) and the composition of the portfolio (i.e., relative to its duration, was it a bullet or a barbell?). Consider the following simple example for two portfolios that have a duration of 4.50 years:

Bond	Coupon	Maturity (Years)	Yield	Modified Duration	Weights
Portfolio A					
A	7.00	4	7.00	2.70	0.555
B	9.00	20	9.00	6.75	0.445
Portfolio B					
C	8.00	10	8.00	4.50	1.000

As shown, the modified durations are equal at the initiation of the portfolio. Assume a nonparallel change in yields where the *yield curve steepens.* Specifically, 4-year yields decline to 6 percent, 10-year yields do not change, and 20-year yields rise to 10 percent. Portfolio B would experience a very small change in value because of stability in yield for 10-year bonds. In contrast, the price for 4-year bonds will experience a small increase (because of small duration) and the value of 20-year bonds will experience a large decline. Overall, the value of Portfolio A will decline because of the weight of Bond B in the portfolio and its large decline in value due to its large modified duration. Obviously, if the yield curve had flattened or inverted, the barbell portfolio would have benefited from the change. This differential performance because of the change in the shape of the yield curve (i.e., it did not experience a parallel shift) is referred to as *yield curve risk,* which cannot be captured by the traditional duration-convexity presentation.

The third limitation of Macaulay and modified durations involves our initial calculation. We assumed that cash flows from the bond *were not affected by yield changes*—that is, we assumed option-free bonds. Later, we saw the effect on the computed duration and convexity when we considered the effect of an embedded call option in Exhibit 19.24. Specifically, we saw that the option-adjusted duration would be some value between the duration to maturity and duration to first call and the specific value would depend on the current market yield relative to the bond's coupon. Further, we saw that when interest rates declined with an embedded call option, the convexity of the bond went from some positive value to *negative* convexity because the price of the callable bond increased at a slower rate or it did not change when the yields declined (i.e., there is *price compression*).

Because of these limitations, practitioners have developed a way to approximate the duration of a bond or any security that can be impacted by a change in interest rates. This is referred to as *effective duration,* which is discussed in the following section.

Effective Duration[32] As noted previously, the purpose of duration is to indicate the price change of an asset to a change in yield—that is, it is *a measure of the interest rate sensitivity of an asset.* Because modified duration is based on Macaulay duration, it can provide a reasonable approximation of the interest rate sensitivity of a bond that experiences a small-yield change and one that is option free—if yield changes do not change the cash flows for the bond. Unfortunately, the Macaulay and modified-duration measures cannot be used (1) for large-yield changes; (2) for assets with embedded options; or (3) for assets that are affected by variables other than interest rates, such as common stocks or real estate.

[32]This section benefited substantially from the very thorough presentation in Frank J. Fabozzi, Gerald W. Buetow, Jr., and Robert R. Johnson, "Measuring Interest Rate Risk," *Handbook of Fixed-Income Securities,* 6th ed.

To overcome these limitations, practitioners use *effective duration,* a direct measure of the interest rate sensitivity of a bond or any asset where it is possible to use a pricing model to estimate the market prices surrounding a change in interest rates. As we will demonstrate, using this measure it is possible to derive negative durations (which is not mathematically possible with Macaulay) or durations that are longer than the maturity of the asset (likewise not possible with Macaulay). Specifically, effective duration measures the interest rate sensitivity of a bond taking into consideration that the cash flows of the bond can change when yields change due to the existence of embedded options (e.g., call or put options). It is also possible to calculate the effective duration for an option-free bond, in which case the computed duration value will be equal to what would be derived for small-yield changes using modified duration.

Notably, to implement the effective duration formula, it is necessary to use an interest rate model and a corresponding pricing model that will provide price estimates for the asset when interest rates and cash flows change. The formulas for calculating effective duration and effective convexity are:

➤19.22 $$\text{Effective Duration } (D_{Eff}) = \frac{(P_-) - (P_+)}{2PS}$$

➤19.23 $$\text{Effective Convexity } (C_{Eff}) = \frac{(P_-) + (P_+) - 2P}{PS^2}$$

where:

P_- = the estimated price of the asset after a downward shift in interest rates
P_+ = the estimated price of the asset after an upward shift in interest rates
P = the current price of the asset (before any interest rate shifts)
S = the assumed shift in the term structure

The formulas are implemented by assuming small changes in yield (10 basis points) both down and up and using a pricing model to estimate the expected market prices (both P_- and P_+) at the new yields. Everything else in the formulas is given. Consider the following bond that we will initially assume is option free:

Par value	$1,000
Coupon	6%
Maturity	8 years
Initial YTM	6%
Initial price (P)	100

Given this initial scenario, we assume a change in yields of 10 basis points. The prices for the bond at yields to maturity of 5.90 percent (P_-) and 6.10 percent (P_+) are:

$$0.0590\ (P_-) = 100.42760054$$
$$0.0610\ (P_+) = \underline{99.57457612}$$
$$(P_-) - (P_+) = 0.85302442$$
$$2PS = (2)(100)(0.001) = 0.20$$

$$D_{Eff} = \frac{0.85302442}{0.20} = 4.265122$$

Because this is a noncallable bond (option free), we know that this effective duration equals the modified duration we would derive based upon the Macaulay duration of 4.39.

$$D_{mod} \frac{4.39}{\left(1+\frac{0.06}{2}\right)} = \frac{4.39}{1.03} = 4.262$$

The difference is due to the rounding of the Macaulay duration.

The bond's effective convexity would equal

$$\begin{aligned} C_{Eff} &= \frac{(P_-)+(P_+)-2P}{PS^2} \\ &= \frac{100.42760054+99.57457612-200}{(100)(0.001)^2} \\ &= \frac{200.00217666-200}{0.0001} \\ &= \frac{0.00217666}{0.0001} = 21.766 \end{aligned}$$

We know from our earlier discussion that, at a lower yield, the duration would be higher. Specifically, if we assumed a YTM of 4 percent, the effective and modified durations would be about 4.34 compared to about 4.26 at 6 percent.

Let us now assume that the bond is callable at 106 of par after 3 years. Using the Black, Derman, and Toy no-arbitrage binomial model to estimate prices for this bond beginning at a yield of 4 percent, we derive the following prices:[33]

$$\begin{aligned} 0.0390\ (P_-) &= 108.55626094 \\ 0.0410\ (P_+) &= 107.92318176 \\ 0.04\ (P) &= 108.24082177 \end{aligned}$$

$$\begin{aligned} D_{Eff} &= \frac{108.55626094-107.92318176}{(2)(108.24082177)(0.001)} \\ &= 2.92 \end{aligned}$$

As expected, because of the embedded call option that would have increased in value with a decline in yields, this duration value (2.92) would be lower than the duration for the option-free bond discussed earlier (4.34). In contrast, the effective durations for callable bonds at higher yields would be equal to the durations for option-free bonds because the value of the option approaches zero.

The effective convexity of this callable bond at 4 percent would be

$$\begin{aligned} C_{Eff} &= \frac{108.55626094+107.92318176-[2(108.24082177)]}{(108.24082177)(0.001)^2} \\ &= -20.33 \end{aligned}$$

[33]F. Black, E. Derman, and Wo Toy, "A One-Factor Model of Interest Rates and Its Application to Treasury Bond Options," *Financial Analysts Journal* 46, no. 1 (January–February 1990): 33–39.

As discussed, this is an example of negative convexity because the price increase is limited because of the increasing value of the call option. For comparison purposes, the convexity of the option-free bond at 4 percent is 23.76, which is, as expected, slightly higher than its convexity of 21.77 at 6 percent (recall that both duration and convexity are inversely related to yield).

Putable Bonds Although it is not feasible to discuss in detail the properties of bonds with put options (putable bonds), it is possible to envision the effects if one considers the basic value of a putable bond as follows:

➤19.24 Value of Putable Bond = Value of Nonputable Bond + Value of the Put Option

In this instance, the investor owns the option, which means it has a positive impact on the value of the bond and this option *increases* in value when interest rates *increase.* Therefore, when rates increase, the price of the bond does not decline as much as an option-free bond, but when rates decline, its price pattern is similar to that of an option-free bond because the value of the put option approaches zero.

A visual presentation of the effect of the call option on the price-yield curve was contained in Exhibit 19.24. Alternatively Exhibit 19.25 and Exhibit 19.26 contain the effective duration-yield curves and the effective convexity–yield curves, which show the significant impact of embedded options on the effective duration and convexity of fixed-income securities.

Effective Duration Greater than Maturity Because effective duration is simply interest rate sensitivity, it is possible to have an asset that is highly levered such that its interest rate sensitivity exceeds its maturity. For example, there are five-year, collateralized mortgage obligations (CMOs) that are highly levered and their prices will change by 15 percent to 20 percent when interest rates change by 100 basis points. Using the formula discussed (Equation 19.22), you would compute an effective duration of 15 or 20 for a five-year maturity security.

Negative Effective Duration We know from the formula for Macaulay duration that it is not possible to compute a negative duration. Further, in the calculation for price volatility where we use modified duration, we use $-D^*$ to reflect the negative relationship between price changes and interest rate changes for *option-free bonds.* At the same time, we know that when we leave the world of option-free bonds and consider bonds with embedded options, it is possible to envision cases where bond prices move in the same direction as yields, which implies negative duration. A prime example would be mortgage-backed securities where a significant decline in interest rates will cause a substantial increase in refinancing prepayments by homeowners, which will reduce the value of these bonds to holders. Therefore, you would see a decline in interest rates *and* a decline in the price of these mortgage-backed bonds, which implies *negative duration.* Another way to explain a price decline with lower interest rates is the value formula (Equation 19.20)—that is, with lower interest rates, the value of the call option increases in value by more than the increase in value of the noncallable bond, which causes a decline in the value of the callable bond.

Empirical Duration[34] In the preceding discussion of effective duration, the point was made that these computations required the use of an interest rate model and a bond pricing model that considered cash flow changes when yields changed and generated market price estimates that were inputs into the effective duration and effective convexity formulas. The question arises regarding what happens when you want to estimate interest rate sensitivity for an asset class

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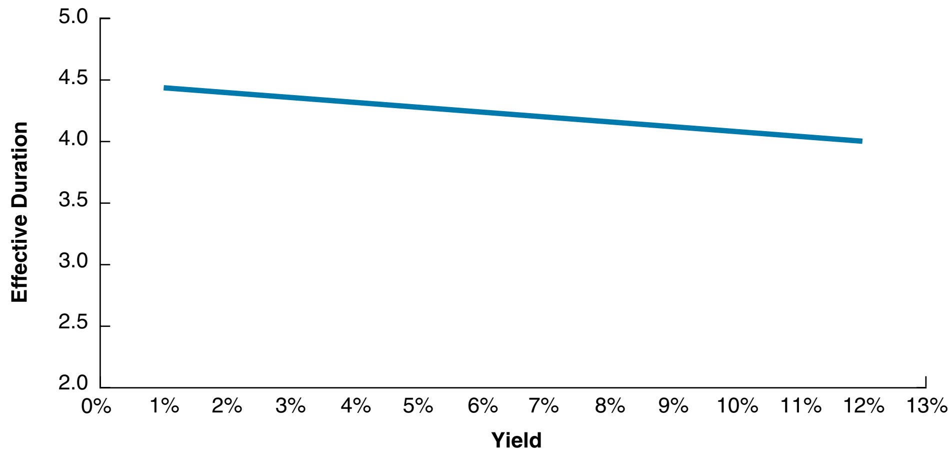
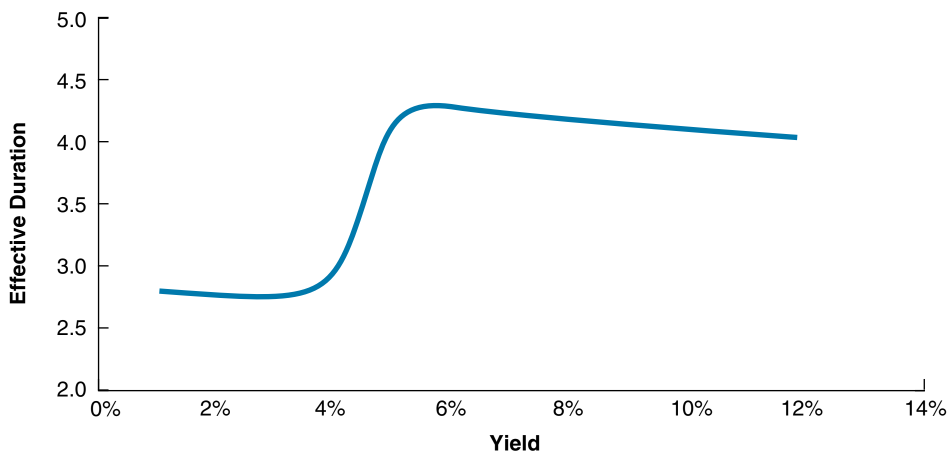
[34]The discussion in this section considered the analysis in Lakhbir Hayre and Hubert Chang, "Effective and Empirical Durations of Mortgage Securities," *Journal of Fixed Income* 6, no. 4 (March 1997): 17–33.

EXHIBIT 19.25 *EFFECTIVE DURATION–YIELD CURVES*

A. Effective Duration–Yield Curve for 8-year, 6% Option-Free Bond



B. Effective Duration–Yield Curve for 8-year, 6% Callable Bond after 3 Years



C. Effective Duration–Yield Curve for 8-year, 6% Putable Bond after 3 Years

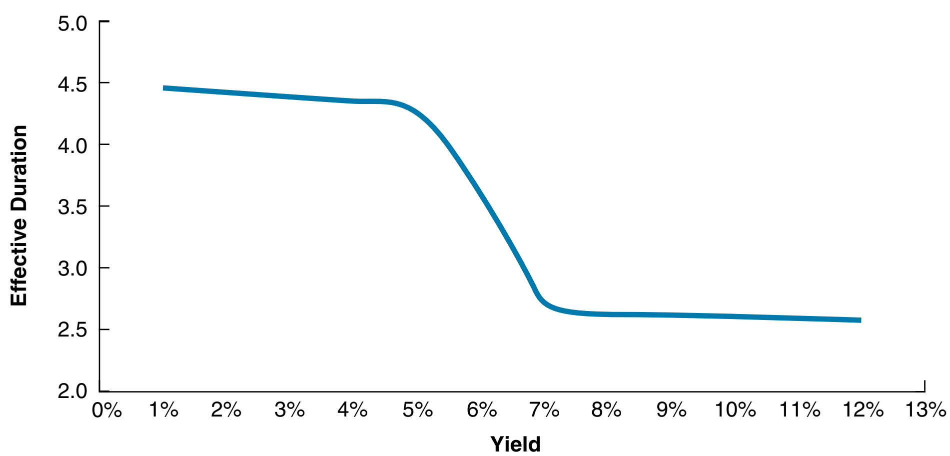
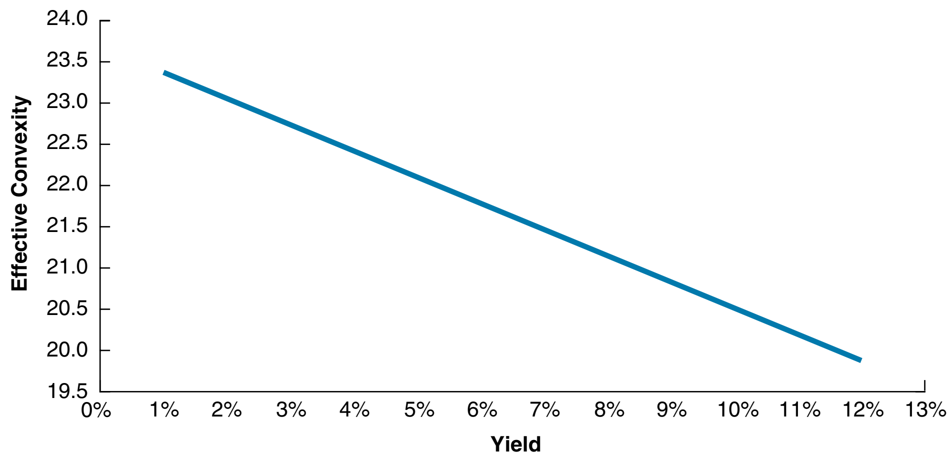
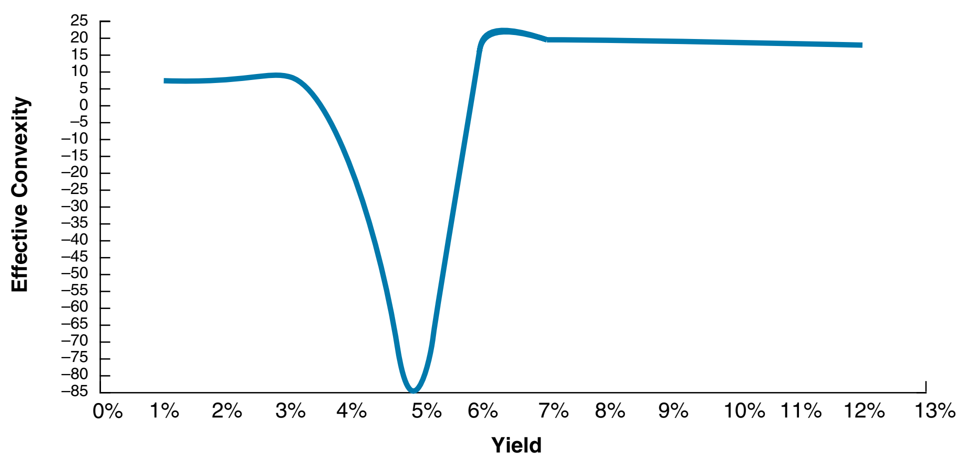


EXHIBIT 19.26 *EFFECTIVE CONVEXITY–YIELD CURVES*

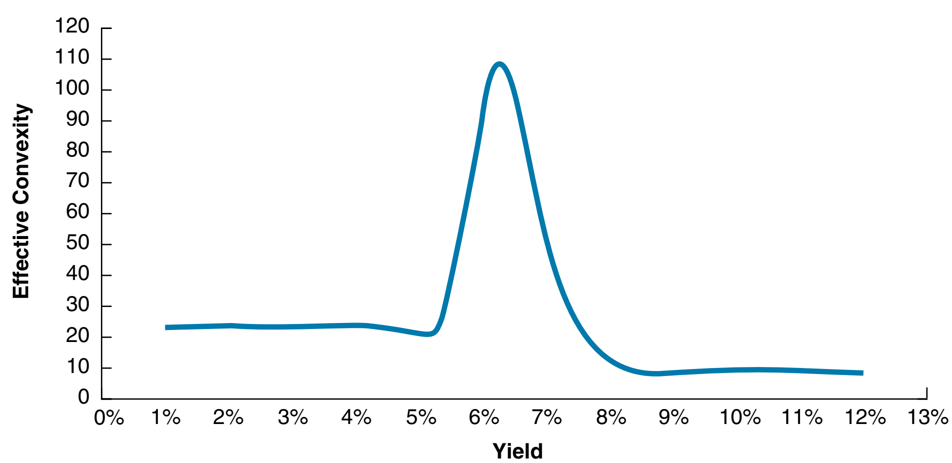
A. Effective Convexity–Yield Curve for 8-year, 6% Option-Free Bond



B. Effective Convexity–Yield Curve for 8-year, 6% Callable Bond after 3 Years



C. Effective Convexity–Yield Curve for 8-year, 6% Putable Bond after 3 Years



where it is not possible to generate well-specified market price estimates in response to yield changes. The classic example would be common stocks where there is an impact on price when interest rates change, but the interest rate effect can be overpowered by the growth rate effect that is likewise unknown. The other obvious example would be bonds with exotic embedded options (including mortgage-backed bonds) where prices can change based upon the value of the exotic option that is difficult to price. In order to derive some estimate of interest rate sensitivity under such circumstances, analysts and portfolio managers employ **empirical duration**, which is the actual percentage price change for an asset in response to a change in yield during a specified time period. The concept is best described by recalling the formula in Equation 19.14 used to determine the percentage price change for a bond using modified duration as follows:

$$\%\Delta Price = -D_{mod} \times (\Delta i)$$

where:

D_{mod} = the modified Macaulay duration
Δi = the change in interest rates in basis points divided by 100

The typical assumption is that we know D_{mod} and Δi and can solve for the approximate percentage price change. Alternatively, given this relationship, we can solve for D_{mod} as follows:

➤19.25 $$-D_{mod} = \frac{\%\Delta Price}{\Delta i}$$

When we solve for it this way, it is no longer D_{mod} (modified duration), but D_{emp}—empirical duration. Given this formulation, if you observe a change in interest rates (Δi) and the change in the price of an asset during the same time period, you can solve for the empirical duration of the asset. Consider the following simple example:

➤ Interest rates decline by 200 BP.
➤ The price of a bond increases by 10 percent.

$$D_{emp} = -\frac{10}{-200/100} = -\frac{10}{-2}$$

Therefore, the change in price coincident with a change in interest rates indicates that this bond has an empirical duration (D_{emp}) of 5. This is a direct measure of the bond's interest rate sensitivity. You should think of it as *the approximate percentage change in price for a 100-basis-point change in interest rates.*

While this simple example indicates the concept of empirical duration, the technique that is generally suggested for estimating empirical duration is to employ the following regression model:

➤19.26 $$\frac{\Delta P}{P} = \alpha + D^{**}\Delta Y + u$$

where:

$\frac{\Delta P}{P}$ = percentage change in price
α = constant term
D^{**} = an estimate of D_{emp} (empirical duration)
ΔY = change in yield in basis points
u = random error term

The time interval for the data and the time period considered can vary based upon the asset and purpose of the analysis. When working with bonds, some analysts employ daily data for short time periods (months), while investigators using the concept for stocks or real estate (to be discussed) have employed weekly and monthly data for longer time periods (quarters or years).

Empirical Duration for Common Stock

If one considers the Macaulay duration of common stock, it is possible to envision a fairly high number because you are dealing with a perpetuity, and some growth stocks pay low dividends for many years. The values derived by Reilly and Sidhu, using various assumptions of price and growth, ranged from 10 years to 20 years.[35] In contrast, using empirical duration, one gets very different results.

Because we are dealing with the interest rate sensitivity of an asset, it is possible to compute an empirical duration for common stock that is much lower than what is implied by Macaulay duration and it is more variable. Observing a change in interest rates and the accompanying percentage change in stock prices would indicate the interest rate sensitivity of stocks. Leibowitz conducted such an analysis and derived a rolling, one-year effective duration for the S&P 500 that ranged *from about zero to almost seven*.[36] When measuring the interest rate sensitivity of common stocks over time, you would expect changes because the correlation between stock and bond returns varies substantially over time.[37] In addition, you might anticipate significant differences in the effective duration for alternative stocks. For example, you would expect a large difference in the interest rate sensitivity (empirical duration) of a banking or utility stock (which is very interest rate sensitive) compared to the empirical duration of a small-cap or technology stock where its value is based more on changes in its specific growth expectations than interest rates.

Yield Spreads with Embedded Options

Earlier in the chapter, we discussed the analysis of yield spread as a technique to enhance bond investments or bond trades. At this point, it is necessary to revisit the concept of yield spreads, keeping in mind the term structure of interest rates but, more important, with an awareness of the significant impact that interest rate volatility has on the value of embedded options in bonds. In this revisitation, we will consider two spreads: (1) **static yield spreads** that consider the total term structure and (2) **option-adjusted spreads** that consider changes in the term structure and alternative estimates of the volatility of interest rates.

Static Yield Spreads

You will recall that the traditional yield spread compares the yields between two bonds with similar coupons and equal maturities as follows:

8%—20-Year AA Corporate Bond	8.20%
8%—20-Year Treasury Bond	7.10%
Yield Spread	1.10%
	110 bp

[35]Frank K. Reilly and Rupinder Sidhu, "The Many Uses of Bond Duration," *Financial Analysts Journal* 36, no. 4 (July–August 1980): 58–72.

[36]Martin L. Leibowitz, *New Perspectives on Asset Allocation* (Charlottesville, Va.: The Research Foundation of the Institute of Chartered Financial Analysts, 1987).

[37]For a specific analysis of the intertemporal correlation between stock returns and Treasury bond returns (which implies the relationship with interest rates), see Frank K. Reilly, David J. Wright, and Kam C. Chan, "Bond Market Volatility Compared to Stock Market Volatility" *Journal of Portfolio Management* 27, no. 1 (Fall 2000): 82–92.

There are three problems with this "traditional" yield spread:

- The two yields do not consider the prevailing term structures of interest rates but only consider the yield spread at the one point on the curve (at 20 years).
- The analysis does not consider the fact that the corporate bond could have an embedded option (put or call), whereby expected interest rate volatility may alter the cash flow for this bond.
- While not true in this example, it is possible that investors would compare two bonds with equal maturities but different coupon cash flow (e.g., a zero coupon bond versus a coupon bond).

The first concern (neglect of the term structure) suggests the consideration of the *static spread.* It is contended that the proper way to compare non-Treasury bonds of the same maturity but with different coupon rates is to compare them to a portfolio of Treasury securities that have the same cash flow. The way to do this, if there is not an existing Treasury bond with the specified flows, is to discount the corporate bond's cash flow as if the flows were risk free. Specifically, discount them using the prevailing Treasury spot rates for the life of the corporate bond. Consider the following example:

Corporate Bond—8%, Five-Year Bond

If we discount this bond's flows using the hypothetical Treasury spot rate curve contained in Exhibit 19.27, the price would be $1,040.56, which is what this bond would sell at if it were a Treasury bond. In fact, the bond is priced at $1,006.70. The *static spread* (also called the *zero volatility spread*) is the spread that will make the present value of the cash flows from the corporate bond when discounted at the Treasury spot rate plus the static spread, equal to the corporate bond's market price. To put it another way, how much of a static spread across all points on the Treasury spot rate curve is required to generate the current market price for this bond? Adding 70 basis points to every spot rate generates a price above $1,006.70, which indicates that we need to consider a larger spread. As shown in Exhibit 19.28, using a spread of 80 basis points generates a price of $1,006.70, which equals the current price of the corporate bond, which indicates that there is a static (zero volatility) spread for the bond of 80 basis points or 0.80 percent.

Option-Adjusted Spread

As noted, the traditional spread was a problem because it did not consider the full-term structure or the impact of interest rate volatility. The term structure problem was addressed by estimating the static spread.

The interest rate volatility factor is considered by the option-adjusted spread (OAS) analysis. Why is interest rate volatility a problem? The point is, as discussed earlier in the chapter, if a bond has an embedded call option, this option can affect the bond's expected cash flow. The likelihood of the call being exercised will depend on future interest rates, the remaining maturity of the bond, the call price, and other costs of a call and new issue.

The goal of the OAS is similar to the static spread except that the technique allows for a *change in the term structure* over time based on some estimates of interest rate volatility.

The concept of OAS is best understood by a presentation of the steps involved in estimating the OAS for a specific bond as follows:

1. Based upon the prevailing Treasury yield curve, estimate the term structure of interest rates (i.e., the prevailing Treasury spot rate curve) and the implied short-term forward rates derived from the spot rates.
2. Select a probability distribution for short-term Treasury spot rates. This should be based on the current term structure and the historical behavior of interest rates. The significant

EXHIBIT 19.27 *CALCULATION OF THE PRICE OF A FIVE-YEAR, 8 PERCENT COUPON BOND USING TREASURY SPOT RATES*

Period	Cash Flow	Treasury Spot Rate	Present Value
1	$ 40	6.20	$ 38.80
2	40	6.30	37.60
3	40	6.40	36.40
4	40	6.50	35.20
5	40	6.60	34.00
6	40	6.70	32.84
7	40	6.80	31.64
8	40	6.90	30.48
9	40	7.00	29.36
10	1040	7.10	734.24
		Theoretical price	$1040.56

EXHIBIT 19.28 *CALCULATION OF THE STATIC SPREAD FOR A FIVE-YEAR, 8 PERCENT COUPON CORPORATE BOND*

Period	Cash Flow	Treasury Spot Rate	80 BP Spread Spot Rate	Present Value
1	$ 40	6.20	7.00	$ 38.64
2	40	6.30	7.10	37.30
3	40	6.40	7.20	35.98
4	40	6.50	7.30	34.66
5	40	6.60	7.40	33.36
6	40	6.70	7.50	32.07
7	40	6.80	7.60	30.81
8	40	6.90	7.70	29.57
9	40	7.00	7.80	28.35
10	1040	7.10	7.90	705.95
			Present Value	$1006.70

estimate is the volatility of interest rates—that is, how much will the forward rates change each period?

3. Using the probability distribution specified in Step 2 and Monte Carlo simulation, it is possible to randomly generate a large number of interest rate paths (e.g., 1,000).
4. For bonds with embedded options (such as callable bonds), develop rules for determining when the option will be exercised. For example, given the coupon, maturity, and call option, at what interest rate will the issue be called?
5. For each path generated in Step 3, determine the cash flows from the bond, given (a) the information about the bond (i.e., its call provision) and (b) the rules established in Step 4 for calling the bond.
6. For an assumed spread relative to the Treasury term structure of spot rates along a path, calculate a present value for all paths created in Step 3.

7. Calculate the *average* present value for all the interest rate paths.
8. Compare the average present value calculated in Step 7 to the market price of the bond. If they are equal, the assumed spread used in Step 6 is the option-adjusted spread. If they are not, try another spread and repeat Steps 6, 7, and 8.

The computed option-adjusted spread (OAS) is the average spread over the Treasury spot rate curve based on the potential paths that can be realized in the future for interest rates. The reason it is referred to as "option adjusted" is because the potential paths of cash flow are adjusted to reflect the effect of the options embedded in the bonds.

The following are some technical issues that an analyst should be aware of when attempting to estimate the OAS and also factors that can cause differences in an estimate of the OAS for a bond by alternative dealers.

- It is necessary to have a large number of paths for the simulation.
- The estimate of the probability distribution, which includes the volatility, is crucial. Notably, if alternative firms differ in this estimate of expected interest rate volatility, it can cause differences in the OAS estimate.
- It is necessary to determine the relationship between short-term rates and refinancing rates. Specifically, how much more does the firm have to pay above the short-term forward rate (i.e., the refinancing rate is a long-term rate)? Empirically, what is this relationship?
- A call rule must be specified. This depends upon the coupon rate for the bond and other costs. It has been assumed to be almost 300 BP below the coupon rate (e.g., 5.0 percent with at least three years to maturity).

As noted, different assumptions regarding these technical issues can cause different estimates of the OAS by alternative dealers. The critical estimate is the expected interest rate volatility and this can vary between dealers; and, also, individual dealers can change their estimates over time.

The Internet *Investments Online*

Bond valuation focuses on bond mathematics, the term structure, and bond features that add to the yield (such as callability) or lead to lower yields (such as putability). Bonds are normally easier to evaluate than stocks, given their stated life, cash flows, and discount rates, which can be read from the term structure. Nonetheless, bond pricing can become quite complicated if the bond has complex options or attributes. It is not surprising that bond market commentary typically focuses on interest rate trends and factors that can favorably or unfavorably affect credit quality.

http://www.bondcalc.com This site discusses a software pricing system for fixed income securities. It includes a description of basic and sophisticated bond analyses.

http://www.kalotay.com The Web site of Andrew Kalotay Associates offers research on bond analytics, for-purchase software for bond valuation and analysis, and freeware for valuing bonds and mortgage-backed securities.

Many brokerage houses offer bond market commentaries and analysis. For example, see **http://www.salomonsmithbarney.com/research** or **http://www.leggmason.com/capitalmarkets/research/commentary/daily_bond_market.asp**. Smartmoney's "living yield curve" feature shows the changes in the yield curve over time: **http://www.smartmoney.com/onebond/index.cfm?story=yieldcurve.**

Summary

- The value of a bond equals the present value of all future cash flows accruing to the investor. Cash flows for the conservative bond investor include periodic interest payments and principal return; cash flows for the aggressive investor include periodic interest payments and the capital gain or loss when the bond is sold prior to its maturity. Bond investors can maximize their portfolio rates of return by accurately estimating the level of interest rates and, more importantly, by estimating changes in interest rates, yield spreads, and credit quality. Similarly, they must compare coupon rates, maturities, and call features of alternative bonds.
- There are five bond yield measures: nominal yield, current yield, promised yield to maturity, promised yield to call, and realized (horizon) yield. The promised YTM and promised YTC equations include the interest-on-interest (or coupon reinvestment) assumption. For the realized (horizon) yield computation, the investor estimates the reinvestment rate and the future selling price for the bond. The fundamental determinants of interest rates are a real risk-free rate, the expected rate of inflation, and a risk premium.
- The yield curve (or the term structure of interest rates) shows the relationship between the yields on a set of comparable bonds and the term to maturity. Based upon this yield curve, it is possible to derive a theoretical spot rate curve. In turn, these spot rates can be used to value bonds using an individual spot rate for each cash flow. This valuation approach is becoming more useful in a world where bonds have very different cash flows. In addition, these spot rates imply investor expectations about future rates referred to as forward rates. Yield curves exhibit four basic patterns. Three theories attempt to explain the shape of the yield curve: the expectations hypothesis, the liquidity preference (term premium) hypothesis, and the segmented market hypothesis.
- It is important to understand what causes changes in interest rates and how these changes in rates affect the prices of bonds. Differences in bond price volatility are mainly a function of differences in yield, coupon, and term to maturity. There are four duration measures that have been used as measures of bond price volatility or interest rate sensitivity. The Macaulay duration measure incorporates coupon, maturity, and yield in one measure. In turn, modified duration (which is directly related to Macaulay duration) provides an estimate of the response of bond prices to changes in interest rates under certain assumptions. Because modified duration provides a straight-line estimate of the curvilinear price-yield function, you must consider modified duration together with the convexity of a bond for large changes in yields and/or when dealing with securities that have high convexity. Notably, an embedded call option feature on a bond can have a significant impact on its duration (the call feature can shorten it dramatically) and on its convexity (the call feature can change the convexity from a positive value to a negative value). Following a discussion of some of the limitations of Macaulay and modified durations as measures of interest rate sensitivity, effective duration is introduced as a direct measure of interest rate sensitivity—that is, it is the estimated percentage change in price for a 100-basis-point change in interest rates and allows for repricing due to changes in cash flow caused by changes in interest rates. Notably, with effective duration, it is necessary to have a valid bond pricing model and it is possible to have durations longer than maturity as well as negative duration.
- Finally, there are instances when it is very difficult to estimate the price when there is a change in interest rates as required for effective duration—such as with some mortgage-backed securities, common stock, and real estate. In these instances, analysts consider estimating empirical duration, which is based on the analysis of historical data on price changes that accompany interest rate changes. While it is possible to derive such estimates for a range of assets, it is important to remember that the duration values derived can vary dramatically and are notoriously unstable.
- We concluded the chapter with a revisitation to yield spreads for bonds with embedded options. To take account of the spread across the total term structure of interest rates, we described and demonstrated the static spread. In order to consider the impact of interest rate volatility on the embedded options, we discussed and described the steps to estimate the option-adjusted spread (OAS) for these bonds.

Given the background in bond valuation and the factors that influence bond value and bond return volatility, we are ready to consider how to build a bond portfolio that is consistent with our goals and objectives. Bond portfolio analysis is the topic for Chapter 20.

Questions

1. Why does the present value equation appear to be more useful for the bond investor than for the common stock investor?
2. What are the important assumptions made when you calculate the promised yield to maturity? What are the assumptions when calculating promised YTC?
3. a. Define the variables included in the following model:

$$i = (RFR, I, RP)$$

   b. Assume that the firm whose bonds you are considering is not expected to break even this year. Discuss which factor will be affected by this information.
4. We discussed three alternative hypotheses to explain the term structure of interest rates. Briefly discuss the three hypotheses and indicate which one you think best explains the alternative shapes of a yield curve.
5. *CFA Examination Level I*
   a. Explain what is meant by *structure of interest rates.* Explain the theoretical basis of an upward-sloping yield curve [8 minutes]
   b. Explain the economic circumstances under which you would expect to see the inverted yield curve prevail. [7 minutes]
   c. Define "real" rate of interest. [2 minutes]
   d. Discuss the characteristics of the market for U.S. Treasury securities. Compare it to the market for AAA corporate bonds. Discuss the opportunities that may exist in bond markets that are less than efficient. [8 minutes]
   e. Over the past several years, fairly wide yield spreads between AAA corporates and Treasuries have occasionally prevailed. Discuss the possible reasons for this. [5 minutes]
6. *CFA Examination Level III*
   As the portfolio manager for a large pension fund, you are offered the following bonds:

	Coupon	Maturity	Price	Call Price	Yield to Maturity
Edgar Corp. (new issue)	14.00%	2012	$101.3/4	$114	13.75%
Edgar Corp. (new issue)	6.00	2012	48.1/8	103	13.60
Edgar Corp. (2000 issue)	6.00	2012	48.7/8	103	13.40

   Assuming that you expect a decline in interest rates over the next three years, identify and justify which of these bonds you would select. [10 minutes]
7. You expect interest rates to decline over the next six months.
   a. Given your interest rate outlook, state what kinds of bonds you want in your portfolio in terms of duration and explain your reasoning for this choice.
   b. You must make a choice between the following three sets of noncallable bonds. For each set, select the bond that would be best for your portfolio given your interest rate outlook and the consequent strategy set forth in Part a. In each case briefly discuss why you selected the bond.

		Maturity	Coupon	Yield to Maturity
Set 1:	Bond A	15 years	10%	10%
	Bond B	15 years	6%	8%
Set 2:	Bond C	15 years	6%	10%
	Bond D	10 years	8%	10%
Set 3:	Bond E	12 years	12%	12%
	Bond F	15 years	12%	8%

8. At the present time, you expect a decline in interest rates and must choose between two portfolios of bonds with the following characteristics:

	Portfolio A	Portfolio B
Average maturity	10.5 years	10.0 years
Average YTM	7%	10%
Modified duration	5.7 years	4.9 years
Modified convexity	125.18	40.30
Call features	Noncallable	Deferred call features that range from 1 to 3 years

Select one of the portfolios and discuss three factors that would justify your selection.

9. The Chartered Finance Corporation has issued a bond with the following characteristics:

Maturity—25 years
Coupon—9%
Yield to maturity—9%
Callable—after 3 years @ 109
Duration to maturity—8.2 years
Duration to first call—2.1 years

a. Discuss the concept of call-adjusted duration and indicate the approximate value (range) for it at the present time.
b. Assuming interest rates increase substantially (i.e., to 13 percent), discuss what will happen to the call-adjusted duration and the reason for the change.
c. Assuming interest rates decline substantially (i.e., they decline to 4 percent), discuss what will happen to the bond's call-adjusted duration and the reason for the change.
d. Discuss the concept of negative convexity as it relates to this bond.

CFA®
10. *CFA Examination Level I*
Duration may be calculated by *two* widely used methods. Identify these *two* methods, and briefly discuss the primary differences between them. [5 minutes]

CFA®
11. *CFA Examination Level II*
Option-adjusted duration and *effective duration* are alternative measures used by analysts to evaluate fixed-income securities with embedded options.

Briefly describe *each* measure and how to apply *each* to the evaluation of fixed-income securities with embedded options. [8 minutes]

CFA®
12. *CFA Examination Level II*
As a portfolio manager, during a discussion with a client, you explain that historical return and risk premia of the type presented in the following table are frequently used in forming estimates of future returns for various types of financial assets. Although such historical data are helpful in forecasting returns, most users know that history is an imperfect guide to the future. Thus, they recognize that there are reasons why these data should be adjusted if they are to be employed in the forecasting process.

U.S. HISTORICAL RETURN AND RISK PREMIA (1926–1994)

	Per Year
Inflation rate	3.0%
Real interest rate on Treasury bills	0.5%
Maturity premium of long Treasury bonds over Treasury bills	0.8%
Default premium of long corporate bonds over long Treasury bonds	0.6%
Risk premium on stock over long Treasury bonds	5.6%
Return on Treasury bills	3.5%
Return on long corporate bonds	4.9%
Return on large-capitalization stocks	9.9%

a. As shown in the table, the historical real interest rate for Treasury bills was 0.5 percent per year and the maturity premium on Treasury bonds over Treasury bills was 0.8 percent. Briefly describe and justify *one* adjustment to *each* of these two data items that should be made before they can be used to form expectations about future real interest rates and Treasury bond maturity premia. [6 minutes]

b. You recognize that even adjusted historical economic and capital markets data may be of limited use when estimating future returns. Independent of your Part a response, briefly describe *three* key circumstances that should be considered when forming expectations about future returns. [8 minutes]

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13. *CFA Examination Level I*

A portfolio manager at Superior Trust Company is structuring a fixed-income portfolio to meet the objectives of a client. This client plans on retiring in 15 years and wants a substantial lump sum at that time. The client has specified the use of AAA-rated securities.

The portfolio manager compares coupon U.S. Treasuries with zero coupon stripped U.S. Treasuries and observes a significant yield advantage for the stripped bonds.

Maturity	Coupon U.S. Treasuries	Zero Coupon Stripped U.S. Treasuries
3 year	5.50%	5.80%
5 year	6.00%	6.60%
7 year	6.75%	7.25%
10 year	7.25%	7.60%
15 year	7.40%	8.80%
30 year	7.75%	7.75%

Briefly discuss *two* reasons why zero coupon stripped U.S. Treasuries could yield more than coupon U.S. Treasuries with the same final maturity. [5 minutes]

CFA®

14. *CFA Examination Level II*

a. In terms of option theory, explain the impact on the offering yield of adding a call feature to a proposed bond issue. [5 minutes]

b. Explain the impact on *both* bond duration and convexity of adding a call feature to a proposed bond issue. [10 minutes]

Assume that a portfolio of corporate bonds is managed to maintain targets for modified duration and convexity.

c. Explain how the portfolio could include *both* callable and noncallable bonds while maintaining the targets. [5 minutes]

d. Describe *one* advantage and *one* disadvantage of including callable bonds in this portfolio. [5 minutes]

CFA®

15. *CFA Examination Level II*

The shape of the U.S. Treasury yield curve appears to reflect two expected Federal Reserve reductions in the Federal Funds rate. The first reduction of approximately 50 basis points (BP) is expected six months from now, and the second reduction of approximately 50 BP is expected one year from now. The current U.S. Treasury term premiums are 10 BP per year for each of the next three years (out through the three-year benchmark.)

You agree that the two Federal Reserve reductions described will occur. However, you believe that they will be reversed in a single 100 BP increase in the Federal Funds rate 2 1/2 years from now. You expect term premiums to remain 10 BP per year for each of the next three years (out through the three-year benchmark.)

a. Describe *or* draw the shape of the Treasury yield curve out through the three-year benchmark. (*Note to Candidates:* Be sure to label your axes and relevant data points carefully.) [4 minutes]

b. State which term structure theory supports the shape of the U.S. Treasury yield curve described in Part a. Justify your choice. [6 minutes]

Kent Lewis, an economist, also expects two Federal Reserve reductions in the Federal Funds rate but believes that the market is too optimistic about how soon they will occur. Lewis believes that the first 50 BP reduction will be made 1 year from now and that the second 50 BP reduction will be made 1½ years from now. He expects these reductions to be reversed by a single 100 BP increase 2½ years from now. He believes that the market will adjust to reflect his beliefs when new economic data are released over the next two weeks.

Assume you are convinced by Lewis's argument and are authorized to purchase either the two-year benchmark U.S. Treasury or a Cash/three-year benchmark U.S. Treasury barbell weighted to have the same duration as the two-year U.S. Treasury.

c. Select an investment in *either* the two-year benchmark U.S. Treasury (bullet) *or* the Cash/three-year benchmark U.S. Treasury barbell. Justify your choice. [5 minutes]

16. *CFA Examination Level II*

Beth Goetz, CFA, has decided to add some asset-backed securities (ABS) to her fixed-income portfolio. She has narrowed the choice to an automobile ABS and a fixed-rate home equity loan (second mortgage) ABS.

Automobile ABS are available at a pricing spread of 75 basis points over comparable-maturity Treasuries, with a zero volatility spread of 67 basis points. Home equity loan ABS are available at a pricing spread of 85 basis points over comparable-maturity Treasuries, with an option-adjusted spread of 60 basis points.

a. Explain why pricing spread is not an appropriate measure of yield advantage for ABS. [3 minutes]
b. Describe the concepts of
   (1) Zero volatility spread
   (2) Option-adjusted spread [8 minutes]
c. Explain why option-adjusted spread is the appropriate measure of yield for a second mortgage ABS. [4 minutes]

17. *CFA Examination Level II*

The asset-backed securities (ABS) market has grown in the past few years partly as a result of credit enhancements to ABS.

a. Describe a "letter of credit" and the risk to the investor associated with relying exclusively on this type of credit enhancement. [6 minutes]
b. Describe "early amortization" and the risk to the investor associated with relying exclusively on this type of credit enhancement. [6 minutes]

18. *CFA Examination Level II*

Rachel Morgan owns a newly issued U.S. government agency fixed-rate pass-through mortgage-backed security (MBS) and wants to evaluate the sensitivity of its principal cash flow to the following interest rate scenario:

- Interest rates instantaneously decline by 250 basis points for all maturities, remain there for one year, and then,
- Interest rates instantaneously increase 350 basis points for all maturities and remain there for the next year.

Currently, the MBS is priced close to par and the yield curve is "flat." Morgan does not expect the shape of the yield curve to change during her interest rate scenario.

a. (1) State whether, in the interest rate scenario described, the MBS principal cash flows
   - Increase or decrease in the first year
   - Increase or decrease in the second year

   (2) Discuss the reason why principal cash flows change. [6 minutes]

Morgan also wants to evaluate the price sensitivity of her MBS to changes in interest rates. She knows that modified duration and effective duration are two possible measures she could use to evaluate price sensitivity.

b. Select *and* justify with *one* reason which duration measure Morgan should use to evaluate the price sensitivity of her MBS. [6 minutes]

Morgan also owns a newly issued U.S. government agency collateralized mortgage obligation interest-only (IO) security.

c. State whether the IO security price increases or decreases in the first year of the interest rate scenario described. Justify your response. [6 minutes]

19. *CFA Examination Level III*

One common goal among fixed-income portfolio managers is to earn high incremental returns on corporate bonds versus government bonds of comparable durations. The approach of some corporate bond portfolio managers is to find and purchase those corporate bonds having the largest initial spreads over comparable-duration government bonds. John Ames, HFS's fixed-income manager, believes that a more rigorous approach is required if incremental returns are to be maximized.

The following table presents data relating to one set of corporate/government spread relationships present in the market at a given date:

CURRENT AND EXPECTED SPREADS AND DURATIONS OF HIGH-GRADE CORPORATE BONDS (ONE-YEAR HORIZON)

Bond Rating	Initial Spread over Governments	Expected Horizon Spread	Initial Duration	Expected Duration One Year from Now
Aaa	31 BP	31 BP	4 years	3.1 years
Aa	40 BP	50 BP	4 years	3.1 years

a. Recommend purchase of *either* Aaa *or* Aa bonds for a one-year investment horizon given a goal of maximizing incremental returns. Show your calculations. (Base your decision *only* on the information presented in the preceding table.) [6 minutes]

Ames chooses not to rely *solely* on initial spread relationships. His analytical framework considers a full range of other key variables likely to impact realized incremental returns, including

- call provisions, and
- potential changes in interest rates.

b. Describe *two* variables, *in addition to those identified,* that Ames should include in his analysis *and* explain how *each* of these *two* variables could cause realized incremental returns to differ from those indicated by initial spread relationships. [10 minutes]

20. *CFA Examination Level III*

Charles Investment Management, Inc., a fixed-income manager of U.S.-only portfolios, has provided significant excess returns for its clients through duration and sector management. The firm defines sectors as either government bonds or corporate bonds. Several of the manager's clients have asked the firm about the possibility of investing in international fixed-income markets. These clients mention the favorable performance of these markets, as exemplified by the "international fixed-income aggregate index" in the accompanying table. The clients are asking Charles to transfer the same management techniques that it has successfully applied in the U.S. market to international fixed-income markets.

ANNUALIZED RATES OF RETURN

Bond Index	One Year	Five Years
International fixed-income aggregate index, unhedged	1.0%	15.9%
International fixed-income aggregate index, hedged	6.5	7.2

a. Infer from the table the effect of changes in the U.S. dollar on international fixed-income returns for U.S. investors in the past one-year *and* five-year periods. [6 minutes]

b. Explain why the firm's techniques to generate excess returns through duration *and* sector management in U.S. fixed-income markets may not be transferrable to international fixed-income markets. [6 minutes]

21. *CFA Examination Level II*
On May 30, 1999, Janice Kerr is considering purchasing one of the following newly issued 10-year AAA corporate bonds shown in the following exhibit. Kerr notes that the yield curve is currently flat and assumes that the yield curve shifts in an instantaneous and parallel manner.

BOND CHARACTERISTICS

Description	Coupon	Price	Callable	Call Price
Sentinel due May 30, 2009	6.00%	100.00	Noncallable	Not applicable
Colina due May 30, 2009	6.20%	100.00	Currently callable	102.00

a. Contrast the effect on the price of *both* bonds if yields decline more than 100 basis points. (No calculation is required). [6 minutes]
b. State and explain under which *two* interest rate forecasts Kerr would prefer the Colina bond over the Sentinel bond. [6 minutes]
c. State the directional price change, if any, assuming interest rate volatility increases, for *each* of the following: [6 minutes]
(1) The Sentinel bond
(2) The Colina bond

Problems

1. Four years ago, your firm issued $1,000 par, 25-year bonds, with a 7 percent coupon rate and a 10 percent call premium.
   a. If these bonds are now called, what is the *approximate* yield to call for the investors who originally purchased them?
   b. If these bonds are now called, what is the *actual* yield to call for the investors who originally purchased them at par?
   c. If the current interest rate is 5 percent and the bonds were not callable, at what price would each bond sell?
2. Assume that you purchased an 8 percent, 20-year, $1,000 par, semiannual payment bond priced at $1,012.50 when it has 12 years remaining until maturity. Compute:
   a. Its promised yield to maturity
   b. Its yield to call if the bond is callable in three years with an 8 percent premium.
3. Calculate the duration of an 8 percent, $1,000 par bond that matures in three years if the bond's YTM is 10 percent and interest is paid semiannually.
   a. Calculate this bond's modified duration.
   b. Assuming the bond's YTM goes from 10 percent to 9.5 percent, calculate an estimate of the price change.
4. Two years ago, you acquired a 10-year zero coupon, $1,000 par value bond at a 12 percent YTM. Recently you sold this bond at an 8 percent YTM. Using semiannual compounding, compute the annualized horizon return for this investment.
5. A bond for the Webster Corporation has the following characteristics:

Maturity—12 years
Coupon—10%
Yield to maturity—9.50%
Macaulay duration—5.7 years
Convexity—48
Noncallable

a. Calculate the approximate price change for this bond using only its duration assuming its yield to maturity increased by 150 basis points. Discuss the impact of the calculation, including the convexity effect.
b. Calculate the approximate price change for this bond (using only its duration) if its yield to maturity declined by 300 basis points. Discuss (without calculations) what would happen to your estimate of the price change if this was a callable bond.

6. *CFA Examination Level I*
The following table shows selected data on a German government bond (payable in Deutschemarks) and a U.S. government bond. Identify the components of return and calculate the total return in U.S. dollars for both of these bonds for the year 1991. Show the calculations for *each* component. (Ignore interest on interest in view of the short time period.) [8 minutes]

		MARKET YIELD			EXCHANGE RATE (DM/$U.S.)	
	Coupon	1/1/91	1/1/92	Modified Duration	1/1/91	1/1/92
German government bond	8.50%	8.50%	8.00%	7.0	1.55	1.50
U.S. government bond	8.00%	8.00%	6.75%	6.5	—	—

7. *CFA Examination Level I*
Philip Morris has issued bonds that pay semiannually with the following characteristics:

Coupon	Yield to Maturity	Maturity	Macaulay Duration
8%	8%	15 years	10 years

a. Calculate modified duration using the preceding information. [5 minutes]
b. Explain why modified duration is a better measure than maturity when calculating the bond's sensitivity to changes in interest rates. [5 minutes]
c. Identify the direction of change in modified duration if
   (1) the coupon of the bond were 4 percent, not 8 percent.
   (2) the maturity of the bond were 7 years, not 15 years. [5 minutes]
d. Define convexity and explain how modified duration *and* convexity are used to approximate the bond's percentage change in price, given a change in interest rates. [5 minutes]

8. *CFA Examination Level I*
You are a U.S. investor considering purchase of one of the following securities. Assume that the currency risk of the German government bond will be hedged, and the six-month discount on Deutschemark forward contracts is –0.75 percent versus the U.S. dollar.

Bond	Maturity	Coupon	Price
U.S. government	June 1, 2003	6.50%	100.00
German government	June 1, 2003	7.50%	100.00

Calculate the expected price change required in the German government bond that would result in the two bonds having equal total returns in U.S. dollars over a six-month horizon. [8 minutes]

9. *CFA Examination Level II*
The following are the average yields on U.S. Treasury bonds at two different points in time:

	YIELD TO MATURITY	
Term to Maturity	**January 15, 19XX**	**May 15, 19XX**
1 year	7.25%	8.05%
2 years	7.50%	7.90%
5 years	7.90%	7.70%
10 years	8.30%	7.45%
15 years	8.45%	7.30%
20 years	8.55%	7.20%
25 years	8.60%	7.10%

a. Assuming a pure expectations hypothesis, define a forward rate. Describe how you would calculate the forward rate for a three-year U.S. Treasury bond two years from May 15, 19XX, using the actual term structure provided. [3 minutes]
b. Discuss how *each* of the *three* major term structure hypotheses could explain the January 15, 19XX, term structures shown. [6 minutes]
c. Discuss what happened to the term structure over the time period and the effect of this change on U.S. Treasury bonds of 2 years *and* 10 years. [5 minutes]
d. Assume that you invest solely on the basis of yield spreads and, in January 19XX, acted upon the expectation that the yield spread between 1-year and 25-year U.S. Treasuries would return to a more typical spread of 170 basis points. Explain what you would have done on January 15, 19XX, and describe the result of this action based upon what happened between January 15, 19XX, and May 15, 19XX. [7 minutes]

10. *CFA Examination Level II*
a. Using the information in the following table, calculate the projected price change for Bond B if the yield to maturity for this bond falls by 75 basis points. [7 minutes]
b. Describe the shortcoming of analyzing Bond A strictly to call or to maturity. Explain an approach to remedy this shortcoming. [6 minutes]

MONTICELLO CORPORATION BOND INFORMATION

	Bond A (Callable)	**Bond B (Noncallable)**
Maturity	2012	2012
Coupon	11.50%	7.25%
Current price	125.75	100.00
Yield to maturity	7.70%	7.25%
Modified duration to maturity	6.20	6.80
Convexity to maturity	0.50	0.60
Call date	2006	—
Call price	105	—
Yield to call	5.10%	—
Modified duration to call	3.10	—
Convexity to call	0.10	—

11. *CFA Examination Level II*
U.S. Treasuries represent a significant holding in Monticello's pension portfolio. You decide to analyze the yield curve for U.S. Treasury Notes.

a. Using the data in the following table, calculate the five-year spot and forward rates assuming annual compounding. Show calculations. [8 minutes]

U.S. TREASURY NOTE YIELD CURVE DATA

Years to Maturity	Par Coupon Yield to Maturity	Calculated Spot Rates	Calculated Forward Rates
1	5.00	5.00	5.00
2	5.20	5.21	5.42
3	6.00	6.05	7.75
4	7.00	7.16	10.56
5	7.00	❐	❐

b. Define and describe *each* of the following *three* concepts:

- Yield to maturity
- Spot rate
- Forward rate

Explain how these *three* concepts are related. [9 minutes]

You are considering the purchase of a zero coupon U.S. Treasury Note with four years to maturity.

c. Based on the preceding yield curve analysis, calculate *both* the expected yield to maturity and the price for the security. Show calculations. [8 minutes]

12. *CFA Examination Level III*

Emily Maguire, manager of the actively managed nongovernment bond portion of PTC's pension portfolio, has received a fact sheet containing data on a new security offering. It will be a bond issued by a U.S. corporation but denominated in Australian dollars (A$), with both principal and interest payable in that currency.

The terms of the offering made in June 1992 are as follows:

- Issuer—Student Loan Marketing Association (SLMA—a U.S. government sponsored corporation)
- Rating—AAA
- Coupon Rate—8.5 percent payable quarterly
- Price—par
- Maturity—June 30, 1997 (noncallable)
- Principal and interest payable in Australian dollars (A$)

As an alternative, Maguire finds that five-year U.S. dollar pay notes issued by SLMA yield 6.75 percent.

She prepares an analysis directed at several specific questions, beginning with the following table of economic data for Australia and the United States.

	UNITED STATES			AUSTRALIA		
Major Economic Indicators	1990	1991	1992E	1990	1991	1992E
Real GNP (annual change)	1.1%	–0.5%	2.2%	1.6%	–0.5%	3.0%
Consumer expenditures (annual change)	0.9%	0.0%	1.0%	1.1%	–0.2%	2.0%
Inflation (annual change)	5.4%	4.2%	3.4%	7.3%	3.2%	3.9%
Long-bond yield (end of year)	8.1%	7.2%	7.0%	9.8%	10.0%	10.2%
Trade balance (U.S. $ billions)	–100	–83	–80	–30	–20	–75

Assuming that interest rates fall 100 basis points in both the U.S. and Australian markets over the next year, identify which of these two bonds will increase the most in value, and justify your answer. [7 minutes]

13. *CFA Examination Level II*
The following table shows yields to maturity on U.S Treasury securities as of January 1, 1993:

Term to Maturity	Yield to Maturity
1 year	3.50%
2 years	4.50%
3 years	5.00%
4 years	5.50%
5 years	6.00%
10 years	6.60%

a. Based on the data in the table, calculate the implied forward one-year rate of interest at January 1, 1996. [5 minutes]
b. Describe the conditions under which the calculated forward rate would be an unbiased estimate of the one-year spot rate of interest at January 1, 1996. [5 minutes]

Assume that one year earlier, at January 1, 1992, the prevailing term structure for U.S. Treasury securities was such that the implied forward one-year rate of interest at January 1, 1996, was significantly higher than the corresponding rate implied by the term structure at January 1, 1993.

c. On the basis of the pure expectations theory of the term structure, briefly discuss two factors that could account for such a decline in the implied forward rate. [8 minutes]

Multiple scenario forecasting frequently makes use of information from the term structure of interest rates.

d. Briefly describe how the information conveyed by this observed decrease in the implied forward rate for 1996 could be used in making a multiple scenario forecast. [5 minutes]

14. *CFA Examination Level III*
TMP is working with the officer responsible for the defined-benefit pension plan of a U.S. company. She has come to the firm for advice on what she calls “the key elements of non-U.S. dollar fixed-income investing.”
The following information, based on TMP’s assessment of the Italian market, has been developed to illustrate the process by which market and currency expectations are integrated.

ITALIAN GOVERNMENT SECURITIES DATA

Security	Modified Duration	Current Price	Current Yield to Maturity	Expected Yield to Maturity in Three Months
Bill	0.25	100.00	12.50%	12.50%
Note	6.00	100.00	10.00%	9.00%

LIRA/$(US) EXCHANGE RATE

Current Rate	Expected Rate in three Months
L1500/$1.00 (US)	L1526/$1.00 (US)

Based on the information provided, calculate the expected return (in U.S. dollars) on *each* security over the three-month period. [9 minutes]

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15. *CFA Examination Level I*
Bonds of Zello Corporation with a par value of $1,000 sell for $960, mature in five years, and have a 7 percent annual coupon rate paid semiannually.
a. Calculate the
(1) current yield;
(2) yield to maturity (to the nearest whole percent, i.e., 3 percent, 4 percent, 5 percent, etc.); *and*
(3) horizon yield (also called realized or total return) for an investor with a three-year holding period and a reinvestment rate of 6 percent over the period. At the end of three years, the 7 percent coupon bonds with two years remaining will sell to yield 7 percent.
Show your work. [9 minutes]
b. Cite *one* major shortcoming for *each* of the following fixed-income yield measures:
(1) current yield;
(2) yield to maturity; *and*
(3) horizon yield (also called realized or total return). [6 minutes]

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16. *CFA Examination Level I*
During 1990, Disney issued $2.3 billion face value of zero coupon subordinated notes that resulted in gross proceeds of $965 million. The notes

- mature in 2005;
- can be exchanged for cash by the note holder at any time for the U.S. dollar equivalent of the current market value of 19.651 common shares of Euro Disney per $1,000 face value of notes; and
- are callable at any time at their issuance price plus accrued interest.

On March 11, 1993, Disney called the notes at a price of $483.50, which is equivalent to a yield to maturity of 6 percent. On the call date, Euro Disney common stock traded at a price of 86.80 French francs per share and the currency exchange rate for U.S. dollars ($US) to French francs (Ffr) was:

	$US/Ffr	Ffr/$US
Exchange rate	.1761	5.6786

a. Calculate, as of the call date,
(1) the price of a share of Euro Disney expressed in U.S. dollars; *and*
(2) the exchange value (conversion value) of a $1,000 face value note in U.S. dollars. [6 minutes]
b. On July 21, 1993, Disney issued, at par, $300 million of 100-year bonds with a coupon rate of 7.55 percent. The bonds are callable in 30 years at 103.02. From Disney's point of view, state *three* disadvantages of calling the zero coupon notes and effectively replacing part of that debt capital with the issue of 100-year bonds. [8 minutes]

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17. *CFA Examination Level II*
Table 1 shows the characteristics of two annual pay bonds from the same issuer with the same priority in the event of default, and Table 2 displays spot interest rates. Neither bond's price is consistent with the spot rates.

Using the information in Tables 1 and 2, recommend *either* Bond A *or* Bond B for purchase. Justify your choice. [10 minutes]

TABLE 1 *BOND CHARACTERISTICS*

	Bond A	Bond B
Coupons	Annual	Annual
Maturity	3 years	3 years
Coupon rate	10%	6%
Yield to maturity	10.65%	10.75%
Price	98.40	88.34

TABLE 2 *SPOT INTEREST RATES*

Term	Spot Rates (Zero Coupon)
1 year	5%
2 year	8%
3 year	11%

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18. *CFA Examination Level II*
You ran a regression of the yield of KC Company's 10-year bond on the 10-year U.S. Treasury benchmark's yield using month-end data for the past year. You found the following result:

$$\text{Yield}_{KC} = 0.54 + 1.22\ \text{Yield}_{Treasury}$$

where Yield_{KC} is the yield on the KC bond and $\text{Yield}_{Treasury}$ is the yield on the U.S. Treasury bond.
The modified duration on the 10-year U.S. Treasury is 7.0 years, and modified duration on the KC bond is 6.93 years.
a. Calculate the percentage change in the price of the 10-year U.S. Treasury, assuming a 50-basis-point change in the yield on the 10-year U.S. Treasury. [3 minutes]
b. Calculate the percentage change in the price of the KC bond, using the regression equation, assuming a 50-basis-point change in the yield on the 10-year U.S. Treasury. [6 minutes]

CFA

19. *CFA Examination Level II*
Table 3 shows prices as a function of yields for four tranches of a collateralized mortgage obligation (CMO).

TABLE 3 *PRICES FOR FOUR CMO TRANCHES AT SELECTED YIELDS*

	YIELD (%)				
CMO Tranche	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**
T-1	111.5	105.5	100.0	95.0	90.5
T-2	107.5	104.0	100.0	95.5	90.5
T-3	112.0	105.5	100.0	95.5	92.0
T-4	104.5	102.0	100.0	98.5	97.5

a. Calculate the effective duration of Tranche T-3. Assume that the relevant current yield is 7.0 percent. Show your work. [5 minutes]
b. Identify the tranche with the negative convexity. Calculate the effective convexity of this tranche. Show your work. [5 minutes]
Table 4 shows the option-adjusted spread for four different mortgage pass-through securities.

TABLE 4 *MORTGAGE PASS-THROUGH OPTION-ADJUSTED SPREADS (ASSUMING INTEREST RATE VOLATILITY OF 8 PERCENT)*

Security	Option-Adjusted Spread (in Basis Points)
A	43
B	70
C	89
D	99

c. Identify which of the patterns of option-adjusted spreads shown in Table 5 is plausible if the assumed interest rate volatility is 12 percent rather than the 8 percent assumed in Table 4. Justify your choice. [5 minutes]

TABLE 5 *MORTGAGE PASS-THROUGH OPTION-ADJUSTED SPREADS (ASSUMING INTEREST RATE VOLATILITY OF 12 PERCENT)*

	OPTION-ADJUSTED SPREAD (IN BASIS POINTS)	
Security	**Pattern A**	**Pattern B**
A	–13	103
B	20	120
C	49	129
D	69	129

20. *CFA Examination Level II*
Patrick Wall is considering the purchase of one of the two bonds described in the following table. Wall realizes his decision will depend primarily on effective duration, and he believes that interest rates will decline by 50 basis points at all maturities over the next six months.

BOND DESCRIPTIONS

Characteristic	CIC	PTR
Market price	101.75	101.75
Maturity date	June 1, 2008	June 1, 2008
Call date	Noncallable	June 1, 2003
Annual coupon	6.25%	7.35%
Interest payment	Semiannual	Semiannual
Effective duration	7.35	5.40
Yield to maturity	6.02%	7.10%
Credit rating	A	A

a. Calculate the percentage price change forecasted by effective duration for *both* the CIC and PTR bonds if interest rates decline by 50 basis points over the next six months. Show your work. [6 minutes]
b. Calculate the six-month horizon return (in percent) for *each* bond, if the actual CIC bond price equals 105.55 and the actual PTR bond price equals 104.15 at the end of six months. Assume you purchased the bonds to settle on June 1, 1998. Show your work. [6 minutes]

Wall is surprised by the fact that although interest rates fell by 50 basis points, the actual price change for the CIC bond was greater than the price change forecasted by effective duration, whereas the actual price change for the PTR bond was less than the price change forecasted by effective duration.

c. Explain why the actual price change would be greater for the CIC bond and the actual price change would be less for the PTR bond. [6 minutes]

21. *CFA Examination Level II*
a. Discuss how *each* of the following theories for the term structure of interest rates could explain an upward slope of the yield curve:
(1) Pure expectations (unbiased)
(2) Uncertainty and term premiums (liquidity preference)
(3) Market segmentation [9 minutes]

The following are the current coupon yields to maturity and spot rates of interest for six U.S. Treasury securities. Assume all securities pay interest annually.

YIELDS TO MATURITY AND SPOT RATES OF INTEREST		
Term to Maturity	Current Coupon Yield to Maturity	Spot Rate of Interest
1-year Treasury	5.25%	5.25%
2-year Treasury	5.75	5.79
3-year Treasury	6.15	6.19
5-year Treasury	6.45	6.51
10-year Treasury	6.95	7.10
30-year Treasury	7.25	7.67

b. Compute, under the pure expectations theory, the two-year implied forward rate three years from now, given the information provided in preceding table. State the assumption underlying the calculation of the implied forward rate. [6 minutes]

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APPENDIX
Chapter 19

EXHIBIT 19A.1 *CALCULATION OF DURATION AND CONVEXITY FOR AN 8 PERCENT FIVE-YEAR BOND SELLING TO YIELD 6 PERCENT*

Period	Cash Flow	Discount Factor	PV	$PV \times t$	$PV \times t \times (t+1)$
1	40.00	0.9709	38.83	38.83	77.67
2	40.00	0.9426	37.70	75.41	226.22
3	40.00	0.9151	36.61	109.82	439.27
4	40.00	0.8885	35.54	142.16	710.79
5	40.00	0.8626	34.50	172.52	1,035.13
6	40.00	0.8375	33.50	201.00	1,406.97
7	40.00	0.8131	32.52	227.67	1,821.32
8	40.00	0.7894	31.58	252.61	2,273.50
9	40.00	0.7664	30.66	275.91	2,759.10
10	1,040.00	0.7441	773.86	7,738.58	85,124.34
		Total	1,085.30	9,234.50	95,874.32

$$\text{Macaulay Duration} = \frac{9,234.50}{2 \times 1,085.30} = 4.25$$

$$\text{Modified Duration} = \frac{4.25}{1.03} = 4.13$$

$$\text{Convexity} = \frac{95,874.32}{(1.03)^2 \times 2^2 \times 1,085.30} = 20.82$$

Chapter 20 Bond Portfolio Management Strategies

After you read this chapter, you should be able to answer the following questions:

- What are the four major alternative bond portfolio management strategies available?
- What are the two passive portfolio management strategies available?
- What are the five alternative active bond portfolio management strategies available?
- What is meant by core-plus bond management and what are some plus strategies?
- What is meant by matched-funding techniques and what are the four specific strategies?
- What are the major contingent procedure strategies that are referred to as structured active management strategies?
- What are the implications of capital market theory for those involved in bond portfolio management?
- What is the evidence on the efficient market hypothesis as it relates to bond markets?
- What are the implications of efficient market studies for bond portfolio managers?

In this chapter, we shift attention from bond valuation and analysis to the equally important bond portfolio management strategies. Initially, we discuss the five alternative bond portfolio management strategies: passive management, active management, core-plus bond management, matched-funding techniques, and structured active management. Next, we consider the implications of capital market theory and bond market efficiency on bond portfolio management.

Alternative Bond Portfolio Strategies

Bond portfolio management strategies can be divided into five groups:[1]

1. Passive portfolio strategies
   a. Buy and hold
   b. Indexing
2. Active management strategies
   a. Interest rate anticipation
   b. Valuation analysis
   c. Credit analysis
   d. Yield spread analysis
   e. Bond swaps
3. Core-plus management strategy

[1]This breakdown benefited from the discussion in Martin L. Leibowitz, "The Dedicated Bond Portfolio in Pension Funds—Part I: Motivations and Basics," *Financial Analysts Journal* 42, no 1 (January–February 1986): 61–75.

4. Matched-funding techniques
   a. Dedicated portfolio, exact cash match
   b. Dedicated portfolio, optimal cash match and reinvestment
   c. Classical ("pure") immunization
   d. Horizon matching
5. Contingent procedures (structured active management)
   a. Contingent immunization
   b. Other contingent procedures

We discuss each of these alternatives because they are all viable for certain portfolios with different needs and risk profiles. Prior to the 1960s, only the first two groups were available, and most bond portfolios were managed on the basis of buy and hold. The early 1970s saw growing interest in alternative active bond portfolio management strategies, while the late 1970s and early 1980s were characterized by record-breaking inflation and interest rates as well as extremely volatile rates of return in bond markets. This led to the introduction of many new financial instruments in response to the increase in return volatility. Since the mid-1980s, matched-funding techniques or contingent portfolio management techniques have been developed to meet the emerging needs of institutional clients.

Passive Management Strategies

Two specific passive portfolio management strategies exist. First is a **buy-and-hold strategy** in which a manager selects a portfolio of bonds based on the objectives and constraints of the client with the intent of holding these bonds to maturity. In the second passive strategy—**indexing**—the objective is to construct a portfolio of bonds that will equal the performance of a specified bond index, such as the Lehman Brothers Corporate/Government Bond Index.

Buy-and-Hold Strategy

The simplest portfolio management strategy is to buy and hold. Obviously not unique to bond investors, it involves finding issues with desired quality, coupon levels, term to maturity, and important indenture provisions, such as call features. Buy-and-hold investors do not consider active trading to achieve attractive returns but, rather, look for vehicles whose maturities (or duration) approximate their stipulated investment horizon to reduce price and reinvestment risk. Many successful bond investors and institutional portfolio managers follow a modified buy-and-hold strategy wherein an investment is made in an issue with the intention of holding it until the end of the investment horizon. However, they still actively look for opportunities to trade into more desirable positions.[2]

Whether the investor follows a strict or modified buy-and-hold approach, the key ingredient is finding investment vehicles that possess attractive maturity and yield features. The strategy does not restrict the investor to accept whatever the market has to offer, nor does it imply that selectivity is unimportant. Attractive high-yielding issues with desirable features and quality standards are actively sought. For example, these investors recognize that agency issues generally provide incremental returns relative to Treasuries with a little sacrifice in quality, that utilities provide higher returns than comparable rated industrials, and that various call features affect the risk and realized yield of an issue. Thus, successful buy-and-hold investors use their knowledge of markets and issue characteristics to seek out attractive realized yields. Aggressive buy-and-hold investors also incorporate timing considerations by using their knowledge of market rates and expectations.

Indexing Strategy

As discussed in the chapter on efficient capital markets, numerous empirical studies have demonstrated that the majority of money managers have not been able to

[2]Obviously, if the strategy becomes too modified, it becomes one of the active strategies.

match the risk-return performance of common stock or bond indexes. As a result, many clients have opted to index some part of their bond portfolios, which means that the portfolio manager builds a portfolio that will match the performance of a selected bond market index, such as a Lehman Brothers Index, Merrill Lynch Index, or Salomon Brothers Index. In such a case, the portfolio manager is judged not on the basis of risk and return compared to an index but by how closely the portfolio *tracks* the designated index. Specifically, the analysis of performance involves examining the **tracking error**, which equals the difference between the rate of return for the portfolio and the rate of return for the bond market index. For example, if the portfolio experienced an annual rate of return of 8.2 percent during a period when the index had a rate of return of 8.3 percent, the tracking error would be minus 10 basis points (8.20 – 8.30 = –0.10).

When initiating an indexing strategy, the selection of the appropriate market index is very important because it directly determines the client's risk-return results. As such, it is necessary to be very familiar with all the characteristics of the index.[3] For bond indexes, it also is important to be aware of how the aggregate bond market and the indexes change over time.[4] Reilly and Wright demonstrated that the market has experienced significant changes in composition, maturity, and duration since 1975. After the appropriate bond index is selected, several techniques are available to accomplish the actual tracking.[5]

Active Management Strategies[6]

Five active management strategies are available, including interest rate anticipation, which involves economic forecasting, as well as valuation analysis and credit analysis, which require detailed bond and company analysis. Alternatively, yield spread analysis and bond swaps, which require economic and market analysis, are also available.

Interest Rate Anticipation

Interest rate anticipation is perhaps the riskiest active management strategy because it involves relying on uncertain forecasts of future interest rates. The idea is to preserve capital when an increase in interest rates is anticipated and achieve attractive capital gains when interest rates are expected to decline. Such objectives usually are attained by altering the maturity (duration) structure of the portfolio (i.e., reducing portfolio duration when

[3]Two articles that discuss how the characteristics of indexes affect their performance in different interest rate environments are Chris P. Dialynas, "The Active Decisions in the Selection of Passive Management and Performance Bogeys"; and Kenneth E. Volpert, "Managing Indexed and Enhanced Indexed Bond Portfolios." Both are in *The Handbook of Fixed-Income Securities,* 6th ed., ed. Frank J. Fabozzi (New York: McGraw-Hill, 2001). For an analysis of a new comprehensive Treasury bond index, see Frank K. Reilly and David J. Wright, "Introducing a Comprehensive U.S. Treasury Bond Market Benchmark," in *Yield Curve Dynamics,* ed. Ronald J. Ryan (Chicago: Glenlake Publishing, 1997).

[4]An article that describes the major bond market indexes, analyzes the relationship among them, and examines how the aggregate bond market has changed is Frank K. Reilly and David J. Wright, "Bond Market Indexes," in the *Handbook of Fixed-Income Securities,* 6th ed., ed. Frank J. Fabozzi (New York: McGraw-Hill, 2001). A similar study for high-yield indexes is Frank K. Reilly and David J. Wright, "An Analysis of High-Yield Bond Benchmarks," *Journal of Fixed Income* 3, no. 4 (March 1994): 6–25.

[5]For a detailed discussion of the alternative tracking techniques available, see Sharmin Mossavar-Rahmani, *Bond Index Funds* (Chicago: Probus Publishing, 1991); and Frank J. Fabozzi, *Bond Markets, Analysis and Strategies,* 3d ed. (Upper Saddle River, N.J.: Prentice-Hall, 1996), Chapter 18.

[6]For further discussion on this topic, see H. Gifford Fong, "Bond Management: Past, Current and Future," *The Handbook of Fixed-Income Securities,* 6th ed. edited Frank J. Fabozzi; Thomas Vock, "Managing Global Fixed-Income Portfolios," in *Global Portfolio Management,* ed. Jan R. Squires (Charlottesville, Va.: Association for Investment Management and Research, 1996); and Jack Malvey, "Global Corporate Bond Portfolio Management," in *The Handbook of Fixed-Income Securities,* 6th ed. For a set of readings, see *Global Bond Management,* ed. Jan R. Squires (Charlottesville, Va.: Association for Investment Management and Research, 1997); and Dwight Churchill, ed., *Fixed-Income Management: Techniques and Practices* (Charlottesville, Va.: Association for Investment Management and Research, 1994).

interest rates are expected to increase and increasing the portfolio duration when a decline in yields is anticipated). Thus, the risk in such portfolio restructuring is largely a function of these duration (maturity) alterations. When maturities are shortened to preserve capital, substantial income could be sacrificed and the opportunity for capital gains could be lost if interest rates decline rather than rise. Similarly, the portfolio shifts prompted by anticipation of a decline in rates are very risky. Specifically, if we assume that we are at a peak in interest rates, it is likely that the yield curve is downward sloping, which means that bond coupons will decline with maturity. Therefore, the investor is sacrificing current income by shifting from high-coupon short bonds to longer-duration bonds. At the same time, the portfolio is purposely exposed to greater price volatility that could work against the portfolio if an unexpected increase in yields occurs. Note that the portfolio adjustments prompted by anticipation of an increase in rates involve less risk of an absolute capital loss. When you reduce the maturity, the worst that can happen is that interest income is reduced and/or capital gains are forgone (opportunity cost).

Once future (expected) interest rates have been determined, the procedure relies largely on technical matters. Assume that you expect an increase in interest rates and want to preserve your capital by reducing the duration of your portfolio. A popular choice would be high-yielding, short-term obligations, such as Treasury bills. Although your primary concern is to preserve capital, you would nevertheless look for the best return possible given the maturity constraint. Liquidity also is important because, after interest rates increase, yields may experience a period of stability before they decline, and you would want to shift positions quickly to benefit from the higher income and/or capital gains.

One way to shorten maturities is to use a *cushion bond*—a high-yielding, long-term obligation that carries a coupon substantially above the current market rate and that, due to its current call feature and call price, has a market price lower than what it should be given current market yields. As a result, its yield is higher than normal. An example would be a 10-year bond with a 12 percent coupon, currently callable at 110. If current market rates are 8 percent, this bond (if it were noncallable) would have a price of about 127; because of its call price, however, it will stay close to 110, and its yield will be about 10 percent rather than 8 percent. Bond portfolio managers look for cushion bonds when they expect a modest increase in rates because such issues provide attractive current income *and* protection against capital loss. Because these bonds are trading at an abnormally high yield, market rates would have to rise to that abnormal level before their price would react.

The portfolio manager who anticipates higher interest rates, therefore, has two simple strategies available: shorten the duration of the portfolio and/or look for an attractive cushion bond.[7] In either case, you would want very liquid issues.

A totally different posture is assumed by investors who anticipate a decline in interest rates. The significant risk involved in restructuring a portfolio to take advantage of a decline in interest rates is balanced by the potential for substantial capital gains and holding period returns. When you expect lower interest rates, you will recall that you should increase the duration of the portfolio because the longer the duration, the greater the positive price volatility. Also, liquidity is important because you want to be able to close out the position quickly when the drop in rates has been completed.

Notably, because interest rate sensitivity is critical, it is important to recall that the higher the quality of an obligation, the more sensitive it is to interest rate changes. Therefore, high-grade securities should be used, such as Treasuries, agencies, or corporates rated AAA through BAA. Finally, you want to concentrate on noncallable issues or those with strong call protection

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[7]For an extended discussion of cushion bonds, see Sidney Homer and Martin L. Leibowitz, *Inside the Yield Book* (Englewood Cliffs, N.J.: Prentice-Hall, 1972), Chapter 5.

because of the substantial call risk discussed in Chapter 19 in connection with the analysis of duration and convexity.

Valuation Analysis With **valuation analysis**, the portfolio manager attempts to select bonds based on their intrinsic value, which is determined based on their characteristics and the average value of these characteristics in the marketplace. As an example, a bond's rating will dictate a certain spread relative to comparable Treasury bonds: long maturity might be worth an added 60 basis points relative to short maturity (i.e., the maturity spread); a given deferred call feature might require a higher or lower yield; a specified sinking fund would likewise mean higher or lower required yields. Given all the characteristics of the bond and the normal cost of the characteristics in terms of yield, you would determine the bond's required yield and, therefore, its implied intrinsic value. After you have done this for a number of bonds, you would compare these derived bond values to the prevailing market prices to determine which bonds are undervalued or overvalued. Based on your confidence in the characteristic costs, you would buy the undervalued issues and ignore or sell the overvalued issues.

Success in valuation analysis is based on understanding the characteristics that are important in valuation and being able to accurately *estimate* the yield cost of these characteristics over time.

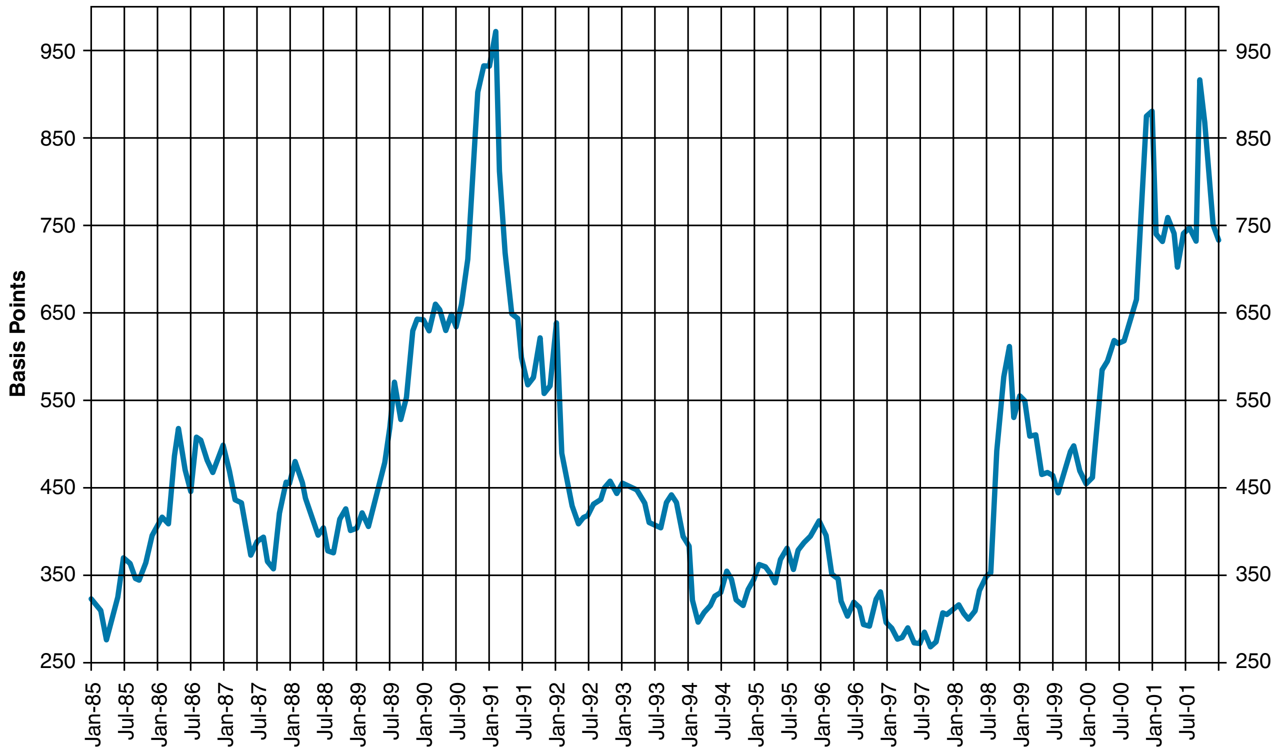
Credit Analysis A **credit analysis** strategy involves detailed analysis of the bond issuer to determine expected changes in its default risk. This involves attempting to project changes in the credit ratings assigned to bonds by the three rating agencies discussed in Chapter 18.[8] These rating changes are affected by internal changes in the entity (e.g., changes in important financial ratios) and by changes in the external environment (i.e., changes in the firm's industry and the economy). During periods of strong economic expansion, even financially weak firms may survive and prosper. In contrast, during severe economic contractions, normally strong firms may find it very difficult to meet financial obligations. Therefore, historically there has been a strong cyclical pattern to rating changes: typically, downgradings increase during economic contractions and decline during economic expansions.

To use credit analysis as a portfolio management strategy, it is necessary to project rating changes prior to the announcement by the rating agencies. As the subsequent discussion on bond market efficiency notes, the market adjusts rather quickly to bond rating changes—especially downgradings. Therefore, you want to acquire bond issues expected to experience upgradings and sell or avoid those bond issues expected to be downgraded.

Credit Analysis of High-Yield (Junk) Bonds One of the most obvious opportunities for credit analysis is the analysis of high-yield (junk) bonds. As demonstrated by several studies, the yield differential between junk bonds that are rated below BBB and Treasury securities ranges from about 200 basis points to over 1,000 basis points. Notably, these yield differentials vary substantially over time as shown by a time-series plot in Exhibit 20.1. Specifically, the average yield spread ranged from a low of less than 300 basis points in 1985 and 1997 to a high of over 900 basis points during early 1991 and late 2001.

[8]For a discussion of changes in the aggregate financial risk of U.S. corporations and the opportunities this has created, see Frank K. Reilly, "The Growing Importance of Credit Analysis," working paper, University of Notre Dame (April 2002). For a presentation on credit analysis that emphasizes changes in credit ratings, see Jane Tripp Howe, "Credit Analysis for Corporate Bonds," in *The Handbook of Fixed-Income Securities, 6th ed.* For a set of readings on global credit analysis, see ed. Jan R. Squires, *Credit Analysis Around the World* (Charlottesville, Va.: Association for Investment Management and Research, 1998).

EXHIBIT 20.1 *YIELD SPREAD HISTORY, MERRILL LYNCH HIGH-YIELD MASTER INDEX VERSUS 10-YEAR TREASURY: MONTHLY, 1985–2001*



Source: Merrill Lynch & Co. Martin S. Fridson, Chief High-Yield Strategist, Merrill Lynch, "This Year in High Yield—2001." Reprinted by permission. Copyright © 2002 Merrill Lynch, Pierce, Fenner & Smith Incorporated.

Although the spreads have changed, a study indicated that the average credit quality of high-yield bonds also changed over time.[9] As an example, interest coverage tends to fluctuate with the business cycle. In addition, the credit quality of bonds *within* rating categories tends to change over the business cycle.[10]

These changes in credit quality will make credit analysis of high-yield bonds not only more important but also more difficult. This means that bond analysts–portfolio managers need to engage in detailed credit analysis to select bonds that will survive. Given the spread in promised yields, if a portfolio manager can—through rigorous credit analysis—avoid bonds with a high probability of default, high-yield bonds will provide substantial rates of return for the investor.[11]

In summary, substantial rates of return can be derived by investing in high-yield bonds if you do the credit analysis required to avoid defaults, which occur with these bonds at substantially higher rates than the overall bond market. Several recent studies have shown that the average cumulative

[9]Barrie A. Wigmore, "The Decline in Credit Quality of New Issue Junk Bonds," *Financial Analysts Journal* 46, no. 5 (September–October 1990): 53–62.

[10]These changes are demonstrated in Reilly, "The Growing Importance of Credit Analysis."

[11]For a discussion regarding the analysis of high-risk bonds, see Jane Tripp Howe, "Credit Considerations in Evaluating High-Yield Debt"; Jane Tripp Howe, "Investing in Chapter 11 and other Distressed Companies"; and Allen A. Vine, "High-Yield Analysis of Emerging Markets Debt." All of these are in *The Handbook of Fixed-Income Securities,* 6th ed.

default rate for high-yield bonds after 10 years is between 30 percent and 35 percent. For example, of the high-yield bonds sold in 1988, about 33 percent had defaulted by 1998.[12]

Exhibit 20.2 lists the results for a study that considers the full spectrum of bonds. It shows substantial differences in cumulative default rates for bonds with different ratings for the periods 5 and 10 years after issue. Over 10 years—the holding period that is widely discussed—the default rate for BBB investment-grade bonds is only 4.66 percent, but the default rate increases to over 17 percent for BB-rated, to almost 33 percent for B-rated bonds, and to over 52 percent for CCC-rated bonds.

These default rates do not mean that investors should avoid high-yield bonds, but they do indicate that extensive credit analysis is a critical component for success within this sector. Given the substantial yield spreads over Treasuries, you may experience high returns *if* you can avoid owning bonds that default or are downgraded. The route to avoiding such bond issues is through rigorous, enlightened credit analysis.

Investing in Defaulted Debt Beyond high-yield bonds that have high credit risk and high default rates, a new set of investment opportunities has evolved—investing in defaulted debt. While this sector requires an understanding of legal procedures surrounding bankruptcy as well as economic analysis, the returns have generally been consistent with the risk—that is, between high-yield debt and common stock.[13]

Credit Analysis Models The credit analysis of high-yield bonds can use a statistical model or basic fundamental analysis that recognizes some of the unique characteristics of these bonds. The Altman-Nammacher book suggests that a modified *Z-score model* used to predict bankruptcy can also be used to predict default for these high-yield bonds or as a gauge of changes in credit quality. The Z-score model combines traditional financial measures with a multivariate technique known as *multiple discriminant analysis* to derive a set of weights for the specified variables. The result is an overall credit score (zeta score) for each firm.[14] The model is of the form

$$\text{Zeta} = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_nX_n$$

where:

Zeta = the overall credit score
$X_1 \ldots X_n$ = the explanatory variables (ratios and market measures)
$a_0 \ldots a_n$ = the weightings or coefficients

[12]Although the details of the analysis differ, the overall results for cumulative defaults are quite consistent. See Edward I. Altman, "Measuring Corporate Bond Mortality and Performance," *Journal of Finance* 44, no. 4 (September 1989): 909–922; and 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* 44, no. 4 (September 1989): 929–952. Another review of these studies is Edward I. Altman, "Revisiting the High-Yield Bond Market," *Financial Management* 21, no 2 (Summer 1992): 78–92. For a recent update, see Martin S. Fridson. "This Year in High Yield—2001," *Extra Credit* (New York: Merrill Lynch, January–February 2002). For a recent analysis of the market performance of high-yield bonds, see Frank K. Reilly and David J. Wright, "The Unique Risk-Return Characteristics of High-Yield Bonds," *Journal of Fixed Income* 11, no. 2 (September 2001): 65–82.

[13]For a discussion of the legal and economic analysis, see Edward I. Altman, *Corporate Financial Distress and Bankruptcy,* 2d ed. (New York: John Wiley & Sons, 1993). For an analysis of the investment performance, see Edward I. Altman, "Defaulted Bonds: Demand, Supply, and Performance, 1987–1992," *Financial Analysts Journal* 49, no 3 (May–June 1993): 55–60; Edward I. Altman and Babe E. Simon, "The Investment Performance of Defaulted Bonds for 2000 and 1987–2000," New York University, Salomon Center (February 2001); David J. Ward and Gary L. Griepentrog, "Risk and Return in Defaulted Bonds," *Financial Analysts Journal* 49, no. 3 (May–June 1993): 61–65; and Frank K. Reilly, David J. Wright, and Edward I. Altman, "Including Defaulted Bonds in the Capital Markets Asset Spectrum," *Journal of Fixed Income* 8, no. 3 (December 1998): 33–48.

[14]Edward I. Altman and Scott A. Nammacher, *Investing in Junk Bonds* (New York: John Wiley & Sons, 1987).

EXHIBIT 20.2 *AVERAGE CUMULATIVE DEFAULT RATES FOR CORPORATE BONDS: 1978–2001*

	YEARS SINCE ISSUE		
RATINGS	5	10	15
AAA	0.10%	0.52%	0.52%
AA	0.26	0.83	1.31
A	0.57	1.58	2.32
BBB	2.16	4.66	6.64
BB	10.59	17.40	19.52
B	25.06	32.61	35.76
CCC	46.87	52.22	54.38

Source: *Rating Performance 2002* (New York: Standard & Poor's, February 2002): 8. Reprinted with permission.

The final model used in this analysis included the following seven financial measures:

X_1 = profitability: earnings before interest and taxes (EBIT)/total assets (TA)
X_2 = stability of profitability measure: the standard error of estimate of EBIT/TA (normalized for 10 years)
X_3 = debt service capabilities (interest coverage): EBIT/interest charges
X_4 = cumulative profitability: retained earnings/total assets
X_5 = liquidity: current assets/current liabilities
X_6 = capitalization levels: market value of equity/total capital (five-year average)
X_7 = size: total tangible assets (normalized)

The weightings, or coefficients, for the variables were not reported.[15]

In contrast to using a model that provides a composite credit score, most analysts simply adapt their basic corporate bond analysis techniques *to the unique needs of high-yield bonds,* which have characteristics of common stock.[16] Howe claims that the analysis of high-yield bonds is the same as with any bond except that the following five areas of analysis should be expanded.[17]

1. What is the firm's *competitive position* in terms of cost and pricing? This can be critical to a small firm.
2. What is the firm's *cash flow* relative to cash requirements for interest, research, growth, and periods of economic decline? Also, what is the firm's *borrowing capacity* that can serve as a safety net and provide flexibility?
3. What is the *liquidity value of the firm's assets?* Are these assets available for liquidation (are there any claims against them)? In many cases, asset sales are a critical part of the strategy for a leveraged buyout.

[15]The following studies have examined the aggregate default rate for high-yield bonds: Jon G. Jonsson and Martin S. Fridson, "Forecasting Default Rates on High-Yield Bonds," *Journal of Fixed Income* 6, no. 1 (June 1996): 69–77; Jean Helwege and Paul Kleiman, "Understanding Aggregate Default Rates of High-Yield Bonds," *Journal of Fixed Income* 7, no. 1 (June 1997): 55–61; and Martin S. Fridson, M. Christopher Garman, and Sheng Wu, "Real Interest Rates and the Default Rate on High-Yield Bonds," *Journal of Fixed Income* 7, no. 2 (September 1997): 29–34.

[16]For an analysis that shows the relationship of high-yield bonds to investment-grade bonds and common stock, see Frank K. Reilly and David J. Wright, "An Analysis of High-Yield Bond Benchmarks," *Journal of Fixed Income* 3, no. 4 (March 1994): 6–25. An updated version is in Theodore M. Barnhill, Jr., William F. Maxwell, and Mark R. Shenkman, eds., *High-Yield Bonds* (New York: McGraw-Hill, 1999).

[17]Jane Tripp Howe, "Credit Considerations in Evaluating High-Yield Bonds," in *The Handbook of Fixed-Income Securities,* 6th ed.

4. How good is the *total management team?* Is the management team committed to and capable of operating in the high-risk environment of this firm?
5. What is the firm's *financial leverage* on an absolute basis and on a market-adjusted basis (using market value of equity and debt)?

Hynes suggests that the following areas require additional analysis as part of the process of evaluating cash flows when analyzing a leveraged buyout (which typically involves the issuance of high-yield debt).[18]

- Inherent business risk
- Earnings growth potential
- Asset redevelopment potential
- Refinancing capability

In addition to the potentially higher financial risk, an increase in business risk may exist if the firm sells off some operations that have favorable risk characteristics with the remaining operations—that is, business risk would increase if the firm sells a division or a company that has low correlation of earnings with other units of the firm. Further, a change in management operating philosophy could have a negative impact on operating earnings. The managements of leveraged buyout (LBO) firms are known for making optimistic growth estimates related to sales and earnings, so the analyst should evaluate these estimates very critically. Asset divestiture plans often are a major element of an LBO because they provide necessary capital that is used to reduce the substantial debt taken on as part of the buyout. Therefore, it is important to examine the liquidity of the assets, their estimated selling values, and the timing of these programs. You must ascertain whether the estimated sales prices for the assets are reasonable and whether the timing is realistic. In contrast, if the divestiture program is successful wherein the prices received are above normal expectations and the assets are sold ahead of schedule, this can be grounds for upgrading the debt. Finally, it is necessary to constantly monitor the firm's refinancing flexibility. Specifically, what refinancing will be necessary, what does the schedule look like, and will the capital suppliers be receptive to the refinancing?[19]

The substantial increase in high-yield bonds issued and outstanding has been matched by an increase in research and credit analysis. The credit analysis of these bonds is similar to that of investment-grade bonds with an emphasis on the following factors: (1) *the use of cash flows* compared to debt obligations under very conservative assumptions; (2) the detailed analysis of *potential asset sales,* including a conservative estimate of sales prices, the asset's true liquidity, the availability of the assets, and a consideration of the timing of the sales; and (3) the recognition that high-yield bonds have many characteristics of common stock, which means that many equity analysis techniques are appropriate. An in-depth analysis of high-yield bonds is critical because of the number of issues, the wide diversity of quality within the high-yield bond universe, and the growing complexity of these issues.

High-Yield Bond Research Because of the growth of high-yield bonds, several investment houses have developed specialized high-yield groups that examine high-yield bond issues and monitor high-yield bond spreads.

[18]Joseph Hynes, "Key Risk Factors for LBOs," *Speculative Grade Debt Credit Review* (New York: Standard & Poor's Corporation, June 15, 1987).

[19]For a set of presentations on credit analysis including distressed securities, see Ashwinpaul C. Sondhi, ed., *Credit Analysis of Nontraditional Debt Securities* (Charlottesville, Va.: Association for Investment Management and Research, 1995); and Jan R. Squires, ed., *Credit Analysis Around the World* (Charlottesville, Va.: Association of Investment Management and Research, 1998).

Merrill Lynch's monthly publication, *High Yield,* provides an overview of the market and reviews several individual industries and firms within these main industries (e.g., retail, steel, building products, and telecommunications). It also contains reports of research done by the firm regarding the high-yield market. As noted earlier, the January/February issue of *High Yield* always contains a detailed annual review of the market with extensive historical tables.

Merrill Lynch's weekly publication, *This Week in High Yield,* discusses current events in the high-yield market. This includes weekly yields and yield spreads for the various sectors of the market and news highlights for specific companies and issues.

High-Yield Market Update, a Salomon Brothers Smith Barney monthly publication, presents monthly and cumulative long-term returns for its high-yield indexes (long-term and intermediate-term corporates, long-term utilities), as well as spreads between rating categories relative to appropriate Treasuries. The publication also features commentary on timely topics within the high-yield market.

The high-yield research group at First Boston publishes *Monthly Market Review,* which contains an extensive performance review of the HY (high-yield) bond market that examines returns by sectors and industries as well as considering yield spreads and changing volatility for these bonds. First Boston also publishes an annual *High Yield Handbook,* which reviews annual events and considers every aspect of risk, return, and correlation of high-yield bonds with other asset classes. There also is a very helpful listing of new issues, retirements, and defaults.

Lehman Brothers publishes a weekly review, *High-Yield Portfolio Advisor,* which analyzes the performance of the firm's high-yield bond indexes and has detailed comments on news events that affect prominent industries in the high-yield market. The firm also publishes a monthly *High-Yield Bond Market Report* that briefly discusses the returns and new issues for the month, contains extensive data on returns for all components of the HY market (BB, B, CCC, CC-D, nonrated, default), and contains descriptive statistics regarding bonds in the composite index and various subindexes, such as average coupon, maturity, duration to worst, modified adjusted duration, price, and yield.

In addition, several bond-rating firms conduct research on these industries and firms. Standard & Poor's publication, *Speculative Grade Debt Credit Review,* discusses the credit analysis of high-yield bonds. The publication also includes a review of several major industries and specific comments on outstanding issues.

Yield Spread Analysis As discussed in Chapter 19, spread analysis assumes normal relationships exist between the yields for bonds in alternative sectors (e.g., the spread between high-grade versus low-grade industrial or between industrial versus utility bonds). Therefore, a bond portfolio manager would monitor these relationships and, when an abnormal relationship occurs, execute various sector swaps. The crucial factor is developing the background to know the normal yield relationship and to evaluate the liquidity necessary to buy or sell the required issues quickly enough to take advantage of the temporary yield abnormality.

The analysis of yield spreads has been enhanced by a paper by Dialynas and Edington that considers several specific factors that affect the aggregate spread.[20] It is acknowledged that the generally accepted explanation of changes in the yield spread is that it is related to the economic environment. Specifically, the spread widens during periods of economic uncertainty and recession because investors require larger risk premiums (i.e., larger spreads). In contrast, the spread will decline during periods of economic confidence and expansion. Although not denying the existence of such a relationship, the authors contend that a more encompassing factor is the

[20]Chris P. Dialynas and David H. Edington, "Bond Yield Spreads—A Postmodern View," *Journal of Portfolio Management* 19, no. 1 (Fall 1992): 60–75.

impact of interest rate (yield) volatility. They contend that yield volatility will affect the spread via three effects: (1) yield volatility and the behavior of embedded options, (2) yield volatility and transactional liquidity, and (3) the effect of yield volatility on the business cycle.

Recall that the value of callable bonds is equal to the value of a noncallable bond minus the value of the call option. Obviously, if the value of the option goes up, the value of the callable bond will decline and its yield will increase. When yield volatility increases, the value of the call option increases, which causes a decline in the price of the callable bond and a rise in the bond's yield and its yield spread relative to Treasury bonds. Similarly, an increase in yield volatility will raise the uncertainty facing bond dealers and cause them to increase their bid-ask spreads that reflect the transactional liquidity for these bonds. This liquidity will have a bigger effect on non-government bonds, so their yield spread relative to Treasury bonds will increase. Finally, interest rate volatility causes uncertainty for business executives and consumers regarding their cost of funds. This typically will precede an economic decline that will, in turn, lead to an increase in the yield spread. It is demonstrated that it is possible to have a change in yield spread for reasons other than economic uncertainty. If there is a period of greater yield volatility that is not a period of economic uncertainty, the yield spread will increase due to the embedded option effect and the transactional liquidity effect. This analysis implies that when examining yield spreads, you should pay particular attention to interest rate (yield) volatility.

Bond Swaps **Bond swaps** involve liquidating a current position and simultaneously buying a different issue in its place with similar attributes but having a chance for improved return. Swaps can be executed to increase current yield, to increase yield to maturity, to take advantage of shifts in interest rates or the realignment of yield spreads, to improve the quality of a portfolio, or for tax purposes. Some swaps are highly sophisticated and require a computer for calculation. However, most are fairly simple transactions with obvious goals and risk. They go by such names as *profit takeouts, substitution swaps, intermarket spread swaps,* or *tax swaps.* Although many of these swaps involve low risk (such as the pure yield pickup swap), others entail substantial risk (the rate anticipation swap). Regardless of the risk involved, all swaps have one basic purpose: portfolio improvement.

Most swaps involve several different types of risk. One obvious risk is that the market will move against you while the swap is outstanding. Interest rates may move up over the holding period and cause you to incur a loss. Alternatively, yield spreads may fail to respond as anticipated. Possibly the new bond may not be a true substitute and so, even if your expectations and interest rate formulations are correct, the swap may be unsatisfactory because the wrong issue was selected. Finally, if the work-out time is longer than anticipated, the realized yield might be less than expected. You must be willing to accept such risks to improve your portfolio. The following subsections consider three of the more popular bond swaps.[21]

Pure Yield Pickup Swap The pure yield pickup involves swapping out of a low-coupon bond into a comparable higher-coupon bond to realize an automatic and instantaneous increase in current yield and yield to maturity. Your risks are (1) that the market will move against you and (2) that the new issue may not be a viable swap candidate. Also, because you are moving to a higher-coupon obligation, there could be greater call risk.

An example of a pure yield pickup swap would be an investor who currently holds a 30-year, Aa-rated 10 percent issue that is trading at an 11.50 percent yield. Assume that a comparable 30-year, Aa-rated obligation bearing a 12 percent coupon priced to yield 12 percent becomes

[21]For additional information on these and other types of bond swaps, see Sidney Homer and Martin L. Leibowitz, *Inside the Yield Book* (Englewood Cliffs, N.J.: Prentice-Hall, 1972); Anand K. Bhattacharya and Frank J. Fabozzi, "Interest Rate Swaps," in *The Handbook of Fixed-Income Securities,* 6th ed.

EXHIBIT 20.3 *A PURE YIELD PICKUP SWAP*

Pure yield pickup swap: A bond swap involving a switch—from a low-coupon bond to a higher-coupon bond of similar quality and maturity—in order to pick up higher current yield and a better yield to maturity.

Example: Currently hold: 30-yr., 10.0% coupon priced at 874.12 to yield 11.5%
Swap candidate: 30-yr., Aa 12% coupon priced at $1,000 to yield 12.0%

	CURRENT BOND	CANDIDATE BOND
Dollar investment	$874.12	$1,000.00[a]
Coupon	100.00	120.00
i on one coupon (12.0% for 6 months)	3.000	3.600
Principal value at year end	874.66	1,000.00
Total accrued	977.66	1,123.60
Realized compound yield	11.514%	12.0%

Value of swap: 48.6 basis points in one year (assuming a 12.0% reinvestment rate).

The rewards for a pure yield pickup swap are automatic and instantaneous in that both a higher-coupon yield and a higher yield to maturity are realized from the swap.

Other advantages include:

1. No specific work-out period needed because the investor is assumed to hold the new bond to maturity
2. No need for interest rate speculation
3. No need to analyze prices for overvaluation or undervaluation

A major disadvantage of the pure yield pickup swap is the book loss involved in the swap. In this example, if the current bond were bought at par, the book loss would be $125.88 ($1,000 – 874.12).

Other risks involved in the pure yield pickup swap include:

1. Increased risk of call in the event interest rates decline
2. Reinvestment risk is greater with higher-coupon bonds.

[a]Obviously, the investor can invest $874.12—the amount obtained from the sale of the bond currently held—and still obtain a realized compound yield of 12.0%.

Swap evaluation procedure is patterned after a technique suggested by Sidney Homer and Martin L. Leibowitz.

Source: Adapted from the book *Inside the Yield Book* by Sidney Homer and Martin L. Leibowitz, Ph.D., 1972, used by permission of the publisher, Prentice-Hall Inc., Englewood Cliffs, N.J., and New York Institute of Finance, New York, N.Y.

available. The investor would report (and realize) some book loss if the original issue was bought at par but is able to improve current yield and yield to maturity simultaneously if the new obligation is held to maturity as shown in Exhibit 20.3.

The investor need not predict rate changes, and the swap is not based on any imbalance in yield spread. The object simply is to seek higher yields. Quality and maturity stay the same as do all other factors *except coupon.* The major risk is that future reinvestment rates may not be as high as expected, and, therefore, the total terminal value of the investment (capital recovery, coupon receipts, and interest-on-interest) may not be as high as expected or comparable to the original obligation. This reinvestment risk can be evaluated by analyzing the results with a number of reinvestment rates to determine the minimum reinvestment rate that would make the swap viable.

Substitution Swap The substitution swap generally is short term and relies heavily on interest rate expectations. Therefore, it is subject to considerably more risk than the pure yield pickup swaps. The procedure assumes a short-term imbalance in yield spreads between issues that are perfect substitutes. The imbalance in yield spread is expected to be corrected in the near future. For example, the investor might hold a 30-year, 12 percent issue that is yielding 12 percent and be offered a comparable 30-year, 12 percent bond that is yielding 12.20 percent. Because the issue offered will trade at a price less than $1,000 for every issue sold, the investor can buy more than one of the offered obligations.

You would expect the yield spread imbalance to be corrected by having the yield on the offering bond decline to the level of your current issue. Thus, you would realize capital gains by switching out of your current position into the higher-yielding obligation. This swap is described in Exhibit 20.4.

EXHIBIT 20.4 *A SUBSTITUTION SWAP*

Substitution swap: A swap executed to take advantage of temporary market anomalies in yield spreads between issues that are equivalent with respect to coupon, quality, and maturity.

Example: Currently hold: 30-yr., Aa 12.0% coupon priced at $1,000 to yield 12.0%
Swap candidate: 30-yr., Aa 12% coupon priced at $984.08 to yield 12.2%
Assumed work-out period: 1 year
Reinvested at 12.0%

	Current Bond	Candidate Bond
Dollar investment	$1,000.00	$ 984.08
Coupon	120.00	120.00
i on one coupon (12.0% for 6 months)	3.60	3.60
Principal value at year end (12.0% YTM)	1,000.00	1,000.00
Total accrued	1,123.60	1,123.60
Total gain	123.60	139.52
Gain per invested dollar	0.1236	0.1418
Realized compound yield	12.00%	13.71%
Value of swap: 171 basis points in one year		

The rewards for the substitution swap are additional basis-point pickups for YTM, additional realized compound yield, and capital gains that accrue when the anomaly in yield corrects itself.

In the substitution swap, any basis-point pickup (171 points in this example) will be realized only during the work-out period. Thus, in our example, to obtain the 171 basis-point increase in realized compound yield, you must swap an average of once a year and pick up an average of 20 basis points in yield to maturity on each swap.

Potential risks associated with the substitution swap include:

1. A yield spread thought to be temporary may, in fact, be permanent, thus reducing capital gains advantages.
2. The market rate may change adversely.

Swap evaluation procedure is patterned after a technique suggested by Sidney Homer and Martin L. Leibowitz.

Source: Adapted from the book *Inside the Yield Book* by Sidney Homer and Martin L. Leibowitz, Ph.D., © 1972, used by permission of the publisher, Prentice-Hall Inc., Englewood Cliffs, N.J., and New York Institute of Finance, New York, N.Y.

Although a modest increase in current income occurs as the yield imbalance is corrected, attractive capital gains are possible, causing a differential in *realized yield.* The work-out time will have an important effect on the differential realized return. Even if the yield is not corrected until maturity, 30 years later, you will still experience a small increase in realized yield (about 10 basis points). In contrast, if the correction takes place in one year, the differential realized return is much greater, as shown in Exhibit 20.4.

After the correction has occurred, you would have additional capital for a subsequent swap or other investment. Several risks are involved in this swap. In addition to the pressure of the work-out time, market interest rates could move against you, the yield spread may not be temporary, and the issue may not be a viable swap candidate (i.e., the spread may be due to the issue's lower quality).

Tax Swap The tax swap is popular with individual investors because it is a relatively simple procedure that involves no interest rate projections and few risks. Investors enter into tax swaps due to tax laws and realized capital gains in their portfolios. Assume you acquired $100,000 worth of corporate bonds and after two years sold the securities for $150,000, implying a capital gain of $50,000. One way to eliminate the tax liability of that capital gain is to sell an issue that has a comparable long-term capital loss.[22] If you had a long-term investment of $100,000 with a current market value of $50,000, you could execute a tax swap to establish the $50,000 capital loss. By offsetting this capital loss and the comparable capital gain, you would reduce your income taxes.

Municipal bonds are considered particularly attractive tax swap candidates because you can increase your tax-free income and use the capital loss (subject to normal federal and state taxation) to reduce capital gains tax liability. To continue our illustration, assume you own $100,000 worth of New York City, 20-year, 7 percent bonds that you bought at par, but they have a current market value of $50,000. Given this tax loss, you need a comparable bond swap candidate. Suppose you find a 20-year New York City bond with a 7.1 percent coupon and a market value of 50. By selling your New York 7s and instantaneously reinvesting in the New York 7.1s, you would eliminate the capital gains tax from the corporate bond transaction. In effect, you have $50,000 of tax-free capital gains, and you have increased your current tax-free yield. The money saved by avoiding the tax liability can then be used to increase the portfolio's yield, as shown in Exhibit 20.5.

An important caveat is that *you cannot swap identical issues* (such as selling the New York 7s to establish a loss and then buying back the same New York 7s). If it is not a different issue, the IRS considers the transaction a *wash sale* and does not allow the loss. It is easier to avoid wash sales in the bond market than it is in the stock market because every bond issue, even with identical coupons and maturities, is considered distinct. Likewise, it is easier to find comparable bond issues with only modest differences in coupon, maturity, and quality. Tax swaps are common at year end as investors establish capital losses because the capital loss must occur in the same taxable year as the capital gain. This procedure differs from other bond swap transactions because it exists due to tax statutes rather than temporary market anomalies.

A Global Fixed-Income Investment Strategy

An active management strategy that considers one or several of the techniques discussed thus far should apply these techniques to a global portfolio. The optimum global fixed-income asset allocation must consider three interrelated factors: (1) the local economy in each country that includes the effect of domestic and international demand, (2) the impact of this total demand and domestic monetary policy on inflation and interest rates, and (3) the effect of the economy,

[22] Although this discussion is concerned with bond tax swaps, comparable strategies could be used with other types of investments.

EXHIBIT 20.5 *A TAX SWAP*

Tax swap: A swap undertaken when you wish to offset capital gains in other securities through the sale of a bond currently held and selling at a discount from the price paid at purchase. By swapping into a bond with as nearly identical features as possible, you can use the capital loss on the sale of the bond for tax purposes and still maintain your current position in the market.

Example: Currently hold: $100,000 worth of corporate bonds with current market value of $150,000
and $100,000 in N.Y., 20-year, 7% bonds with current market value of $50,000
Swap candidate: $50,000 in N.Y., 20-year, 7.1% bonds

A. Corporate bonds sold and long-term capital gains profit established	$50,000	
Capital gains tax liability (assume you have 20% capital gains tax Rate) ($50,000 × 0.20)		$10,000
B. N.Y. 7s sold and long-term capital *loss* established	$50,000	
Reduction in capital gains tax liability ($50,000 × 0.20)		($10,000)
Net capital gains tax liability		0
Tax *savings* realized		$10,000
C. Complete tax swap by buying N.Y. 7.1s from proceeds of N.Y. 7s		
Sale (therefore, amount invested remains largely the *same*)[a]		
Annual tax-free interest income—N.Y. 7s	$ 7,000	
Annual tax-free interest income—N.Y.7.1s	$ 7,100	
Net *increase* in *annual* tax-free interest income	$ 100	

[a]N.Y. 7.1s will result in substantial capital gains when liquidated at maturity (because they were bought at deep discounts) and, therefore, will be subject to future capital gains tax liability. The swap is designed to use the capital loss resulting from the swap to offset capital gains from other investments. At the same time, your funds remain in a security almost identical to your previous holding while you receive a slight increase in both current income and YTM.

Because the tax swap involved no projections in terms of work-out period, interest rate changes, etc., the risks involved are minimal. Your major concern should be to avoid potential wash sales.

inflation, and interest rates on the exchange rates among countries.[23] Based on the evaluation of these factors, a portfolio manager must decide on the relative weight for each country. In addition, one might consider an allocation within each country among government, municipal, and corporate bonds. In the examples that follow, most portfolio recommendations concentrate on the country allocation and do not become more specific except in the case of the United States.

Exhibit 20.6 is from the March 31, 2002, *Quarterly Investment Strategy* by UBS Global Asset Management, a global institutional asset manager. The table's "Benchmark" column indicates what the asset allocation would be if UBS had no opinion regarding the expected bond market

[23]For a detailed discussion of the benefits of international bond investing as well as what is involved in the analysis, see Christopher B. Steward, "International Bond Markets and Instruments"; Michael R. Rosenberg, "International Fixed-Income Investing: Theory and Practice"; Jack Malvey, "Global Corporate Bond Portfolio Management; and Christopher B. Steward and Adam Greshin, "International Bond Investing and Portfolio Management." All four are included in *The Handbook of Fixed-Income Securities, 6th ed.* Also see Dwight D. Churchhill, ed., *Fixed-Income Management: Techniques and Practices* (Charlottesville, Va.: Association of Investment Management and Research, 1994); Jan R. Squires, ed., *Global Portfolio Management* (Charlottesville, Va.: Association of Investment Management and Research, 1996); Jan R. Squires, ed., *Global Bond Management* (Charlottesville Va.: Association of Investment Management and Research, 1997); *Managing Currency Risk* (Charlottesville, Va.: Association of Investment Management and Research, 1997); "*Global Bond Management II: The Search for Alpha*" (Charlottesville, Va.: Association for Investment Management and Research, 2000); and Katheryn Dixon Jost, ed., *Fixed-Income Management for the 21st Century* (Charlottesville, Va.: Association for Investment Management and Research, 2002).

EXHIBIT 20.6 *UBS GLOBAL BOND PORTFOLIO STRATEGY*

Market Allocation as of March 31, 2002

	GLOBAL		
	BENCHMARK	OVER/UNDER WEIGHT	MARKET STRATEGY
North America	**27.2%**	**4.4%**	**31.6%**
Canada	2.7	3.0	5.7
U.S.	24.5	1.4	25.9
EMU	**36.7**	**8.5**	**45.2**
Other Europe (except United Kingdom)	**2.5**	**0.0**	**2.5**
Denmark	1.1	–1.1	0.0
Sweden	0.9	1.7	2.6
Switzerland	0.6	–0.6	0.0
United Kingdom	**4.9**	**–3.0**	**1.9**
Japan	**28.3**	**–11.5**	**16.8**
Australia	**0.4**	**1.6**	**2.0**
	100.0%		**100.0%**

	EUROPE (EMU)		
	BENCHMARK	OVER/UNDER WEIGHT	MARKET STRATEGY
Austria	3.5%	–0.5%	3.0%
Belgium	7.0	–7.0	0.0
Finland	1.5	–1.5	0.0
France	21.8	–0.6	21.2
Germany	22.6	4.0	26.6
Greece	3.4	–3.4	0.0
Ireland	0.6	–0.6	0.0
Italy	23.3	5.5	28.8
Netherlands	5.7	–0.1	5.6
Portugal	1.8	–1.8	0.0
Spain	8.8	5.9	14.7
	100.0%	100.0%	

Currency Allocation

	GLOBAL		
	BENCHMARK	OVER/UNDER WEIGHT	MARKET STRATEGY
North America	**27.2%**	**–10.0%**	**17.2%**
Canada	2.7	2.0	4.7
U.S.	24.5	–12.0	12.5
EMU	**36.7**	**12.9**	**49.6**
Other Europe (except United Kingdom)	**2.5**	**0.0**	**2.5**
Denmanrk	1.1	0.0	1.1
Sweden	0.9	0.0	0.9
Switzerland	0.6	0.0	0.6
United Kingdom	**4.9**	**–4.9**	**0.0**
Japan	**28.3**	**–4.0**	**24.3**
Australia	**0.4**	**6.0**	**6.4**
	100.0%	**100.0%**	**100.0%**

Totals may not add to 100% due to rounding.

Source: UBS Global Asset Management, *Quarterly Investment Strategy,* 31 March 2002 (Chicago, Ill.: UBS Global Asset Management).

performance in the alternative countries. In most cases, this normal allocation is based on the country's relative market value. Here, the normal allocation is 24.5 percent for the United States, 28.3 percent for Japan, and the remaining 47.2 percent for the other countries, including 36.7 percent for the combined EMU countries. Clearly, UBS *does* have an opinion regarding these countries (as shown in its market strategy) because it has overweighted the U.S. bond market with an allocation of 25.9 percent (versus 24.5 percent) and underweighted the Japan bond market with an allocation of only 16.8 percent (versus 28.3 percent). In turn, several other countries are heavily overweighted—Canada, Sweden, and Australia—while several are clearly underweighted, including Denmark, Switzerland, and the United Kingdom. In addition, UBS does a specific currency allocation among countries that would likewise be based on the normal policy weight unless the firm had an opinion on currencies. Again, UBS has a definite opinion: it heavily underweighted the U.S. dollar, the Japanese yen, and the U.K. pound and was overweighted in the currencies of the EMU, Canada, and Australia.

In making your own allocations based on these specific expectations, you would look for U.S. securities in which yields were expected to decline relative to Treasury securities and for bond markets in foreign countries that likewise had bullish interest rate expectations. Finally, you would look for countries in which the currency was expected to be strong relative to the United States.

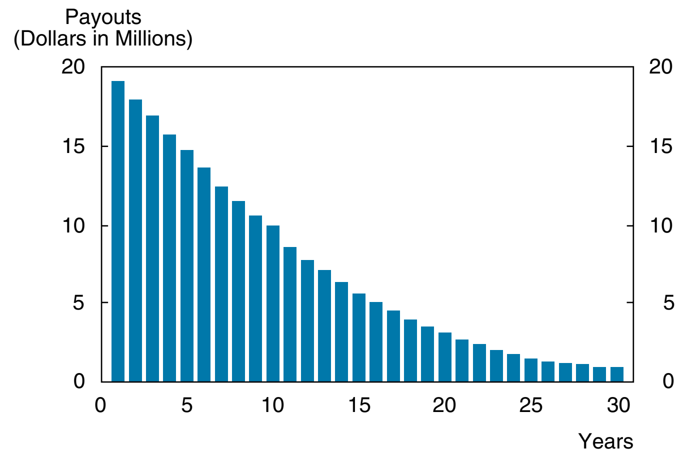
In summary, assuming you want to actively manage a bond portfolio, this example shows an approach to the asset allocation decision on a global scale. Similar to our discussion on equity securities, global bond allocation requires substantially more research because you must evaluate each country—individually and relative to every other country. Finally, your global fixed-income recommendation also must consider exchange rate changes—that is, you must make a currency decision for each country.

Core-Plus Bond Portfolio Management

Beyond a pure passive policy or one of the several active portfolio management styles, there has been an increase in a combination approach referred to as **core-plus bond-portfolio management**. The idea is to have a significant (core) part of the portfolio (e.g., 70 percent to 75 percent) managed passively in a widely recognized sector such as the U.S. Aggregate Sector or the U.S. Government/Corporate sector. The difference between these two sectors is that the aggregate includes the rapidly growing mortgage-backed and asset-backed sectors. It is suggested that this core of the portfolio be managed passively because these segments of the bond market are quite efficient so that it is not worth the time and cost to attempt to derive excess returns within these sectors. The rest of the portfolio would be managed actively in one or several additional "plus" sectors, where it is felt that there is a higher probability of achieving positive abnormal rates of return because of potential inefficiencies. The major areas suggested for the "plus" of the portfolio include high-yield bonds (HY bonds), foreign bonds, and emerging-market debt. These are considered good candidates for active management since they generally experience above-average rates of return; but, while they have *high total risk* as measured by their standard deviation of returns, they have relatively *low systematic risk* relative to a total bond market portfolio because they have low correlations with other fixed-income sectors. An example would be HY bonds that have *very high* standard deviations but are correlated only about 0.30 with investment-grade bonds and/or other large bond benchmarks so they have *very low* systematic risk.[24]

[24]Two recent conferences by the Association for Investment Management and Research consider this concept and discuss potential areas for active management. See *Global Bond Management II: The Search for Alpha* (Charlottesville, Va.: Association for Investment Management and Research, August 2000); and *Core-Plus Bond Management* (Charlottesville, Va.: Association for Investment Management and Research, March 2001).

EXHIBIT 20.7 *A PRESCRIBED SCHEDULE OF LIABILITIES*



Matched-Funding Techniques[25]

As discussed previously, because of an increase in interest rate volatility and the needs of many institutional investors, there has been a growth in the use of matched-funding techniques ranging from pure cash-matched dedicated portfolios to portfolios involved in contingent immunization.

Dedicated Portfolios **Dedication** refers to bond portfolio management techniques that are used to service a prescribed set of liabilities. The idea is that a pension fund has a set of future liabilities, and those responsible for administering these liabilities want a money manager to construct a portfolio of assets with cash flows that will match this liability stream. Such a "dedicated" portfolio can be created in several ways. We will discuss two alternatives.

A **pure cash-matched dedicated portfolio** is the most conservative strategy. Specifically, the objective of pure cash matching is to develop a portfolio of bonds that will provide a stream of payments from coupons, sinking funds, and maturing principal payments that will exactly match the specified liability schedules. An example of a typical liability stream for a retired-lives component of a pension system is shown in Exhibit 20.7.

The goal is to build a portfolio that will generate sufficient funds in advance of each scheduled payment to ensure that the payment will be met. One alternative is to find a number of zero coupon Treasury securities that will exactly cash match each liability. Such an exact cash match is referred to as a *total passive* portfolio because it is designed so that any prior receipts would not be reinvested (i.e., it assumes a zero reinvestment rate).

Dedication with reinvestment is the same as the pure cash-matched technique except it is assumed that the bonds and other cash flows do not have to exactly match the liability stream. Specifically, any inflows that precede liability claims can be reinvested at some reasonably conservative rate. This assumption allows the portfolio manager to consider a substantially wider set of bonds that may have higher return characteristics. In addition, the assumption of reinvestment

[25]An overview of these alternative strategies is contained in Martin L. Leibowitz, "The Dedicated Bond Portfolio in Pension Funds—Part I: Motivations and Basics," *Financial Analysts Journal* 42, no. 1 (January–February 1986): 68–75; and Frank J. Fabozzi and Peter F. Christensen, "Dedicated Bond Portfolios," *The Handbook of Fixed-Income Securities,* 6th ed.

within each period and between periods also will generate a higher return for the asset portfolio. As a result, the net cost of the portfolio will be lower, with almost equal safety, assuming the reinvestment rate assumption is conservative. An example would be to assume a reinvestment rate of 6 percent in an environment where market interest rates are currently ranging from 7 percent to 10 percent.

Potential problems exist with both of these approaches to a dedicated portfolio. For example, when selecting potential bonds for these portfolios, it is critical to be aware of call/prepayment possibilities (refundings, calls, sinking funds) with specific bonds or mortgage-backed securities. These prepayment possibilities become very important following periods of historically high rates. A prime example was the period 1982 to 1986, when interest rates went from over 18 percent to under 8 percent. Because of this substantial change in rates, many dedicated portfolios constructed without adequate concern for complete call protection were negatively affected when numerous bonds were called that were not expected to be called "under normal conditions." For example, bonds selling at deep discounts (which typically provide implicit call protection), when rates were 16 percent to 18 percent, went to par and above when rates declined to under 10 percent—and they were called. Obviously, the reinvestment of these proceeds at the lower rates caused many dedicated portfolios to be underfunded. Therefore, it is necessary to find bonds with complete call protection or to consider deep discount bonds under conservative interest rate conditions.

Although quality also is a legitimate concern, it is probably not necessary to invest only in Treasury bonds if the portfolio manager diversifies across industries and sectors. A diversified portfolio of AA or A industrial bonds can provide a current and total annual return of 40 to 60 basis points above Treasuries. This differential over a 30-year period can have a significant impact on the net cost of funding a liability stream.

Immunization Strategies Instead of using a passive strategy, an active strategy, or a dedicated portfolio technique, a portfolio manager (after client consultation) may decide that the optimal strategy is to immunize the portfolio from interest rate changes. The *immunization techniques* attempt to derive a specified rate of return (generally quite close to the current market rate) during a given investment horizon regardless of what happens to market interest rates.

Components of Interest Rate Risk A major problem encountered in bond portfolio management is deriving a given rate of return to satisfy an ending-wealth requirement at a future specific date—that is, the **investment horizon**. If the term structure of interest rates were flat and market rates never changed between the time of purchase and the horizon date when funds were required, you could acquire a bond with a term to maturity equal to the desired investment horizon, and the ending wealth from the bond would equal the promised wealth position implied by the promised yield to maturity. Specifically, the ending-wealth position would be the beginning wealth times the compound value of a dollar at the promised yield to maturity. For example, assume you acquire a 10-year, $1 million bond with an 8 percent coupon at its par value (8 percent Y_m). If conditions were as specified (there was a flat yield curve and there were no changes in the curve), your wealth position at the end of your 10-year investment horizon (assuming semiannual compounding) would be

$$\$1{,}000{,}000 \times (1.04)^{20} = \$1{,}000{,}000 \times 2.1911 = \$2{,}191{,}100$$

You can get the same answer by taking the $40,000 interest payment every six months and compounding it semiannually to the end of the period at 4 percent and adding the $1,000,000 principal at maturity. Unfortunately, in the real world, the term structure of interest rates typically is not flat and the level of interest rates is constantly changing. Consequently, the bond portfolio manager faces **interest rate risk** between the time of investment and the future target date. Interest rate risk is the uncertainty regarding the ending-wealth value of the portfolio due to changes in market interest rates between the time of purchase and the investor's horizon date. Notably, interest rate risk involves two component risks: **price risk** and **coupon reinvestment risk**.

The price risk occurs because if interest rates change before the horizon date and the bond is sold before maturity, the realized market price for the bond will differ from the *expected* price, assuming there had been no change in rates. If rates increased after the time of purchase, the realized price for the bond in the secondary market would be below expectations, whereas if rates declined, the realized price for the bond would be above expectations. Because you do not know whether interest rates will increase or decrease, you are uncertain about the bond's future price.

The coupon reinvestment risk arises because the yield to maturity computation implicitly assumes that all coupon cash flows will be reinvested at the promised yield to maturity.[26] If, after the purchase of the bond, interest rates decline, the coupon cash flows will be reinvested at rates below the promised Y_m, and the ending wealth will be below expectations. In contrast, if interest rates increase, the coupon cash flows will be reinvested at rates above expectations, and the ending wealth will be above expectations. Again, because you are uncertain about future rates, you are uncertain about these reinvestment rates.

Classical Immunization and Interest Rate Risk The price risk and the coupon reinvestment risk caused by a change in interest rates have opposite effects on the ending-wealth position. An increase in interest rates will cause an ending price below expectations, but the reinvestment rate for interim cash flows will be above expectations. A decline in market interest rates will cause the reverse situation. Clearly, a bond portfolio manager with a specific target date (investment horizon) will attempt to eliminate these two components of interest rate risk. The process intended to eliminate interest rate risk is referred to as **immunization** and was discussed by Redington in the early 1950s.[27] It has been specified in detail by Fisher and Weil as follows:

> A portfolio of investments in bonds is *immunized* for a holding period if its value at the end of the holding period, regardless of the course of interest 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.[28]

Fisher and Weil found a significant difference between the *promised* yields and the *realized* returns on bonds for the period 1925 to 1968, indicating the importance of immunizing a bond portfolio. They showed that it is possible to immunize a bond portfolio if you can assume that any change in interest rates will be the same for all maturities—that is, if forward interest rates change, all rates will change by the same amount (there is a parallel shift of the yield curve). Given this assumption, Fisher and Weil proved that *a portfolio of bonds is immunized from interest rate risk if the modified duration of the portfolio is always equal to the desired investment horizon.* For example, if the investment horizon of a bond portfolio is eight years, the *modified duration* of the bond portfolio should equal eight years to immunize the portfolio. To attain a given modified duration, the weighted average modified duration (with weights equal to the

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[26]This point was discussed in detail in Chapter 19 and in Homer and Leibowitz, *Inside the Yield Book,* Chapter 1.

[27]F. M. Redington, "Review of the Principles of Life—Office Valuations," *Journal of the Institute of Actuaries* 78 (1952): 286–340.

[28]Lawrence Fisher and Roman L. Weil, "Coping with the Risk of Interest-Rate Fluctuations: Returns to Bondholders from Naive and Optimal Strategies," *Journal of Business* 44, no. 4 (October 1971): 408–431.

proportion of value) is set at the desired length following an interest payment, and all subsequent cash flows are invested in securities *to keep the portfolio modified duration equal to the remaining investment horizon.*

Fisher and Weil showed that price risk and reinvestment rate risk are affected in opposite directions by a change in market rates and that modified duration is the time period when these two risks are of equal magnitude but opposite in direction.[29]

Application of the Immunization Principle Fisher and Weil simulated the effects of applying the immunization concept (a duration-matched strategy) compared to a naive portfolio strategy where the portfolio's maturity was equal to the investment horizon. They compared the ending-wealth ratio for the duration-matched and for the naive strategy portfolios to a wealth ratio that assumed no change in the interest rate structure. In a perfectly immunized portfolio, the actual ending wealth should equal the expected ending wealth implied by the promised yield, so these comparisons should indicate which portfolio strategy does a superior job of immunization. The duration-matched strategy results were consistently closer to the promised yield results; however, the results were not perfect. The duration portfolio was not perfectly immunized because the basic assumption did not always hold; that is, when interest rates changed, all interest rates did not change by the same amount.

Bierwag and Kaufman pointed out several specifications of the duration measure.[30] The Macaulay duration measure, one of the duration measures discussed in Chapter 19, discounts all flows by the prevailing yield to maturity on the bond being measured.[31] Alternatively, Fisher and Weil defined duration using future one-period interest rates (forward rates) to discount the future flows.[32] Depending on the shape of the yield curve, the two definitions could give different answers. If the yield curve is flat, the two definitions will compute equal durations. Bierwag and Kaufman computed alternative measures of duration and found that, except at high coupons and long maturities, the duration values of the alternative definitions were similar, and the Macaulay definition is preferable because it is a function of the yield to maturity of the bond. This means you do not need a forecast of one-period forward rates over the maturity of the bond.[33]

Example of Classical Immunization Exhibit 20.8 shows the effect of attempting to immunize a portfolio by matching the investment horizon and the duration of a bond portfolio using a single bond. The portfolio manager's investment horizon is eight years, and the current yield to maturity for eight-year bonds is 8 percent. Therefore, if we assumed no change in yields, the ending-wealth ratio for an investor should be 1.8509 (1.08^8) with annual compounding.[34] As noted, this also should be the ending-wealth ratio for a completely immunized portfolio.

The example considers two portfolio strategies: (1) the maturity strategy, where the portfolio manager would acquire a bond with a term to maturity of eight years, and (2) the duration strategy, where the portfolio manager sets the duration of the portfolio at eight years. For the **maturity strategy**, the portfolio manager acquires an eight-year, 8 percent bond; for the **duration**

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[29]This also is noted and discussed in G. O. Bierwag and George G. Kaufman, "Coping with the Risk of Interest Rate Fluctuations: A Note," *Journal of Business* 50, no. 3 (July 1977): 364–370; and G. O. Bierwag, "Immunization, Duration, and the Term Structure of Interest Rates," *Journal of Financial and Quantitative Analysis* 12, no. 5 (December 1977): 725–742.

[30]Bierwag and Kaufman, "Coping with the Risk of Interest Rate Fluctuations," 364–370.

[31]Frederick R. Macaulay, *Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields, and Stock Prices in the United States since 1856* (New York: National Bureau of Economic Research, 1938).

[32]Fisher and Weil, "Coping with the Risk of Interest Rate Fluctuations," 408–431.

[33]Bierwag and Kaufman, "Coping with the Risk of Interest Rate Fluctuations," 367.

[34]We use annual compounding to compute the ending-wealth ratio because the example uses annual observations.

EXHIBIT 20.8 *AN EXAMPLE OF THE EFFECT OF A CHANGE IN MARKET RATES ON A BOND (PORTFOLIO) THAT USES THE MATURITY STRATEGY VERSUS THE DURATION STRATEGY*

	RESULTS WITH MATURITY STRATEGY			RESULTS WITH DURATION STRATEGY		
YEAR	CASH FLOW	REINVESTMENT RATE	END VALUE	CASH FLOW	REINVESTMENT RATE	END VALUE
1	$ 80	.08	$ 80.00	$ 80	.08	$ 80.00
2	80	.08	166.40	80	.08	166.40
3	80	.08	259.71	80	.08	259.71
4	80	.08	360.49	80	.08	360.49
5	80	.06	462.12	80	.06	462.12
6	80	.06	596.85	80	.06	596.85
7	80	.06	684.04	80	.06	684.04
8	$1,080	.06	$1,805.08	$1,120.64[a]	.06	$1,845.72

Expected Wealth Ratio = 1.8509 or $1,850.90

[a]The bond could be sold at its market value of $1,040.64, which is the value for an 8 percent bond with two years to maturity priced to yield 6 percent.

strategy, the manager acquires a 10-year, 8 percent bond that has approximately an eight-year duration (8.12 years), assuming an 8 percent Y_m. We assume a single shock to the interest rate structure at the end of Year 4, when rates go from 8 percent to 6 percent and stay there through Year 8.

As shown, due to the interest rate change, the ending-wealth ratio for the maturity strategy bond is *below* the desired wealth ratio because of the shortfall in the reinvestment cash flow after Year 4 when the interim coupon cash flow was reinvested at 6 percent rather than 8 percent. Note that *the maturity strategy eliminated the price risk* because the bond matured at the end of Year 8. Alternatively, the duration strategy portfolio likewise suffered a shortfall in reinvestment cash flow because of the change in market rates. In contrast to the maturity strategy, this reinvestment shortfall was partially offset by an *increase* in the ending value for the bond because of the decline in market rates. This second bond is sold at the end of Year 8 at 104.06 of par because it is an 8 percent coupon bond with two years to maturity selling to yield 6 percent. Because of this partial offset due to the price increase, the duration strategy had an ending-wealth value (1,845.72) that was much closer to the expected wealth ratio (1,850.90) than the maturity strategy (1,805.08). The point is, the reinvestment rate shortfall was almost completely offset by the positive price effect in the duration strategy.

If market interest rates had increased during this period, the maturity strategy portfolio would have experienced an *excess* of reinvestment income compared to the expected cash flow and the ending-wealth ratio for this strategy would have been above expectations. In contrast, in the duration portfolio, the excess cash flow from reinvestment under this assumption would have been partially offset by a *decline* in the ending price for the bond (i.e., it would have sold at a small discount to par value). Although the ending-wealth ratio for the duration strategy would have been lower than the maturity strategy in this example, it would have been closer to the expected-wealth ratio. Although the maturity strategy would have provided a higher than expected ending value for this scenario, the whole purpose of immunization is to *eliminate uncertainty* due to interest rate changes by having the realized-wealth position equal the expected-wealth position. As shown, this is what is accomplished with the duration-matched strategy.

Another View of Immunization The prior example assumed that both bonds were acquired and held to the end of the investment horizon. An alternative way to envision what is expected to happen with an immunized portfolio is to concentrate on the specific growth path from the beginning-wealth position to the ending-wealth position and examine what happens when interest rates change.

Assume that the initial-wealth position is $1 million, your investment horizon is 10 years, and the coupon and current YTM are 8 percent. We know from an earlier computation that this implies that the expected ending-wealth value is $2,191,100 (with semiannual compounding). Exhibit 20.9A shows the compound growth rate path from $1 million to the expected ending value at $2,191,100. In Exhibit 20.9B, it is assumed that at the end of Year 2, interest rates increase 200 basis points from 8 percent to 10 percent. We know that with no prior rate changes, at the end of Year 2 the value of the portfolio would have grown at an 8 percent compound rate to $1,169,900 [$1.04^4 = 1.1699$]. Given the rate change, we know there will be two changes for this portfolio: (1) the price (value of the portfolio) will decline to reflect the higher interest rate; and (2) the reinvestment rate, which is the growth rate, will increase to 10 percent. An important question is, How much will the portfolio value decline? The answer depends on the modified duration of the portfolio when rates change. Fisher and Weil showed that *if the modified duration is equal to the remaining horizon, the price change will be such that at the new reinvestment (growth) rate (10 percent), the new portfolio value will grow to the expected-wealth position.* You can approximate the change in portfolio value using the modified duration and the change in market rates. (Recall that this will not give an exact estimate because of the convexity of the portfolio.) The approximate change in price is 16 percent based on a modified duration of eight years and a 200-basis-point change. This would imply an approximate portfolio value of $982,716 ($1,169,900 × 0.84). In fact, the actual value would be $1,003,743. (Recall that the estimated value based on using modified duration always is below the value implied by the price-yield curve.) If this new portfolio value grows at 10 percent a year for eight years, the ending-wealth value will be

$$\$1{,}003{,}743 \times 2.1829 \text{ (5\% for 16 Periods)} = \$2{,}191{,}070$$

The difference between the expected value and projected value is due to rounding. This example shows that the price decline is almost exactly offset by the higher reinvestment rate—assuming that the modified duration of the portfolio at the time of the rate change was equal to the remaining investment horizon.

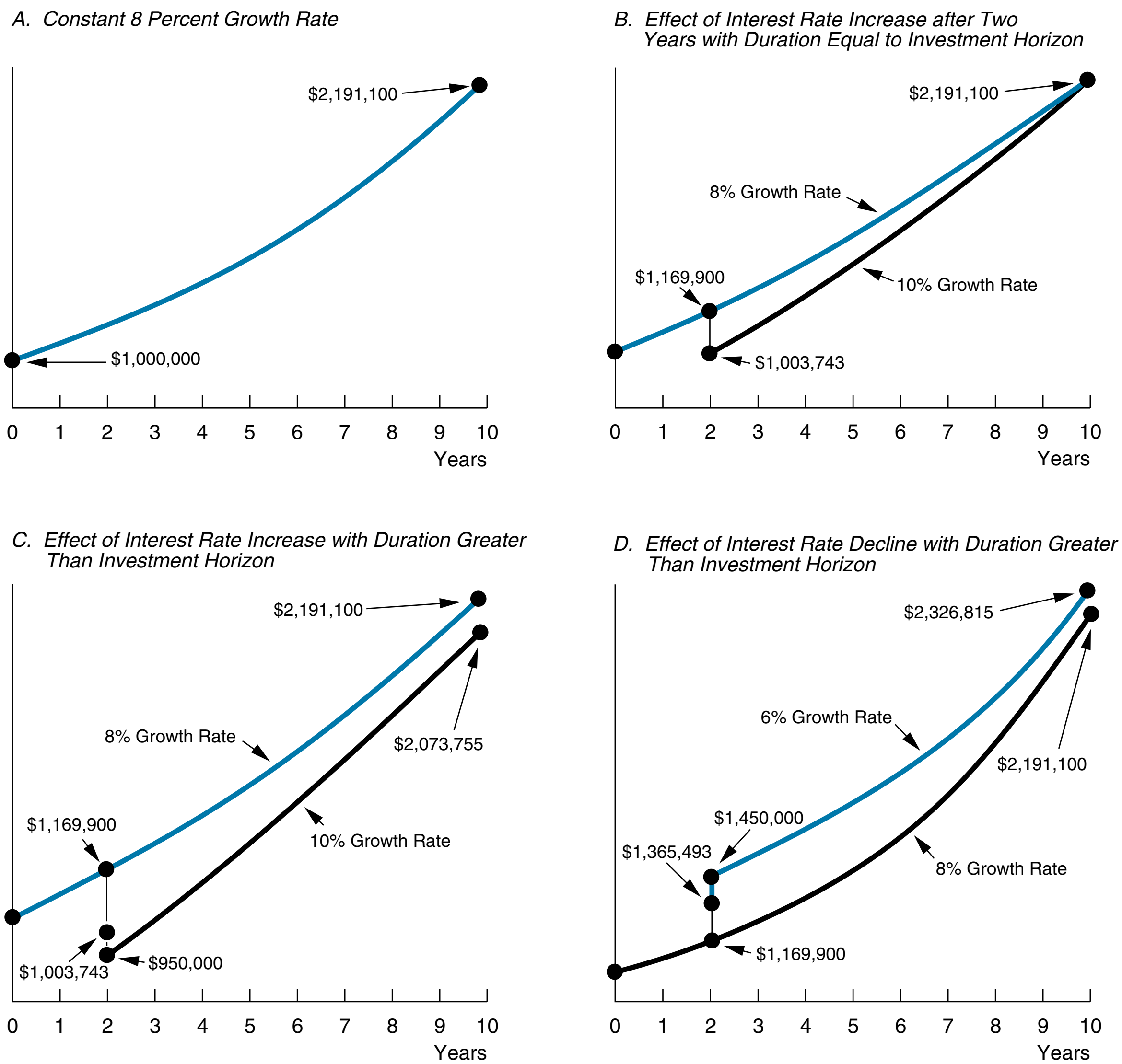
What happens if the portfolio is not properly matched? If the modified duration is greater than the remaining horizon, the price change will be greater. Thus, if interest rates increase, the value of the portfolio after the rate change will be less than $1,003,743. In this case, even if the new value of the portfolio grew at 10 percent a year, it would not reach the expected ending-wealth value. This scenario is shown in Exhibit 20.9C, where it is assumed that the portfolio value declined to $950,000. If this new value grew at 10 percent a year for the remaining 8 years, its ending value would be

$$\$950{,}000 \times 2.1829 \text{ (5\% for 16 Periods)} = \$2{,}073{,}755$$

Therefore, the shortfall of $118,000 between the expected-wealth value and the realized-wealth value is because the portfolio was not properly duration matched (immunized) when interest rates changed.

Alternatively, if interest rates had declined, and the modified duration had been longer than eight years, the portfolio value would have increased such that the new portfolio value would have been greater than the required value. Exhibit 20.9D shows what can happen if the portfolio

EXHIBIT 20.9 *THE GROWTH PATH TO THE EXPECTED ENDING-WEALTH VALUE AND THE EFFECT OF IMMUNIZATION*



is not properly matched and interest rates decline by 200 basis points to 6 percent. First, if the portfolio *is* properly matched, the value will increase to $1,365,493. If this new portfolio value grows at 6 percent for eight years, its ending value will be

$$\$1,365,493 \times 1.6047 \text{ (3\% for 16 Periods)} = \$2,191,207$$

Again, this deviates slightly from the expected ending-wealth value ($2,191,100) due to rounding. Alternatively, if the modified duration had been above eight years, the new portfolio value would have been greater than the required current value of $1,365,493. Assume that because the duration of the portfolio exceeded the remaining horizon, the portfolio value increased to $1,450,000. If so, the ending value would be

$$\$1{,}450{,}000 \times 1.6047 \text{ (3\% for 16 Periods)} = \$2{,}326{,}815$$

In this example, the ending-wealth value would have been greater than the expected-wealth value because you were mismatched and interest rates went in the right direction. When you are not duration matched, you are speculating on interest rate changes, and the result can be very good or very bad. The purpose of immunization is to avoid these uncertainties and to ensure the expected ending-wealth value ($2,191,100), regardless of interest rate changes.

Application of Classical Immunization Once you understand the reasoning behind immunization (i.e., it is meant to offset the components of interest rate risk) and the general principle (you need to match modified duration and the investment horizon), you might conclude that this strategy is fairly simple to apply. You might even consider it a passive strategy; simply match modified duration and the investment horizon, and you can ignore the portfolio until the end of the horizon period. The following discussion will show that *immunization is neither a simple nor a passive strategy.*

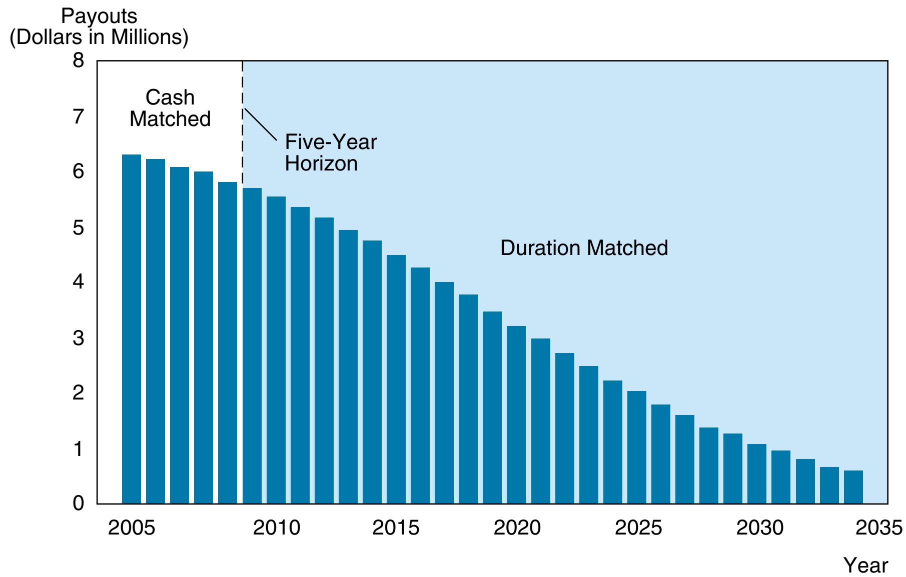
Except for the case of a zero coupon bond, *an immunized portfolio requires frequent rebalancing* because the modified duration of the portfolio always should be equal to the remaining time horizon. The zero coupon bond is unique because it is a pure discount bond. As such, because there is no cash flow, there is *no reinvestment risk* because the discounting assumes that the value of the bond will grow at the discount rate. For example, if you discount a future value at 10 percent, the present value factor assumes that the value will grow at a compound rate of 10 percent to maturity. Also, there is *no price risk* if you set the duration at your time horizon because you will receive the face value of the bond at maturity. Also, recall that the duration of a zero coupon bond always is equal to its term to maturity. In summary, if you immunize by matching your horizon with a zero coupon bond of equal duration, you do not have to rebalance.

In contrast, if you immunize a portfolio using coupon bonds, several characteristics of duration make it impossible to set a duration equal to the remaining horizon at the initiation of the portfolio and ignore it thereafter. First, *duration declines more slowly than term to maturity, assuming no change in market interest rates.* For example, assume you have a security with a computed duration of five years at a 10 percent market yield. A year later, if you compute the duration of the security at 10 percent, you will find that it has a duration of approximately 4.2 years; that is, although the term to maturity has declined by a year, the duration has declined by only 0.8 year. This means that, assuming no change in market rates, the portfolio manager must rebalance the portfolio to reduce its duration to four years. Typically, this is not difficult because cash flows from the portfolio can be invested in short-term T-bills if necessary.

Second, *duration changes with a change in market interest rates.* In Chapter 19, we discussed the inverse relationship between market rates and duration—with higher market rates, there will be lower duration and vice versa. Therefore, a portfolio that has the appropriate modified duration at a point in time can have its duration changed immediately if market rates change. If this occurs, a portfolio manager will have to rebalance the portfolio if the deviation from the required duration becomes too large.

Third, you will recall from our initial discussion of immunization that one of the assumptions is that when market rates change, they will change by the same amount and in the same direction (i.e., there will be a parallel shift of the yield curve). Clearly, if this does not happen, it will affect the performance of a portfolio of diffuse bonds. For example, assume you own a portfolio of long- and short-term bonds with a weighted average six-year duration (e.g., 2-year duration bonds and 10-year duration bonds). Assume the term structure curve changes such that short-

EXHIBIT 20.10 *THE CONCEPT OF HORIZON MATCHING*



"Horizon Matching: A New Generalized Approach for Developing Minimum Cost Dedicated Portfolios." Copyright 1983 Salomon Brothers Inc. This chart was prepared for Salomon Brothers Inc. by Martin Leibowitz, a former Managing Director; Thomas E. Klaffky, Managing Director; Steven Mandel, a former Managing Director; and Alfred Weinberger, a former Director. Although the information in this chart has been obtained from sources that Salomon Brothers Inc. believed to be reliable, SSB does not guarantee their accuracy, and such information may be incomplete or condensed. All figures included in this chart constitute SSB's judgment as of the original publication date. Reprinted with permission from SalomonSmithBarney.

term rates decline and long-term rates *rise* (there is an increase in the slope of the yield curve). In such a case, you would experience a major price decline in the long-term bonds but would be penalized on reinvestment, assuming you generally reinvest the cash flow in short-term securities. This potential problem (caused by a change in the shape of the yield curve) suggests that you should attempt to bunch your portfolio selections close to the desired duration (i.e., use a bullet approach). For example, an eight-year duration portfolio should be made up of seven- to nine-year duration securities to avoid this yield curve reshaping problem.

Finally, there always can be a problem acquiring the bonds you select as optimum for your portfolio. For instance, can you buy long-duration bonds at the price you consider acceptable? In summary, it is important to recognize that classical immunization is *not a passive strategy* because it is subject to all of these potential problems.[35]

Horizon Matching Horizon matching is a combination of two of the techniques discussed: cash-matching dedication and immunization. As shown in Exhibit 20.10, the liability stream is divided into two segments. In the first segment, the portfolio is constructed to provide a cash match for the liabilities during this horizon period (e.g., the first five years). The second segment is the remaining liability stream following the end of the horizon period—in the example, it is the 25 years after the horizon period. During this second time period, the liabilities are covered

[35]Several of these problems are discussed in Frank J. Fabozzi and Peter Christensen, "Bond Immunization: An Asset/Liability Optimization Strategy," in *The Handbook of Fixed-Income Securities,* 6th ed.

by a duration-matched strategy based on immunization principles. As a result, the client receives the certainty of cash matching during the early years and the cost saving and flexibility of duration-matched flows thereafter.

The combination technique also helps alleviate one of the problems with classical immunization: the potential for nonparallel shifts in the yield curve. Most of the problems related to nonparallel shifts are concentrated in the short end of the yield curve because this is where the most severe curve reshaping occurs. Because the short end is taken care of by the cash matching, these are not of concern and we know that the long end of the yield curve tends toward parallel shifts.

An important decision when using horizon matching is the length of the horizon period. The trade-off when making this decision is between the safety and certainty of cash matching and the lower cost and flexibility of duration-based immunization. The portfolio manager should provide to the client a set of horizon alternatives and the costs and benefits of each of them and allow the client to make the decision.

It also is possible to consider *rolling out* the cash-matched segment over time. Specifically, after the first year the portfolio manager would restructure the portfolio to provide a cash match during the original Year 6, which means that you would still have a five-year horizon. The ability and cost of rolling out depends on movements in interest rates (ideally, you would want parallel shifts in the yield curve).[36]

Contingent Procedures

Contingent procedures are a form of structured active management. The procedure we discuss here is contingent immunization, which entails allowing the portfolio manager some opportunity to actively manage the portfolio with a structure that constrains the portfolio manager if he or she is unsuccessful.

Contingent Immunization

Subsequent to the development and application of classical immunization, Leibowitz and Weinberger developed a portfolio strategy called *contingent immunization.*[37] Basically, it allows a bond portfolio manager to pursue the highest returns available through active strategies, while relying on classical bond immunization techniques to ensure a given minimal return over the investment horizon—that is, it allows active portfolio management with a safety net provided by classical immunization.

To understand contingent immunization, it is necessary to recall our discussion of classical immunization. Remember that when the portfolio duration is equal to the investment horizon, a change in interest rates will cause a change in the dollar value of the portfolio such that when the new asset value is compounded at the new market interest rate, it will equal the desired ending value. This required change in value occurs *only* when the modified duration of the portfolio is equal to the remaining time horizon, which is why the modified duration of the portfolio must be maintained at the horizon value.

Consider the following example of this process. Assume that your desired ending-wealth value is \$206.3 million. Given a specific ending value and the number of years to your horizon value, it is possible to determine how much you must invest today to attain that ending value if you assume a rate of return on the portfolio. Obviously, this is just the reverse of the price com-

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[36]For a further discussion on this topic, see Martin L. Leibowitz, Thomas E. Klaffky, Steven Mandel, and Alfred Weinberger, *Horizon Matching: A New Generalized Approach for Developing Minimum-Cost Dedicated Portfolios* (New York: Salomon Brothers, 1983); and Martin L. Leibowitz, "The Dedicated Bond Portfolio in Pension Funds—Part II: Immunization, Horizon Matching, and Contingent Procedures," *Financial Analysts Journal* 42, no. 2 (March–April 1986): 47–57.

[37]Martin L. Leibowitz and Alfred Weinberger, "Contingent Immunization—Part I: Risk Control Procedures," *Financial Analysts Journal* 38, no. 6 (November–December 1982): 17–32; and Martin L. Leibowitz and Alfred Weinberger, "Contingent Immunization—Part II: Problem Areas," *Financial Analysts Journal* 39, no. 1 (January–February 1983): 35–50. This section draws heavily from these articles.

pounding exercise—that is, you compute the present value of the ending value at the expected yield for the horizon period. In this case, we assume a 5-year horizon and a 15 percent return, which means we compute the present value of \$206.3 million at 15 percent for 5 years or 7.5 percent for 10 periods assuming semiannual compounding. The present value factor of 0.48473 times the \$206.3 million ending value equals \$100 million—that is, this is the required initial investment under these assumptions to attain the desired ending value. Assuming the five year horizon, we can do it for other interest rates as follows:

PERCENT	PRESENT VALUE FACTOR[a]	REQUIRED INVESTMENT (\$ MIL.)	PERCENT	PRESENT VALUE FACTOR[a]	REQUIRED INVESTMENT (\$ MIL.)
10	0.6139	\$126.65	16	0.4632	\$95.56
12	0.5584	115.20	18	0.4224	87.14
14	0.5083	104.86	20	0.3855	79.53
15	0.48473	100.00			

[a]Present value for 10 periods (5 years) at one-half the annual percent.

Exhibit 20.11 reflects these calculations—that is, the dark line indicates the required initial amount that must be invested at every yield level to attain \$206.3 million in five years. Clearly, at lower yields you need a larger initial investment (e.g., \$126 million at 10 percent), and it declines with higher yields (e.g., it is less than \$80 million at 20 percent). The dotted line in Exhibit 20.11 indicates that the price sensitivity of a portfolio with a modified duration of five years will have almost exactly the price sensitivity required.

EXHIBI1T 20.11 *CLASSICAL IMMUNIZATION*

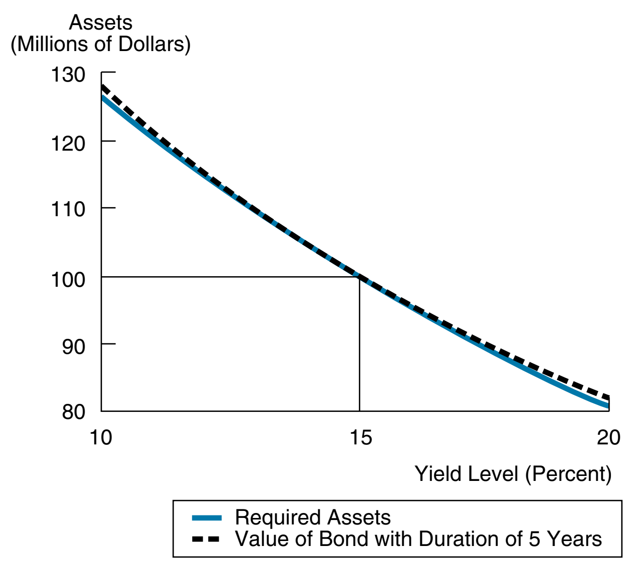
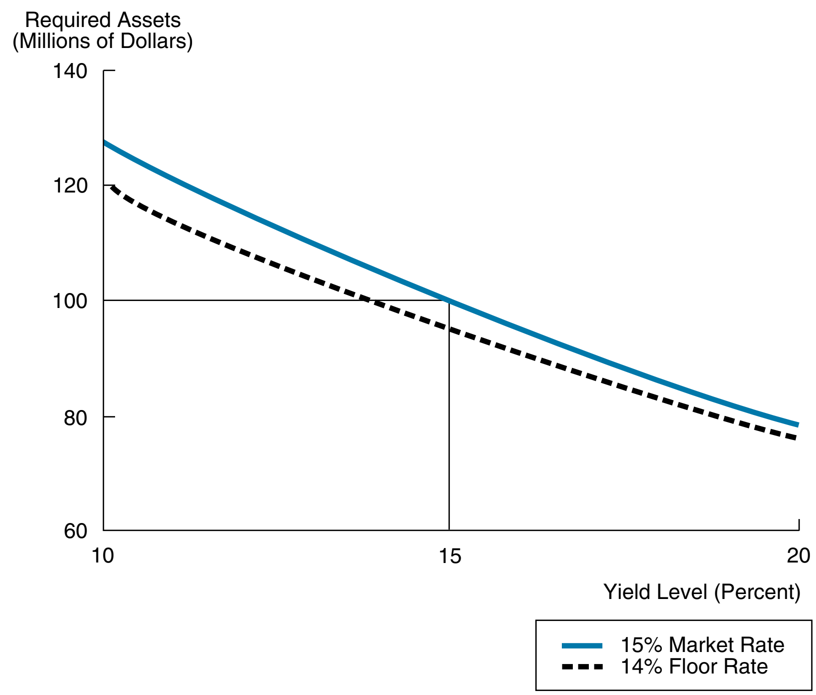


EXHIBIT 20.12 *PRICE BEHAVIOR REQUIRED FOR FLOOR RETURN*

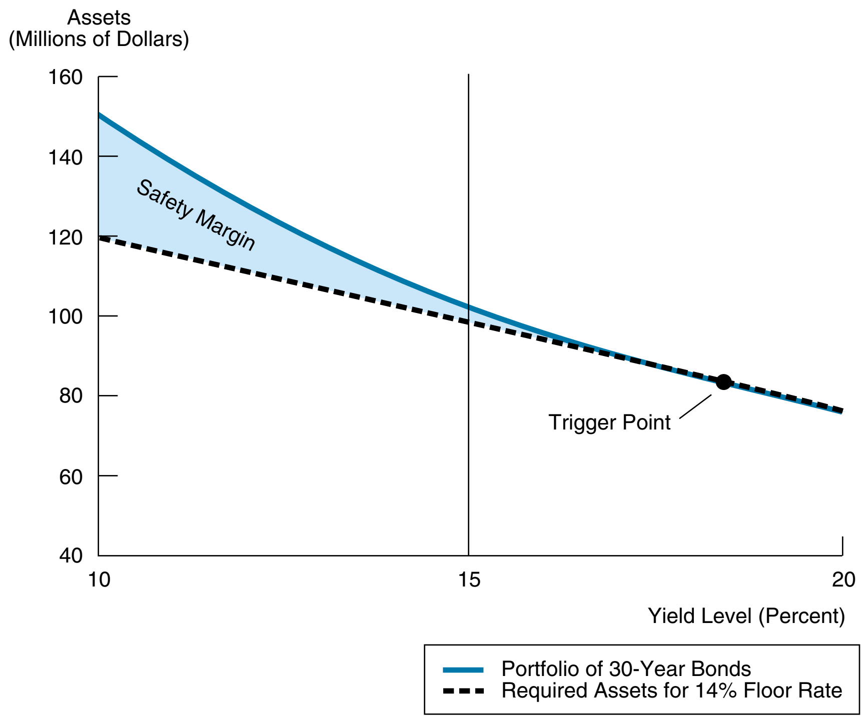


Contingent immunization requires that the client be willing to accept a potential return below the current market return, referred to as a *cushion spread*—the difference between the current market return and some floor rate. This cushion spread in required yield provides flexibility for the portfolio manager to engage in active portfolio strategies. For example, if current market rates are 15 percent, the client might be willing to accept a floor rate of 14 percent. If we assume the client initiated the fund with $100 million, the acceptance of this lower rate will mean that the portfolio manager does not have the same ending-asset requirements. Specifically, at 14 percent the required ending-wealth value would be $196.72 million (7 percent for 10 periods) compared to the $206.3 million at 15 percent. Because of this lower floor rate (and lower ending-wealth value), it is possible to experience some declines in the value of the portfolio while attempting to do better than the market through active management strategies.

Exhibit 20.12 shows the value of assets that are required at the beginning assuming a 14 percent required return and the implied ending-wealth value of $196.72 million. Notably, assuming current market rates of 15 percent, the required value of assets at the beginning would be $95.56 million, which is the present value of $196.72 million at 15 percent for 15 years. The difference between the client's initial fund of $100 million and the required assets of $95.56 million is the dollar cushion available to the portfolio manager. As noted, this dollar cushion arises because the client has agreed to a lower investment rate and, therefore, a lower ending-wealth value.

At this point, the portfolio manager can engage in various active portfolio management strategies to increase the ending-wealth value of the portfolio above that required at 14 percent. As an example, assume that the portfolio manager believes that market rates will decline. Under such

EXHIBIT 20.13 *SAFETY MARGIN FOR A PORTFOLIO OF 30-YEAR BONDS*

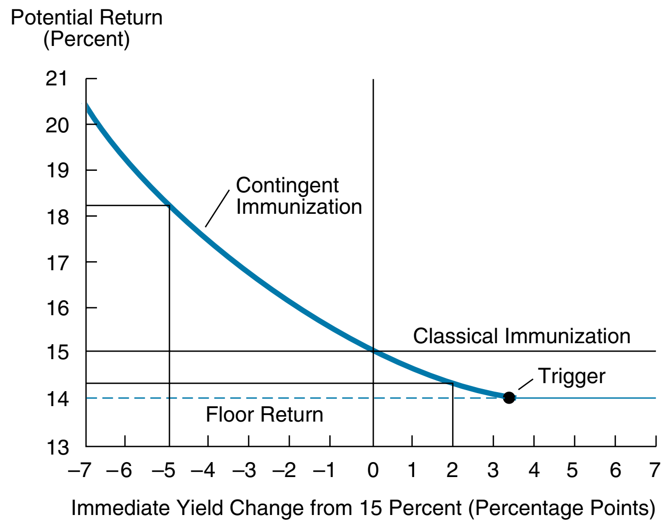


conditions, the portfolio manager might consider acquiring a 30-year bond that has a duration greater than the investment horizon of 5 years and, therefore, has greater price sensitivity to changes in market rates. Hence, if rates decline as expected, the value of the long-duration portfolio will rise above the initial value. In contrast, if rates increase, the value of the portfolio will decline rapidly. In this case, depending on how high rates go, the value of the portfolio could decline to a value below that needed to reach the desired ending-wealth value of $196.72 million.

Exhibit 20.13 shows what happens to the value of this portfolio if we assume an instantaneous change in interest rates when the fund is established. Specifically, if rates decline from 15 percent, the portfolio of long-duration, 30-year bonds would experience a large increase in value and develop a *safety margin*—a portfolio value above the required value. In contrast, if rates increase, the value of the portfolio will decline until it reaches the asset value required at 14 percent. When the value of the portfolio reaches this point of minimum return (referred to as a *trigger point*), it is necessary to stop active portfolio management and use classical immunization with the remaining assets to ensure that you attain the desired ending-wealth value (i.e., $196.72 million).

Potential Return The concept of *potential return* is helpful in understanding the objective of contingent immunization. This is the return the portfolio would achieve over the entire investment horizon if, at any point, the assets in hand were immunized at the prevailing market rate. Exhibit 20.14 contains the various potential rates of return based on dollar asset values shown in Exhibit 20.13. If the portfolio were immediately immunized when market rates were 15 percent,

EXHIBIT 20.14 *THE POTENTIAL RETURN CONCEPT*

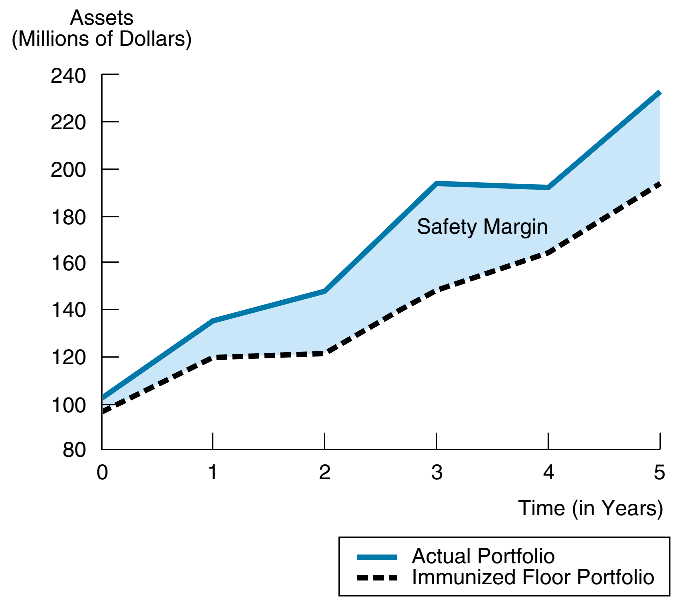


it would naturally earn the 15 percent market rate; that is, its potential return would be 15 percent. Alternatively, if yields declined instantaneously to 10 percent, the portfolio's asset value would increase to $147 million (see Exhibit 20.13). If this $147 million portfolio were immunized at the market rate of 10 percent over the remaining five-year period, the portfolio would compound at 10 percent to a total value of $239.45 million ($147 million × 1.6289, which is the compound growth factor for 5 percent and 10 periods). This ending value of $239.45 million represents an 18.25 percent realized (horizon) rate of return on the original $100 million portfolio. Consequently, as shown in Exhibit 20.14, if rates decline by 5 percent, the potential return for this portfolio at this point in time is 18.25 percent.

In contrast, if interest rates increase, the value of the portfolio will decline substantially and the potential return will decline. For example, if market rates rise to 17 percent (i.e., a yield change of 2 percent), the asset value of the 30-year bond portfolio will decline to $88 million (see Exhibit 20.13). If this portfolio of $88 million were immunized for the remaining five years at the prevailing market rate of 17 percent, the ending value would be $199 million. This ending value implies a potential return of 14.32 percent for the total period.

As Exhibit 20.13 shows, if interest rates rose to 18.50 percent, the 30-year bonds would decline to a value of $81.16 million (the trigger point) and the portfolio would have to be immunized. At this point, if the remaining assets of $81.16 million were immunized at this current market rate of 18.50 percent, the value of the portfolio would grow to $196.73 million ($81.16 × 2.424, which is the compound value factor for 9.25 percent for 10 periods). This ending value implies that the potential return for the portfolio would be exactly 14 percent as shown in Exhibit 20.14. Regardless of what happens to subsequent market rates, the portfolio has been immunized at the floor rate of 14 percent. That is a major characteristic of the contingent immunized portfolio; if there is proper monitoring, you will always know your trigger point where you must immunize and can be assured of receiving a return no less than the minimum rate of return specified.

EXHIBIT 20.15 *CONTINGENT IMMUNIZATION FLOOR PORTFOLIO OVER TIME*

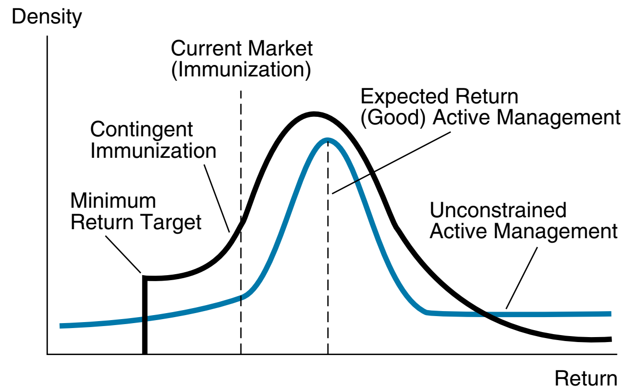


Monitoring the Immunized Portfolio Clearly, a crucial factor in managing a contingent immunized portfolio is monitoring it to ensure that if the asset value falls to the trigger point, it will be detected and the appropriate action taken to ensure that the portfolio is immunized at the floor-level rate. This can be done using a chart as in Exhibit 20.15. The top line is the current market value of the portfolio over time. The bottom line is the required value of the immunized floor portfolio. Specifically, the bottom line is *the required value of the portfolio* if we were to immunize at *today's rates* to attain the necessary ending-wealth value. This required minimum value for the portfolio is calculated by *computing the present value of the promised ending-wealth value at the prevailing market rate.*

To demonstrate how this floor portfolio would be constructed, consider our example where we derived a promised ending-wealth value in five years of \$196.72 million based on an initial investment of \$100 million and an acceptable floor rate of 14 percent. If one year after the initiation of the portfolio, market rates were 10 percent, you would need a minimum portfolio value of approximately \$133.14 million to get to \$196.72 million in four years. To compute this minimum required value, you multiply the \$196.72 million (promised ending-wealth value) times the present value factor for 5 percent for eight periods, assuming semiannual compounding (.6768). The logic is that \$133.14 million (\$196.72 × .6768) invested (immunized) at 10 percent for four years will equal \$196.72 million.

If the active manager had predicted correctly that market rates would decline and had a long-duration portfolio under these conditions, the *actual* value of the portfolio would be much higher than this *minimum required* value, and there would be a safety margin. A year later (after Year 2), you would determine the assets needed at the rate prevailing at that point in time. Assuming interest rates had increased to 12 percent, you could determine that you would need a floor portfolio of about \$138.69 million. Specifically, this is the present value of the \$196.72 million for

EXHIBIT 20.16 *COMPARISON OF RETURN DISTRIBUTIONS*



three years at 12 percent, assuming semiannual compounding (0.7050). Again, you would expect the actual value of the portfolio to be greater than this required floor portfolio, so you still have a safety margin. If you ever reached the point where the actual value of the portfolio was equal to the required floor value, you would stop the active management and immunize what was left *at the current market rate* to ensure that the ending value of the portfolio would be $196.72 million.

In summary, the contingent immunization strategy encompasses the opportunity for a bond portfolio manager to engage in various active portfolio strategies if the client is willing to accept a floor return (and ending-wealth value) that is below what is currently available. The graph in Exhibit 20.16 describes the trade-offs involved in contingent immunization. Specifically, by allowing for a slightly lower minimum target rate, the client is making it possible to experience a much higher potential return from active management by the portfolio manager.

Implications of Capital Market Theory and the EMH on Bond Portfolio Management

The high level of interest rates that has prevailed since the latter part of the 1960s has provided increasingly attractive returns to bond investors, and the wide swings in interest rates that have accompanied these high market yields have provided numerous capital gains opportunities for bond portfolio managers. As a result, the average compound rates of return on bonds during the 1980s were the highest of any 10-year period in this century, and this performance continued into the 1990s. Specifically, the results contained in Exhibit 20.17 indicate that the annual returns on the aggregate of high-grade bonds during the period 1980–2001 ranged from –2.92 percent (the only negative annual return) to 32.64 percent, and the geometric mean returns of 10.04 percent were clearly impressive even compared to the average returns on common stocks of 14.69 percent. When these are compared to the long-term results since 1926 (see Exhibit 20.19), it appears that it will be difficult to continue such performance. Still, these results indicate that there are some wonderful opportunities available in bonds. An important consideration for portfolio managers, therefore, is the proper role of fixed-income securities when considering the implications of portfolio theory, capital market theory, and research related to efficient capital markets.

EXHIBIT 20.17 *ANNUAL RATES OF RETURN, RISK MEASURES, AND RANGES OF RETURN FOR LEHMAN BROTHERS BOND INDEXES AND THE S&P 500 TOTAL RETURN STOCK INDEX: 1980–2001*

	Arithmetic Mean	Geometric Mean	Standard Deviation	Coefficient of Variation[a]	High Year	Low Year
Lehman Brothers Gov./Corp.	10.21	9.95	7.84	0.77	31.10	–3.51
Lehman Brothers Government	10.03	9.81	7.23	0.72	27.74	–3.37
Lehman Brothers Corporate	10.86	10.47	9.69	0.89	39.23	–3.93
Lehman Brothers Mortgage	10.69	10.32	7.87	0.90	43.04	–1.61
Lehman Brothers Non-Corp. Inv. Gr.[b]	8.98	8.72	9.72	0.88	23.44	–4.94
Lehman Brothers Aggregate	10.30	10.04	7.89	0.77	32.64	–2.92
S&P 500	15.69	14.69	15.21	0.97	37.43	–13.04

[a]Coefficient of Variation = Standard Deviation/Arithmetic Mean Return.

[b]Data only available from 1990.

Source: *Global Family of Indices*—Historical Database 1973–2001, Lehman Brothers, Fixed Income Research. Reprinted with permission.

Bonds and Total Portfolio Theory

The performance of bonds has improved even more than indicated by returns alone because bonds offer substantial diversification benefits. In an efficient market, neither stocks nor bonds should dominate a portfolio, but some combination of them should provide a superior risk-adjusted return compared to either one taken alone (assuming low correlation between stocks and bonds). In the study by Reilly, Kao, and Wright, which showed that stock returns were superior to bond yields, they also showed that, due to the low correlation between bonds and equities (about 0.30), the combination of the stocks and bonds in a portfolio vastly improved the return per unit of risk.[38]

Bonds and Capital Market Theory

Capital market theory contends that there should be an upward-sloping market line, meaning that greater return should be accompanied by greater risk. Compared to other market vehicles, fixed-income securities were traditionally viewed as low risk and their rates of return were typically modest until the late 1970s. At that time, the inflation rate and bond yields increased. Also, during periods of high economic uncertainty, such as the recessions of 1981–1982 and 1990–1991, the risk premiums on bonds increased substantially because the risk of default for low-rated obligations increased.[39] As demonstrated earlier in the chapter (Exhibit 20.1), the risk premium on high-yield bonds has fluctuated dramatically over time.

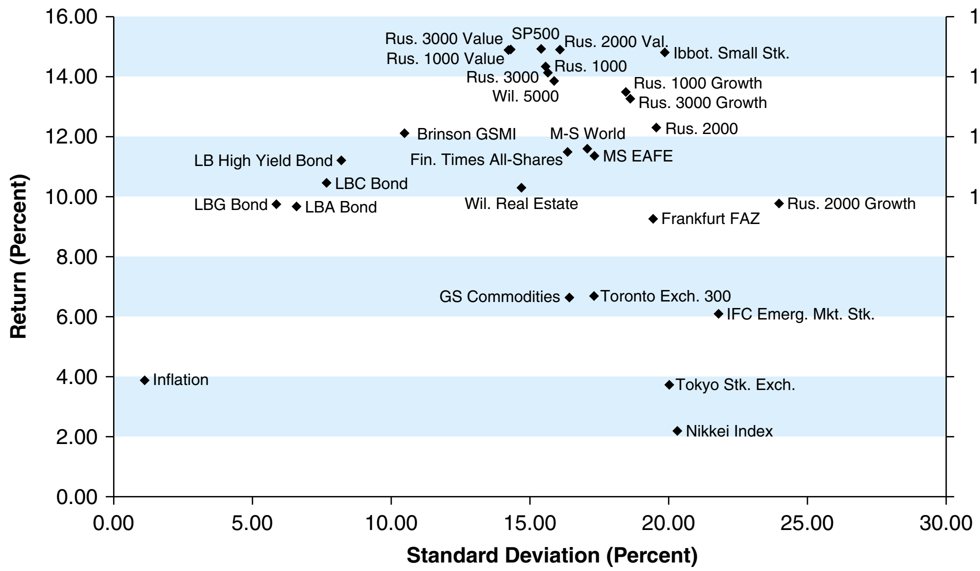
Capital market theory also relates the risk-return behavior of fixed-income securities to other financial assets. Because fixed-income securities are considered to be relatively conservative investments, we would expect them to be on the lower end of the capital market line. A study by Reilly and Wright examined the comparative risk-return characteristics of 36 classes of long-term securities.[40] Exhibit 20.18 shows the basic findings of the study and confirms the a priori expectations. Specifically, government and high-grade corporate bonds were at the low end of the risk

[38]Frank K. Reilly, Wenchi Kao, and David J. Wright, "Alternative Bond Market Indexes," *Financial Analysts Journal* 48, no. 3 (May–June 1992): 44–58. These correlations were confirmed for the period 1980–2001 in Frank K. Reilly and David J. Wright, "An Analysis of Global Capital Market Risk-Adjusted Returns," mimeo (July 2002).

[39]For a detailed discussion on this topic that considers several studies on the subject, see James C. Van Horne, *Financial Market Rates and Flows,* 5th ed. (Englewood Cliffs, N.J.: Prentice-Hall, 1998), Chapter 6.

[40]Frank K. Reilly and David J. Wright, "An Analysis of Global Capital Market Risk-Adjusted Returns," University of Notre Dame Working Paper (July 2002).

EXHIBIT 20.18 *TOTAL RISK-RETURN COMPARISON FOR ALTERNATIVE CAPITAL MARKET ASSETS: 1980–2001*



Source: Frank K. Reilly and David J. Wright, "An Analysis of Global Capital Market Risk-Adjusted Returns," University of Notre Dame Working Paper (July 2002).

spectrum, and it progressed to high-quality common stocks, small-cap stocks, foreign stocks, and, finally, emerging-market stocks. An annual analysis of capital market returns by Ibbotson Associates comparing corporate and government bonds (long- and intermediate-term) to common stocks (total NYSE and small-firm) and Treasury bill obligations indicated similar results. As Exhibit 20.19 shows, Treasury bills have the least risk and return, followed by government bonds, corporate bonds, large company common stocks, and, finally, small company common stocks.

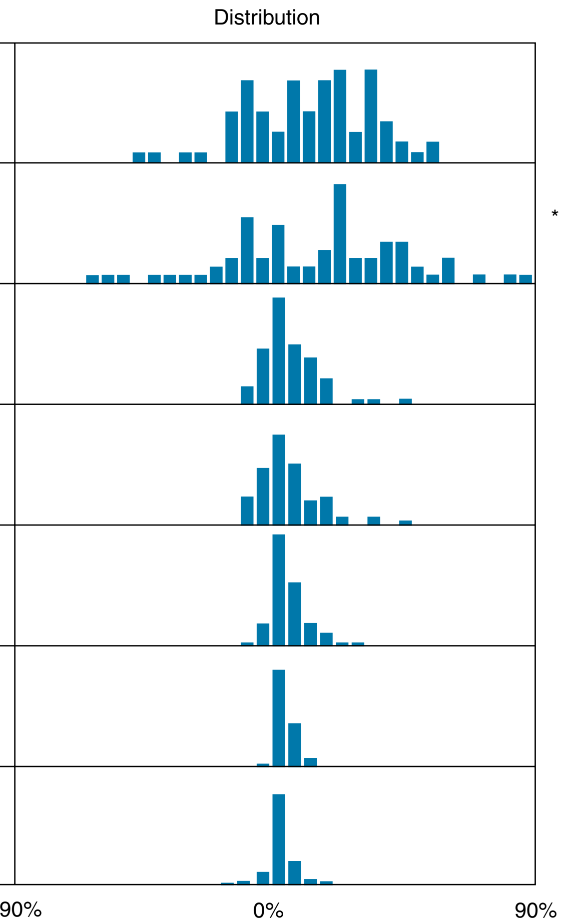
Bond Price Behavior in a CAPM Framework

The capital asset pricing model (CAPM) is expected to provide a framework for explaining realized security returns as a function of nondiversifiable market risk. Bond returns should be linked directly to risk of default and interest rate risk. Although interest rate risk for investment-quality bonds should be nondiversifiable, some evidence exists that default risk also is largely nondiversifiable because default experience is closely related to the business cycle.[41] Therefore,

[41]W. Braddock Hickman, *Corporate Bond Quality and Investor Experience* (New York: National Bureau of Economic Research, 1958); Thomas R. Atkinson, *Trends in Corporate Bond Quality* (New York: National Bureau of Economic Research, 1967); Dwight M. Jaffee, "Cyclical Variations in the Risk Structure of Interest Rates," *Journal of Monetary Economics* 1, no. 2 (July 1975): 309–325; Douglas J. Lucas and John G. Lonski, "Changes in Corporate Credit Quality 1970–1990," *Journal of Fixed Income* 1, no. 4 (March 1992): 7–14; Jean Helwege and Paul Kleiman, "Understanding Aggregate Default Rates of High-Yield Bonds," *Journal of Fixed Income* 7, no. 1 (June 1997): 55–61; Martin S. Fridson, M. Christopher Garman, and Sheng Wu, "Real Interest Rates and the Default Rate on High-Yield Bonds," *Journal of Fixed Income* 7, no. 2 (September 1997): 29–34; and Chunsheng Zhon, "Credit Rating and Corporate Defaults," *Journal of Fixed Income* 11, no. 3 (December 2001): 30–40.

EXHIBIT 20.19 *MEAN RATE OF RETURN AND STANDARD DEVIATION OF RETURNS FOR COMMON STOCKS, GOVERNMENT AND CORPORATE BONDS, T-BILLS, AND INFLATION: 1926–2001*

Series	Geometric Mean	Arithmetic Mean	Standard Deviation
Large-company stocks	11.7%	12.7%	20.2%
Small-company stocks	12.5	17.3	33.2
Long-term corporate bonds	5.8	6.1	8.6
Long-term government bonds	5.3	5.7	9.4
Intermediate-term government bonds	5.3	5.5	5.7
U.S. Treasury bills	3.8	3.9	3.2
Inflation	3.1	3.1	4.4



*The 1933 small-company stocks total return was 142.9 percent.

Source: *Stocks, Bonds, Bills, and Inflation® 2002 Yearbook,* © 2002 Ibbotson Associates, Inc. Based on copyrighted works by Ibbotson and Sinquefield.

because the major bond risks are largely nondiversifiable, this implies that we should be able to define bond returns in the context of the CAPM. Still, few studies have attempted it because of data-collection problems.

Reilly and Joehnk found that average bond betas had no significant or consistent relationships with agency ratings.[42] Because the study involved only investment-grade securities, the major factor affecting bond prices was market interest rate movements. Evidence that high-grade bond risk is almost all systematic risk is found in the Reilly-Wright study, which shows that the returns among these investment-grade bonds, regardless of sector (government, corporate, mortgages)

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[42]Frank K. Reilly and Michael D. Joehnk, "The Association between Market-Determined Risk Measures for Bonds and Bond Ratings," *Journal of Finance* 31, no. 5 (December 1976): 1387–1403.

or ratings, were correlated 0.90 to 0.99.[43] This systematic interest rate risk has an overpowering effect on price performance and largely negates the effects of differential default risk, which is reflected in comparative agency ratings. Notably, the overpowering effect of systematic interest rate risk does *not* prevail when one considers high-yield (junk) bonds. As shown by Reilly and Wright, the correlation between high-yield bonds and investment-grade bonds is *lower* than the strong correlation between high-yield bonds and common stock, which is because both high-yield bonds and common stocks have substantial unsystematic risk.[44]

Alexander examined some of the assumptions of the market model as related to bonds and found two major problems.[45] First, the bond beta results were sensitive to the market index used.[46] Second, the results were sensitive to the time period used; the bond betas increased during periods of high bond yields.

Weinstein computed betas for bonds using several market series and related the betas to term to maturity, coupon, and bond ratings.[47] The results were likewise affected by the market indexes used. No significant relationship existed between the betas and bond ratings for the top four classes of ratings (similar to the findings of Reilly and Joehnk), but there was a weak relationship using the top six ratings. The author postulated that the risk of default becomes significant only for low ratings, which is consistent with default rates in Exhibit 20.2.

In a subsequent study, Weinstein computed bond betas and examined their stability over time.[48] He found that a bond's beta was related to firm characteristics (e.g., debt-equity ratios, and the variance of rate of return on assets) and to bond characteristics (coupon, term to maturity).

Thus, evidence on the usefulness of the CAPM as related to the bond market is mixed. Specifically, there are obvious problems regarding the appropriate market index to use, the systematic risk measure is unstable, and the risk-return relationship did not hold for the higher-quality bonds. Finally, there appears to be a relationship between the systematic risk measure and some characteristics of the firm.

Bond Market Efficiency

Two versions of the efficient market hypothesis (EMH) are examined in the context of fixed-income securities: the weak and the semistrong theories. The weak-form hypothesis contends that security price movements are independent events so historical price information is useless in predicting future price behavior. Studies of weak-form efficiency have examined the ability of investors to forecast interest rates, because if you can forecast interest rates you can forecast bond price behavior. Also, interest rate expectations are important for bond portfolio management.

Several studies[49] reached the same conclusion: interest rate behavior cannot be consistently and accurately forecast! In all cases, the most naive model, or no forecast at all, provided the best

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[43]Frank K. Reilly and David J. Wright, "Bond Market Indexes" in *The Handbook of Fixed-Income Securities,* 6th ed.

[44]Frank K. Reilly and David J. Wright, "An Analysis of High-Yield Bond Indices" in *High-Yield Bonds,* ed. Theodore M. Barnhill, Jr., William F. Maxwell, and Mark R. Shenkman (New York: McGraw-Hill, 1999).

[45]Gordon J. Alexander, "Applying the Market Model to Long-Term Corporate Bonds," *Journal of Financial and Quantitative Analysis* 15, no. 5 (December 1980): 1063–1080.

[46]This is similar to the well-known work by Roll on market series.

[47]Mark I. Weinstein, "The Systematic Risk of Corporate Bonds," *Journal of Financial and Quantitative Analysis* 16, no. 3 (September 1981): 156–278.

[48]Mark I. Weinstein, "Bond Systematic Risk and the Option Pricing Model," *Journal of Finance* 38, no. 5 (December 1983): 1415–1429.

[49]See, for example, William A. Bomberger and W. J. Frazer, "Interest Rates, Uncertainty, and the Livingston Data," *Journal of Finance* 36, no. 3 (June 1981): 661–675; Stephen K. McNees, "The Recent Record of Thirteen Forecasters," *New England Economic Review,* Federal Reserve Bank of Boston (September–October 1981): 3–10; and Adrian W. Throop, "Interest Rate Forecasts and Market Efficiency," Federal Reserve Bank of San Francisco *Economic Review* (Spring 1981): 29–43.

measure of future interest rate behavior. Clearly, if it is not possible to forecast interest rates, then bond prices cannot be forecast using historical prices, all of which support the weak-form EMH.

The semistrong EMH asserts that current prices fully reflect all public knowledge and that efforts to act on public information are largely unproductive. Several studies have examined the informational value of bond rating changes. Katz examined monthly changes in bond yields surrounding ratings changes and found a significant impact of the change.[50] Weinstein examined monthly bond returns surrounding the announcement of rating changes and found an effect during the interval from 18 months to 7 months before the announcement but no effect during the period from 6 months before the announcement to 6 months after the announcement.[51]

In contrast, several studies have examined the impact of bond rating changes on stock prices and returns.[52] The results indicated either very little impact on stocks or a differential impact, depending on whether it was an upgrade or a downgrade.

The Internet *Investments Online*

Fixed-income management analytics and software are typically proprietary. The sites listed below offer some additional information about the techniques discussed in the text and will give you insight into the use of various analytical and portfolio management techniques.

http://www.ryanlabs.com Ryan Labs is a leader in the construction and analysis of fixed-income indexes. Their site offers information on its research, data, indexing, consulting, and asset/liability management skills (this latter feature is of particular importance to portfolios that must meet a stream of cash outflows, such as a pension fund). The site discusses the quantitative nature of bond-portfolio management, fixed-income index construction, and the variety of risk and reward measures used for bond investment analysis.

http://cmsbondedge.com The home page of CMS BondEdge allows users to move to sites featuring CMS's various products. CMS sells fixed-income analytical software to institutional investment managers. Research papers on fixed income security analysis are offered free of charge to users who fill out an on-line form. BondEdge is a product offering "what-if" simulations, volatility appraisals, and other analytics to fixed-income portfolio managers.

Brokerage houses offer fixed-income portfolio information and strategies with an orientation to the individual investor. See, for example, **http://www.salomonsmithbarney.com/research/fixed_income.html**.

Summary

- During the past decade, there has been a significant increase in the number and range of bond portfolio management strategies available. Bond portfolio management strategies include the relatively straightforward buy-and-hold and bond indexing strategies, several alternative active portfolio strategies, dedicated cash matching, classical immunization, horizon matching, and contingent immunization.

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[50]Steven Katz, "The Price Adjustment Process of Bonds to Rating Reclassifications: A Test of Bond Market Efficiency," *Journal of Finance* 29, no. 2 (May 1974): 551–559.

[51]Mark I. Weinstein, "The Effect of a Rating Change Announcement on Bond Price," *Journal of Financial Economics* 5, no. 3 (December 1977): 329–350.

[52]George E. Pinches and Clay Singleton, "The Adjustment of Stock Prices to Bond Rating Changes," *Journal of Finance* 33, no. 1 (March 1978): 29–44; Paul A. Griffin and Antonio Z. Sanvicente, "Common Stock Returns and Rating Changes: A Methodological Comparison," *Journal of Finance* 37, no. 1 (March 1982): 103–119; and Robert W. Holthausen and Richard W. Leftwich, "The Effect of Bond Rating Changes on Common Stock Prices," *Journal of Financial Economics* 17, no. 1 (September 1986): 57–89.

Although you should understand the alternatives available and how to implement them, you also should recognize that the choice of a specific strategy is based on the needs and desires of the client. In turn, the success of any strategy will depend on the background and talents of the portfolio manager.

- The risk-return performance of bonds as a unique asset class has been consistent with expectations. In addition, their inclusion has generally enhanced overall portfolio performance because of their low covariance with other financial assets. The application of CAPM concepts to bonds has been mixed because it has been difficult to derive acceptable measures of systematic risk, and the risk measures derived have been unstable.
- Studies in the bond market have supported the theory of weak-form efficiency. The evidence for semi-strong efficiency has been mixed. The results that indicate a lack of efficiency could be due to the relatively inactive secondary markets for most corporate bonds, which causes pricing and adjustment problems compared to the active markets for equities.

Questions

1. What is meant by an indexing portfolio strategy and why is it used?
2. Briefly define the following bond swaps: pure yield pickup swap, substitution swap, and tax swap.
3. Briefly describe three active bond portfolio management strategies.
4. Discuss two variables you would examine very carefully if you were analyzing a high-yield bond, and indicate why they are important.
5. How would you explain to a casual observer why high-yield bond returns are more correlated to common stock returns than to investment-grade bond returns?
6. What are the advantages and difficulties of a cash-matched dedicated portfolio?
7. Describe the two components of interest rate risk.
8. What is meant by bond portfolio immunization?
9. If the yield curve were flat and did not change, how would you immunize your portfolio?
10. You begin with an investment horizon of four years and a portfolio with a duration of four years with a market interest rate of 10 percent. A year later, what is your investment horizon? Assuming no change in interest rates, what is the duration of your portfolio relative to your investment horizon? What does this imply about your ability to immunize your portfolio?
11. It has been contended that a zero coupon bond is the ideal financial instrument to use for immunizing a portfolio. Discuss the reasoning for this statement.
12. During a conference with a client, the subject of classical immunization is introduced. The client questions the fee charged for developing and managing an immunized portfolio. The client believes it is basically a passive investment strategy, so the management fee should be substantially lower. What would you tell the client to show that it is not a passive policy?
13. With contingent immunization, what do you give up and what do you gain?
14. *CFA Examination Level III*

    The ability to *immunize* a bond portfolio is very desirable for bond portfolio managers in some instances.

    a. Discuss the components of interest rate risk. Assuming a change in interest rates over time, explain the two risks faced by the holder of a bond.
    b. Define immunization and discuss why a bond manager would immunize a portfolio.
    c. Explain why a duration-matching strategy is a superior technique to a maturity-matching strategy for the minimization of interest rate risk.
    d. Explain in specific terms how you would use a zero coupon bond to immunize a bond portfolio. Discuss why a zero coupon bond is an ideal instrument in this regard.
    e. Explain how *contingent immunization,* another bond portfolio management technique, differs from *classical immunization.* Discuss why a bond portfolio manager would engage in contingent immunization. [35 minutes]
15. *CFA Examination Level III*

    During the past several years, there has been substantial growth in the dollar amount of portfolios managed using *immunization* and *dedication* techniques. Assume a client wants to know the basic differences between (1) classical immunization, (2) contingent immunization, (3) cash-matched dedication, and (4) duration-matched dedication.

a. Briefly describe each of these four techniques.
b. Briefly discuss the ongoing investment action you would have to carry out if managing an *immunized portfolio.*
c. Briefly discuss three of the major considerations involved with creating a *cash-matched dedicated* portfolio.
d. Describe two parameters that should be specified when using *contingent immunization.*
e. Select one of the four alternative techniques that you believe requires the least degree of active management and justify your selection. [20 minutes]

16. *CFA Examination Level III*
After you have constructed a structured fixed-income portfolio (i.e., one that is dedicated, indexed, or immunized), it may be possible over time to improve on the initial optimal portfolio while continuing to meet the primary goal. Discuss three conditions that would be considered favorable for a restructuring—assuming no change in objectives for the investor—and cite an example of each condition. [10 minutes]

17. *CFA Examination Level III*
The use of bond index funds has grown dramatically in recent years.
a. Discuss the reasons you would expect it to be easier or more difficult to construct a bond market index than a stock market index.
b. It is contended that the *operational process* of managing a corporate bond index fund is more difficult than managing an equity index fund. Discuss three examples that support this contention. [15 minutes]

18. *CFA Examination Level III* (adapted)
Hans Kaufmann is a global fixed-income portfolio manager based in Switzerland. His clients are primarily U.S.-based pension funds. He allocates investments in the United States, Japan, Germany, and the United Kingdom. His approach is to make investment allocation decisions among these four countries based on his global economic outlook. To develop this economic outlook, Kaufmann analyzes the following five factors for each country: real economic growth, inflation, monetary policy, interest rates, and exchange rates.

When Kaufmann believes that the four economies are equally attractive for investment purposes, he equally weights investments in the four countries. When the economies are not equally attractive, he overweights the country or countries where he sees the largest potential returns.

Table 1 through Table 5 present relevant economic data and forecasts.
a. Indicate, before taking into account currency hedging, whether Kaufmann should overweight or underweight investments in each country. Justify your position. [15 minutes]
b. Briefly describe how your answer to Part a might change with the use of currency-hedging techniques. [5 minutes]

TABLE 1 *REAL GDP (ANNUAL CHANGES)*

	1996	1997	1998	1999E
United States	3.0%	2.9%	2.4%	2.7%
Japan	4.7	2.4	3.2	3.4
Germany	2.0	2.5	1.5	2.1
United Kingdom	3.4	3.0	3.4	2.3

TABLE 2 *GDP DEFLATOR (ANNUAL CHANGES)*

	1996	1997	1998	1999E
United States	3.2%	2.6%	3.3%	3.8%
Japan	1.5	2.8	3.0	3.0
Germany	2.2	3.1	2.5	2.2
United Kingdom	6.0	3.5	4.5	4.8

TABLE 3 *NARROW MONEY (MI) (ANNUAL CHANGES)*

	1996	1997	1998	1999E
United States	9.2%	13.4%	5.5%	7.0%
Japan	5.0	6.9	9.9	10.0
Germany	4.3	8.5	7.5	8.5
United Kingdom	7.0	8.0	6.7	5.5

TABLE 4 *LONG-TERM INTEREST RATES (ANNUAL RATES)*

	1996	1997	1998	1999E
United States	10.6%	7.7%	8.8%	9.0%
Japan	5.5	4.1	4.7	4.7
Germany	9.9	5.9	6.1	7.0
United Kingdom	10.6	9.9	9.8	9.5

TABLE 5 *EXCHANGE RATES (CURRENCY PER U.S. DOLLARS)*

	1996	1997	1998	1999E
United States (dollars)	1.00	1.00	1.00	1.00
Japan (yen)	130.10	121.50	111.40	108.35
Germany (marks)	1.95	1.80	1.60	1.52
United Kingdom (pounds)	0.67	0.60	0.58	0.59

Sources: International Monetary Fund.

19. *CFA Examination Level I*
Robert Devlin and Neil Parish are portfolio managers at the Broward Investment Group. At their regular Monday strategy meeting, the topic of adding international bonds to one of their portfolios came up. The portfolio, an ERISA-qualified pension account for a U.S. client, was currently 90 percent invested in U.S. Treasury bonds and 10 percent invested in 10-year Canadian government bonds.

Devlin suggested buying a position in 10-year German government bonds, while Parish argued for a position in 10-year Australian government bonds.

a. Briefly discuss the *three* major issues that Devlin and Parish should address in their analysis of the return prospects for German and Australian bonds relative to those of U.S. bonds. [6 minutes]
Having made no changes to the original portfolio, Devlin and Parish hold a subsequent strategy meeting and decide to add positions in the government bonds of Japan, the United Kingdom, France, Germany, and Australia.
b. Identify and discuss *two* reasons for adding a broader mix of international bonds to the pension portfolio. [9 minutes]

20. *CFA Examination Level III*
The investment committee of the money management firm of Gentry, Inc., has typically been very conservative and has avoided investing in high-yield (junk) bonds, although they have had major positions in investment-grade corporate bonds. Recently, Pete Squire, a member of the committee, suggested that they should review their policy regarding junk bonds because they currently constitute over 25 percent of the total corporate bond market.

As part of this policy review, you are asked to respond to the following questions:

a. Briefly discuss the liquidity *and* pricing characteristics of junk bonds relative to *each* of the following types of fixed-income securities:
   - Treasuries
   - High-grade corporate bonds
   - Corporate loans
   - Private placements

Briefly discuss the implications of these differences for Gentry's bond portfolio managers. The committee has learned that the correlation of rates of return between Treasuries and high-grade corporate bonds is approximately 0.98, while the correlation between Treasury/high-grade corporate bonds and junk bonds is approximately 0.45.

b. Briefly explain the reason for this difference in correlations, and briefly discuss its implications for bond portfolios.

The committee has also heard that durations at the times of issue for junk bonds are typically much shorter than for newly issued high-grade corporate bonds.

c. Briefly explain the reason for this difference in duration, and briefly discuss its implication for the volatility of high-yield bond portfolios. [15 minutes]

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21. *CFA Examination Level II*

Greg Kemp, CFA, Chief Investment Officer of Anchor Advisors, has received the following recommendation from his bond management group.

> "We believe the current environment has focused excessive pessimism on high-grade corporate bonds. Fears of 'event risk' and weakness in the junk bond market have widened yield spreads to attractive levels.
>
> "It is recommended that our employee benefit bond accounts reduce their current U.S. Treasury weightings from 75 percent to 25 percent, with this money to be invested in callable Single-A and AA utility bonds with coupon rates between 9 percent and 11 percent. The durations of the bonds purchased will be equal to those sold."

Kemp accepts the idea that yield spreads are wider than normal between U.S. Treasury bonds and corporate issues. Interest rates on long-term U.S. Treasury issues are currently 9 percent. He expects a significant (more than 100 basis points) drop in interest rates.

a. Kemp has some concerns about the volatility implications of the proposed trade in light of his understanding of the concepts of duration, convexity, and option-adjusted spreads. Given his interest rate expectations, identify and explain *two* key questions that Kemp should raise about the proposed trade. [10 minutes]

b. Recommend *two* modifications to the proposed trade that would address Kemp's concerns mentioned in Part a. [5 minutes]

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22. *CFA Examination Level II*

Bond analysis often requires more than traditional credit ratio analysis. Discuss *each* of the following *three* considerations as they relate to evaluating a specific fixed-income security:

(a) Competition within the industry
(b) Liquidation value of net assets
(c) Management [6 minutes]

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23. *CFA Examinaton Level III*

A consultant suggests that the weighted-average portfolio duration calculation for a global bond portfolio is the same as for a domestic bond portfolio.

a. State whether the use of portfolio duration in international bond portfolio management is more limiting than in domestic bond portfolio management. Support your conclusion with *two* reasons. [8 minutes]

The consultant recognizes that currency, duration, and investing outside the benchmark are possible sources of excess return in global bond management. He is also curious about additional methods of adding value through global bond management.

b. List and discuss *two* additional potential sources of excess return. [6 minutes]

Problems

1. You have a portfolio with a market value of $50 million and a Macaulay duration of seven years (assuming a market interest rate of 10 percent). If interest rates increase to 12 percent, what would be the estimated value of your portfolio using modified duration? Show all your computations.
2. Answer the following questions assuming that at the initiation of an investment account, the market value of your portfolio is $200 million, and you immunize the portfolio at 12 percent for six years. During the first year, interest rates are constant at 12 percent.
   a. What is the market value of the portfolio at the end of Year 1?
   b. Immediately after the end of the year, interest rates *decline* to 10 percent. Estimate the new value of the portfolio, assuming you did the required rebalancing (use only modified duration).
3. Compute the Macaulay duration under the following conditions:
   a. A bond with a five-year term to maturity, a 12 percent coupon (annual payments), and a market yield of 10 percent.
   b. A bond with a four-year term to maturity, a 12 percent coupon (annual payments), and a market yield of 10 percent.
   c. Compare your answers to Parts a and b, and discuss the implications of this for classical immunization.
4. Compute the Macaulay duration under the following conditions:
   a. A bond with a four-year term to maturity, a 10 percent coupon (annual payments), and a market yield of 8 percent
   b. A bond with a four-year term to maturity, a 10 percent coupon (annual payments), and a market yield of 12 percent
   c. Compare your answers to Parts a and b. Assuming it was an immediate shift in yields, discuss the implications of this for classical immunization.
5. A major requirement in running a contingent immunization portfolio policy is monitoring the relationship between the current market value of the portfolio and the required value of the floor portfolio. In this regard, assume a $300 million portfolio with a horizon of five years. The available market rate at the initiation of the portfolio is 14 percent, but the client is willing to accept 12 percent as a floor rate to allow you to use active management strategies. The current market values and current market rates at the end of Years 1, 2, and 3 are as follows:

End of Year	Market Value ($ Mil)	Market Yield	Required Floor Portfolio	Safety Margin (Deficiency)
1	340.00	0.12		
2	375.00	0.10		
3	360.20	0.14		

   a. What is the required ending-wealth value for this portfolio?
   b. What is the value of the required floor portfolio at the end of Years 1, 2, and 3?
   c. Compute the safety margin or deficiency at the end of Years 1, 2, and 3.
6. Evaluate the following pure yield pickup swap: You currently hold a 20-year, Aa-rated, 9.0 percent coupon bond priced to yield 11.0 percent. As a swap candidate, you are considering a 20-year, Aa-rated, 11 percent coupon bond priced to yield 11.5 percent. (Assume reinvestment at 11.5 percent.)

	Current Bond	Candidate Bond
Dollar investment	____________	______________
Coupon	____________	______________
i on one coupon	____________	______________
Principal value at year end	____________	______________
Total accrued	____________	______________
Realized compound yield	____________	______________
Value of swap: _________________ basis points in one year		

7. Evaluate the following substitution swap: You currently hold a 25-year, 9.0 percent coupon bond priced to yield 10.5 percent. As a swap candidate, you are considering a 25-year, Aa-rated, 9.0 percent coupon bond priced to yield 10.75 percent. (Assume a one-year work-out period and reinvestment at 10.5 percent.)

	Current Bond	Candidate Bond
Dollar investment	__________	__________
Coupon	__________	__________
i on one coupon	__________	__________
Principal value at year end	__________	__________
Total accrued	__________	__________
Realized compound yield	__________	__________
Value of swap: ______________	basis points in one year	

CFA®
8. *CFA Examination Level III*
Reinvestment risk is a major factor for bond managers to consider when determining the most appropriate or optimal strategy for a fixed-income portfolio. Briefly describe each of the following bond portfolio management strategies, and explain how each deals with reinvestment risk:
a. Active management
b. Classical immunization
c. Dedicated portfolio
d. Contingent immunization [20 minutes]

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9. *CFA Examination Level III*
A major requirement in managing a fixed-income portfolio using a contingent immunization policy is monitoring the relationship between the current market value of the portfolio and the required value of the floor portfolio. This difference is defined as the *margin of error.* In this regard, assume a \$300 million portfolio with a time horizon of five years. The available market rate at the initiation of the portfolio is 12 percent, but the client is willing to accept 10 percent as a floor rate to allow use of active management strategies. The current market values and current market rates at the end of Years 1, 2, and 3 are as follows:

End of Year	Market Value (\$ Mil)	Market Yield	Required Floor Portfolio (\$ Mil)	Margin of Error (\$ Mil)
1	\$340.9	10%		
2	405.5	8		
3	395.2	12		

Table 1
Present Value Table (use tables in appendix in the back of book)
Table 2
Compound Value Table (use tables in appendix in the back of book)

Assuming semiannual compounding:
a. Calculate the required ending-wealth value for this portfolio.
b. Calculate the value of the required floor portfolios at the end of Years 1, 2, and 3.
c. Compute the margin of error at the end of Years 1, 2, and 3.
d. Indicate the action that a portfolio manager utilizing a *contingent immunization* policy would take if the margin of error at the end of any year had been zero or negative.

CFA®
10. *CFA Examination Level III*
PTC's Investment Committee has decided to allocate 50 percent of the pension plan portfolio's fixed-income investment to non-U.S. government bonds (i.e., bonds representing non-U.S. sovereign credits). For a number of reasons, BAG—the Committee's consultant—has recommended against using a

pure dedication approach to management of the bonds. Instead, it has presented the committee with three alternative strategies for consideration, accompanied by the 15-year historical performance data for each strategy shown in Table 6.

a. Based on the management strategy characteristics set forth in Table 6, as well as your general knowledge, identify and explain *three* advantages of *each* strategy as an alternative for the Investment Committee to consider. In developing your response, regard yourself as a strong advocate as you explain the advantages of *each* of the three alternatives. [15 minutes]
b. Identify and explain *one* key *disadvantage* of *each* of the three strategies. [5 minutes]

TABLE 6

15-Year Historical Universe Performance

	Average Returns Annualized	Average Top Decile Returns[a] Annualized	Average Bottom Decile Returns[b] Annualized	Standard Deviation of Returns
Strategy Characteristics				
Active management	12.9%	15.6%	6.8%	18.6%
Duration shifts + or – 40% of Salomon WGB Index[c]				
Deviations from country allocation benchmarks in Index are unrestricted				
Transactions permitted for any management purpose				
Fee: 35 basis points/year				
Passive management	11.8%	12.8%	10.7%	16.0%
Duration shifts + or – 5% of Salomon WGB Index[c]				
Country allocation deviations limited relative to index proportions				
Transactions permitted only for replacement of deteriorating credits				
Fee: 15 basis points/year				
Indexed management	11.3%	12.0%	11.0%	14.9%
Match return of Salomon WGB Index[c]				
No duration shifts permitted				
Transactions allowed only for portfolio rebalancing				
Fee: 6 basis points/year				

[a]Top decile returns are simple average of the 10 best manager records in BAG's 100-manager universe.

[b]Bottom decile returns are a simple average of the 10 worst manager records in BAG's 100-manager universe.

[c]Salomon Brothers World Government Bond Index (WGB)

PTC has now decided to index the segment of the fixed-income portfolio to be invested in non-U.S. government bonds, using the Salomon Brothers World Government Bond Index as the benchmark portfolio. Assume this index includes the sovereign credits of nine major countries in the following proportions:

Country	Weighting
Australia	2%
Canada	8
Denmark	2
France	11
Germany	19
Japan	37
The Netherlands	8
Switzerland	2
United Kingdom	11

Several members of the Investment Committee favor use of the full replication approach to indexing the non-U.S. government bonds, while the chairman favors use of the stratified sampling approach. As the BAG representative assigned to the PTC account, you have been asked to assist the committee in choosing between the two indexing methods.

c. Describe and evaluate *each* of these two indexing alternatives for the purpose of creating and managing a bond portfolio intended to represent the Salomon Brothers World Government Bond Index benchmark. [10 minutes]

d. Evaluate the appropriateness of using the Salomon Brothers World Government Bond Index as a benchmark for purposes of monitoring PTC's non-U.S. portfolio exposures in relation to its pension benefit liability exposures. [5 minutes]

11. *CFA Examination Level II*

PowerTool is the largest U.S. manufacturer of industrial hand tools. Its sales force is strong, but clients have complained that marketing is weak. The industrial tool business is mature, with little or no future expected growth.

PowerTool has acquired Fenton Manufacturing, a small, innovative company whose sales are entirely in the retail tool market. The retail tool market is expected to grow at a 5 percent annual rate.

Fenton recently developed a patented line of rechargeable home power tools that displayed strong potential in test markets. Fenton expects this line to generate 50 percent of its sales within five years but lacks a sales force to market this product line. Jerry Fenton, the company's founder, recently retired.

PowerTool management is highly respected and the company has experienced little management turnover. However, the Chief Executive Officer has announced her retirement after 18 years of service and will be replaced by the current Chief Operating Officer.

You are a private investor with a large investment in PowerTool bonds and wish to determine the effect of the acquisition of Fenton on PowerTool's bonds.

Table 7 presents financial ratios and debt ratings of PowerTool and Fenton prior to the merger and pro forma ratios of the combined company following the acquisition.

a. Explain how *each* of the following *three* ratios should be used to evaluate a firm's financial risk:
   (1) Total debt to total capital
   (2) Pretax interest coverage
   (3) Operating cash flow to total debt [9 minutes]

TABLE 7 *FINANCIAL RATIOS AND DEBT RATINGS: JUNE 1, 1996*

Company	Total Debt to Total Capital	Pretax Interest Coverage	Operating Cash Flow to Total Debt	Debt Rating
PowerTool	30%	6.2 times	50%	A+
Fenton	72	2.1 times	8	Not rated
Combined	42	5.4 times	40	To be determined

TABLE 8 *BOND RATING CRITERIA: JUNE 1, 1996*

Debt Rating	Total Debt to Total Capital	Pretax Interest Coverage	Operating Cash Flow to Total Debt
AA	26%	8.8 times	75%
A	37	4.6 times	44
BBB	48	2.5 times	29

PowerTool has issued debt with the following covenants, which continue in force after its acquisition of Fenton.

Dividend Test Covenant
PowerTool may not pay any cash dividend or repurchase shares if such payment would result in a total debt-to-capital ratio in excess of 50 percent.

Put Option Covenant
If PowerTool's debt rating falls below A, bondholders have the right to redeem the bonds at a price of 105 plus accrued interest within 60 days following the change in rating.

b. Discuss the impact of *each* of the *two* debt covenants as just described on PowerTool's financial flexibility following its acquisition of Fenton:
   (1) Dividend Test covenant
   (2) Put Option Covenant [8 minutes]

Use only the information provided in the introduction in answering the following question.

c. Discuss, *from the PowerTool bondholders' point of view, two* advantages and *two* disadvantages to PowerTool of the acquisition of Fenton, with regard to the following product lines:
   - Industrial tool business
   - Retail tool business [12 minutes]

   PowerTool debt has not yet been re-rated following the acquisition of Fenton. PowerTool bonds are currently trading at a price comparable to A-rated bonds.

   Table 8 displays financial ratios used to determine bond ratings.

d. Recommend whether you should *hold* or *sell* the PowerTool bonds. Support your recommendations with *four* reasons drawn from the Introduction, Tables 7 and 8, and your answers to Parts a through c. [13 minutes]

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12. *CFA Examination Level II*
As a new employee at Clayton Asset Management, Emma Bennett has been assigned to evaluate the credit quality of BRT Corporation bonds. Clayton holds the bonds in its high-yield bond portfolio. The following information is provided to assist in the analysis.

BRT Corporation is a rapidly growing company in the broadcast industry. It has grown primarily through a series of aggressive acquisitions.

Early in 1996, BRT announced it was acquiring a competitor in a hostile takeover that would double its assets but also increase debt burdens. The credit rating of BRT debt fell from BBB to BB. The acquisition reduced the financial flexibility of BRT but increased its presence in the broadcasting industry.

Now, mid-1997, BRT has announced its merging with another large entertainment company. The merger will alter BRT's capital structure and place it as a leader in the broadcast industry. The early 1996 acquisition combined with this merger will increase the total assets of BRT by a factor of four. A large portion of the total assets are intangible, representing franchise and distribution rights.

Although the outlook for the broadcasting industry remains healthy, large telecommunication companies attempting to enter the broadcasting industry are keeping competitive pressures high. Laws and regulations also promote the competitiveness of the environment, but initial start-up costs make it difficult for new companies to enter the industry. Large capital expenditures are required to maintain and improve existing systems as well as to expand current business.

For Bennett's analysis, she has been provided with the financial data shown in Table 9 through Table 12.

a. Calculate the following ratios using the *projected 1997* financial information:
   (1) Operating income to sales
   (2) Earnings before interest and taxes to total assets
   (3) Times interest earned
   (4) Long-term debt to total assets [4 minutes]
b. Discuss the effect of the 1997 merger on the creditworthiness of BRT through an analysis of *each* of the ratios in Part a. [8 minutes]

BRT Corporation 10-year bonds are currently rated BB and are trading at a yield to maturity of 7.70 percent. The current 10-year Treasury note is yielding 6.15 percent.

c. State and justify, based on your work in Parts a and b, the information in Tables 11 and 12, and the introduction, whether Clayton should hold or sell the BRT Corporation bonds in its portfolio. Include a discussion of *two* qualitative factors. [10 minutes]

TABLE 9

BRT CORPORATION BALANCE SHEET DATA AT YEAR END—DECEMBER 31 (IN MILLIONS)

	1993	1994	1995	1996	Projected 1997
Current assets	$ 654	$ 718	$2,686	$ 2,241	$ 5,255
Net fixed assets	391	379	554	1,567	2,583
Other assets (Intangibles)	2,982	3,090	3,176	8,946	20,435
Total assets	$4,027	$4,187	$6,416	$12,754	$28,273
Current liabilities	$ 799	$ 876	$ 966	$ 1,476	$ 3,731
Long-term debt	2,537	2,321	2,378	7,142	15,701
Other liabilities	326	292	354	976	349
Total equity	365	698	2,718	3,160	8,492
Total liabilities and equity	$4,027	$4,187	$6,416	$12,754	$28,273

TABLE 10

BRT CORPORATION INCOME STATEMENT DATA—YEARS ENDING DECEMBER 31 (IN MILLIONS EXCEPT PER-SHARE DATA)

	1993	1994	1995	1996	Projected 1997
Net sales	$1,600	$1,712	$2,005	$4,103	$9,436
Operating expenses	1,376	1,400	1,620	3,683	8,603
Operating income	$ 224	$ 312	$ 385	$ 420	$ 833
Interest expense	296	299	155	270	825
Income taxes	20	42	130	131	4
Net income	$ (92)	$ (29)	$ 100	$ 19	$ 4
Earnings per share	($ 0.86)	($ 0.24)	$ 0.83	$ 0.09	$ 0.01
Average price per share	$26.30	$34.10	$ 4.90	$40.10	$40.80
Average shares outstanding	107	120	121	198	359

TABLE 11 *BRT CORPORATION SELECTED FINANCIAL RATIOS*

	1993	1994	1995	1996	Projected 1997
Operating income to sales (%)	14.0%	18.2%	19.2%	10.2%	*
Sales to total assets	0.39 times	0.41 times	0.31 times	0.32 times	0.33 times
Earnings before interest and taxes to total assets	5.5%	7.4%	6.0%	3.3%	*
Times interest earned	0.76 times	1.04 times	2.48 times	1.55 times	*
Long-term debt to total assets	63.0%	55.4%	37.0%	55.9%	*

TABLE 12 *CLAYTON ASSET MANAGEMENT CREDIT RATING STANDARDS*

	Average Ratios by Rating Category						
	AA	A	BBB	BB	B	CCC	CC
Financial Ratios							
Operating income to sales (%)	16.2	13.4	12.1	10.3	8.5	6.4	5.2
Sales to total assets	2.50 times	2.00 times	1.50 times	1.00 times	0.75 times	0.50 times	0.25 times
Earnings before interest and taxes to total assets	15.0%	10.0%	8.0%	6.0%	4.0%	3.0%	2.0%
Times interest earned	5.54 times	3.62 times	2.29 times	1.56 times	1.04 times	0.79 times	0.75 times
Long-term debt to total assets	19.5%	30.4%	40.2%	51.8%	71.8%	81.0%	85.4%
Bond Credit Spread Information							
Current yield spread in basis points over 10-year Treasuries	45	55	85	155	225	275	350

TABLE 13 *FINANCIAL INFORMATION*

Ratio	1997	1998	1999
Sturdy Machines			
Cash flow/total debt (%)	37.3	31.0	33.0
Total debt/capital (%)	38.2	40.1	41.3
Pretax interest coverage (×)	4.2	2.3	1.1
Patriot Manufacturing			
Cash flow/total debt (%)	34.6	38.0	43.1
Total debt/capital (%)	40.0	37.3	34.9
Pretax interest coverage (×)	2.7	4.5	6.1

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13. *CFA Examination Level II*

Jane Berry is a fixed-income analyst at an investment management firm. She has been following the developments at two companies, Sturdy Machines and Patriot Manufacturing, which are both U.S.-based industrial companies that sell their products worldwide. Both companies operate in cyclical industries.

Sturdy Machine's profits have suffered from a rising dollar and a slump in its business. The company has said that major cuts in its operating expenses are likely to be necessary if it is to make a profit next year. On the other hand, Patriot Manufacturing has been able to maintain its profitability and enhance its balance sheet, as shown in Table 13.

Berry has been monitoring the bonds of these companies for possible purchase. She notices that a rating agency recently downgraded the senior debt of Sturdy Machines from A1 to A2 and upgraded the senior debt of Patriot Manufacturing from A3 to A2. Berry has received the following yield quotes from a broker:

- Sturdy Machines 7.50 percent due June 1, 2008, was quoted at 7.10 percent.
- Patriot Manufacturing 7.50 percent due June 1, 2008, was quoted at 7.10 percent.

Recommend which bond Berry should buy. Justify your choice with *two* factors from Table 13 and *two* qualitative factors from the preceding discussion. [16 minutes]

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14. *CFA Examination Level II*
Mike Smith, CFA, an analyst with Blue River Investments, is considering buying a Montrose Cable Company Corporate bond. He has collected the following balance sheet and income statement information for Montrose as shown in Exhibit 1. He has also calculated the three ratios shown in Exhibit 2, which indicate that the bond is currently rated "A" according to the firm's internal bond-rating criteria shown in Exhibit 4.

Smith has decided to consider some off-balance-sheet items in his credit analysis, as shown in Exhibit 3. Specifically, Smith wishes to evaluate the impact of each of the off-balance-sheet items on each of the ratios found in Exhibit 2.

a. Calculate the combined effect of the *three* off-balance-sheet items in Exhibit 3 on *each* of the following *three* financial ratios shown in Exhibit 2. [9 minutes]
(1) EBITDA/interest expense.
(2) Long-term debt/equity.
(3) Current assets/current liabilities.

The bond is currently trading at a credit premium of 55 basis points. Using the internal bond-rating criteria in Exhibit 4, Smith wants to evaluate whether or not the credit yield premium incorporates the effect of the off-balance-sheet items.

b. State and justify whether or not the current credit yield premium compensates Smith for the credit risk of the bond based on the internal bond-rating criteria found in Exhibit 4. [6 minutes]

EXHIBIT 1 *MONTROSE CABLE COMPANY: YEAR ENDED MARCH 31, 1999 (US$ THOUSAND)*

Balance Sheet	
Current assets	$ 4,735
Fixed assets	43,225
Total assets	$47,960
Current liabilities	$ 4,500
Long-term debt	10,000
Total liabilities	$14,500
Shareholder's equity	33,460
Total liabilities and shareholder's equity	$47,960
Income Statement	
Revenue	$18,500
Operating and administrative expenses	14,050
Operating income	$ 4,450
Depreciation and amortization	1,675
Interest expense	942
Income before income taxes	$ 1,833
Taxes	641
Net income	$ 1,192

EXHIBIT 2 *SELECTED RATIOS AND CREDIT YIELD PREMIUM DATA FOR MONTROSE*

EBITDA/interest expense	4.72
Long-term debt/equity	0.30
Current assets/current liabilities	1.05
Credit yield premium over U.S. Treasuries	55 basis points

EXHIBIT 3

MONTROSE OFF-BALANCE-SHEET ITEMS

- Montrose has guaranteed the long-term debt (principal only) of an unconsolidated affiliate. This obligation has a present value of $995,000.
- Montrose has sold $500,000 of accounts receivable with recourse at a yield of 8 percent.
- Montrose is a lessee in a new noncancelable operating leasing agreement to finance transmission equipment. The discounted present value of the lease payments is $6,144,000 using an interest rate of 10 percent. The annual payment will be $1,000,000.

EXHIBIT 4

BLUE RIVER INVESTMENTS: INTERNAL BOND-RATING CRITERIA AND CREDIT YIELD PREMIUM DATA

Bond Rating	Interest Coverage (EBITDA/ Interest Expense)	Leverage (Long-Term Debt/Equity)	Current Ratio (Current Assets/ Current Liabilities)	Credit Yield Premium over U.S. Treasuries (in Basis Points)
AA	5.00 to 6.00	0.25 to 0.30	1.15 to 1.25	30 BPs
A	4.00 to 5.00	0.30 to 0.40	1.00 to 1.15	50 BPs
BBB	3.00 to 4.00	0.40 to 0.50	0.90 to 1.00	100 BPs
BB	2.00 to 3.00	0.50 to 0.60	0.75 to 0.90	125 BPs

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