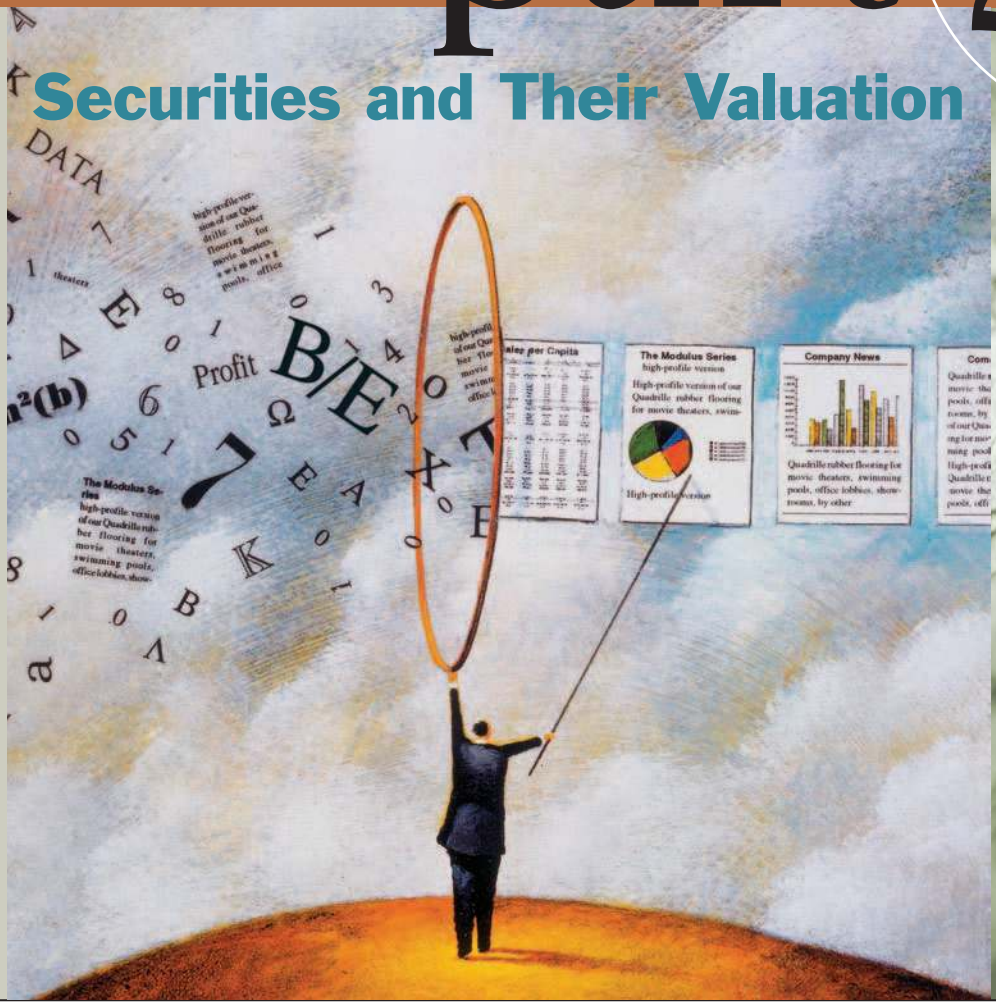
part 2

Securities and Their Valuation



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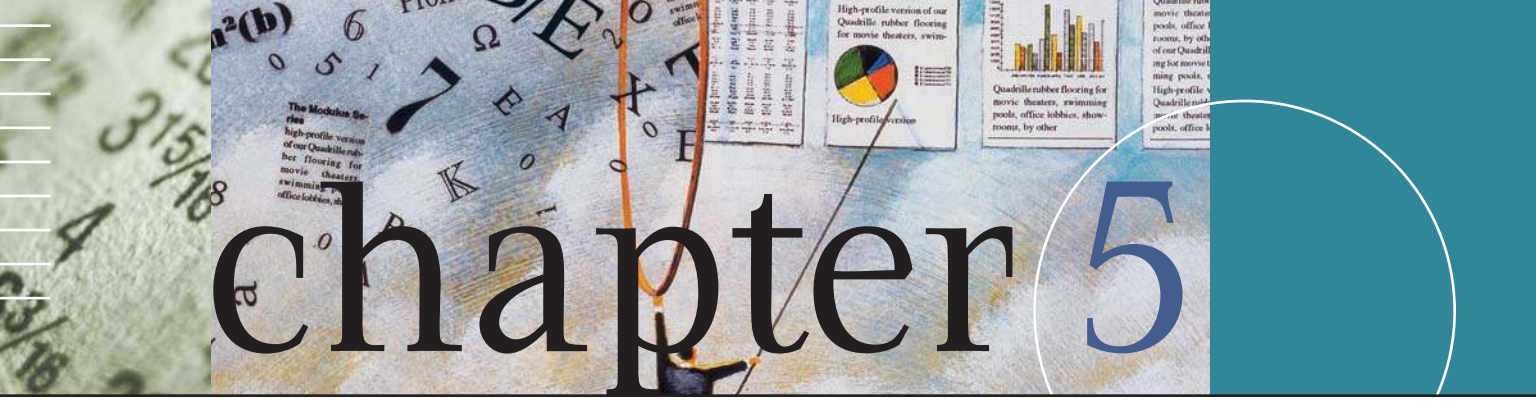

chapter 5

Bonds, Bond Valuation, and Interest Rates

A lot of U.S. bonds have been issued, and we mean a LOT! According to the Federal Reserve, there are about $4.8 trillion of outstanding U.S. Treasury securities, more than $2.2 trillion of municipal securities, $3.0 trillion of corporate bonds, and more than $947 billion of foreign bonds held in the United States. Not only is the dollar amount mind-boggling, so is the variety. Bonds come in many shapes and flavors, with a number of new varieties introduced each year. For instance, two of the most interesting bonds don't pay any interest, and one actually has a negative interest rate.

How can a bond not pay interest? An investor might buy such a bond today for $558 in exchange for the promise of $1,000 in 10 years. The investor would not receive any cash interest payments, but the 10-year increase from the original purchase price to the $1,000 repayment would provide a 6% annual return on the investment. Although there are no annual cash interest payments, the government still allows corporate issuers to deduct an imputed annual interest expense from their taxable income based on the bond's annual appreciation in value. Thus, the company gets a tax deduction each year, even though it isn't making actual interest payments. Of course, the downside is that the company will have to come up with the full $1,000 per bond in 10 years to pay off the bondholders, plus the bondholders must report the imputed interest and pay taxes on it.

Even more interesting, Berkshire Hathaway (chaired by Warren Buffett) issued bonds with a negative interest rate in 2002. Technically, Berkshire's bonds called for a 3% interest payment, but they also had an attached warrant that allows an investor to purchase shares of Berkshire Hathaway stock at a fixed price in the future. If the stock price rises above the specified price, then investors can profit by exercising the warrants. However, Berkshire Hathaway didn't just give away the warrants—it required investors to make annual installment payments equal to 3.75% of the bond's face value. Thus, investors receive a 3% interest payment, but they must then pay a 3.75% warrant fee, for a net interest rate of negative 0.75%. Berkshire Hathaway can deduct the 3% interest payment for tax purposes, but the 3.75% warrant fee is not taxable, further increasing Berkshire Hathaway's annual after-tax cash flow.

Think about the implications of these and other bonds as you read this chapter.

Source: **http://www.federalreserve.gov/releases/Z1/current/**, "Flow of Funds Accounts of the United States, Section L.2, Credit Market Debt Owed by Nonfinancial Sectors."

Growing companies must acquire land, buildings, equipment, inventory, and other operating assets. The debt markets are a major source of funding for such purchases. Therefore, every manager should have a working knowledge of the types of bonds companies and government agencies issue, the terms that are contained in bond contracts, the types of risks to which both bond investors and issuers are exposed, and procedures for determining the values of and rates of return on bonds.

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The textbook's Web site contains an *Excel* file that will guide you through the chapter's calculations. The file for this chapter is ***FM12 Ch 05 Tool Kit.xls,*** and we encourage you to open the file and follow along as you read the chapter.

5.1 Who Issues Bonds?

A **bond** is a long-term contract under which a borrower agrees to make payments of interest and principal, on specific dates, to the holders of the bond. For example, on January 5, 2008, MicroDrive Inc. borrowed $50 million by issuing $50 million of bonds. For convenience, we assume that MicroDrive sold 50,000 individual bonds for $1,000 each. Actually, it could have sold one $50 million bond, 10 bonds with a $5 million face value, or any other combination that totals to $50 million. In any event, MicroDrive received the $50 million, and in exchange it promised to make annual interest payments and to repay the $50 million on a specified maturity date.

Investors have many choices when investing in bonds, but bonds are classified into four main types: Treasury, corporate, municipal, and foreign. Each type differs with respect to expected return and degree of risk.

Treasury bonds, sometimes referred to as government bonds, are issued by the U.S. federal government.[1] It is reasonable to assume that the federal government will make good on its promised payments, so these bonds have no default risk. However, Treasury bond prices decline when interest rates rise, so they are not free of all risks.

Corporate bonds, as the name implies, are issued by corporations. Unlike Treasury bonds, corporate bonds are exposed to default risk—if the issuing company gets into trouble, it may be unable to make the promised interest and principal payments. Different corporate bonds have different levels of default risk, depending on the issuing company's characteristics and the terms of the specific bond. Default risk often is referred to as "credit risk," and the larger the default or credit risk, the higher the interest rate the issuer must pay.

Municipal bonds, or "munis," are issued by state and local governments. Like corporate bonds, munis have default risk. However, munis offer one major advantage over all other bonds: The interest earned on most municipal bonds is exempt from federal taxes and also from state taxes if the holder is a resident of the issuing state. Consequently, municipal bonds carry interest rates that are considerably lower than those on corporate bonds with the same default risk.

Foreign bonds are issued by foreign governments or foreign corporations. Foreign corporate bonds are, of course, exposed to default risk, and so are some foreign government bonds. An additional risk exists if the bonds are denominated

[1]The U.S. Treasury actually issues three types of securities: "bills," "notes," and "bonds." A bond makes an equal payment every 6 months until it matures, at which time it makes an additional lump sum payment. If the maturity at the time of issue is less than 10 years, it is called a note rather than a bond. A T-bill has a maturity of 52 weeks or less at the time of issue, and it makes no payments at all until it matures. Thus, bills are sold initially at a discount to their face, or maturity, value.

Corporate Valuation and Risk

In Chapter 1, we told you that managers should strive to make their firms more valuable, and that the value of a firm is determined by the size, timing, and risk of its free cash flows (FCF). This chapter shows you how to measure a bond's risk and the return demanded by a firm's bondholders, which affect the firm's weighted average cost of capital, which in turn affects the firm's value.

$$\text{Value} = \frac{FCF_1}{(1 + WACC)^1} + \frac{FCF_2}{(1 + WACC)^2} + \frac{FCF_3}{(1 + WACC)^3} + \cdots + \frac{FCF_\infty}{(1 + WACC)^\infty}$$

in a currency other than that of the investor's home currency. For example, if a U.S. investor purchases a corporate bond denominated in Japanese yen and the yen subsequently falls relative to the dollar, then the investor will lose money, even if the company does not default on its bonds.

SELF-TEST

What is a bond?
What are the four main types of bonds?
Why are U.S. Treasury bonds not riskless?
To what types of risk are investors of foreign bonds exposed?

5.2 Key Characteristics of Bonds

Although all bonds have some common characteristics, they do not always have identical contractual features, as described below.

An excellent site for information on many types of bonds is the Yahoo! Finance bond site, which can be found at **http://bonds.yahoo.com.** The site has a great deal of information about corporates, municipals, Treasuries, and bond funds. It includes free bond searches, through which the user specifies the attributes desired in a bond and then the search returns the publicly traded bonds meeting the criteria. The site also includes a bond calculator and an excellent glossary of bond terminology.

Par Value

The **par value** is the stated face value of the bond; for illustrative purposes we generally assume a par value of $1,000, although any multiple of $1,000 (for example, $5,000) can be used. The par value generally represents the amount of money the firm borrows and promises to repay on the maturity date.

Coupon Interest Rate

MicroDrive's bonds require the company to pay a fixed number of dollars of interest each year (or, more typically, each six months). When this **coupon payment,** as it is called, is divided by the par value, the result is the **coupon interest rate.** For example, MicroDrive's bonds have a $1,000 par value, and they pay $100 in interest each year. The bond's coupon interest is $100, so its coupon interest rate is $100/$1,000 = 10%. The coupon payment, which is fixed at the time the bond is issued, remains in force during the life of the bond.[2] Typically, at the time a bond

[2]At one time, bonds literally had a number of small (1/2- by 2-inch), dated coupons attached to them, and on each interest payment date the owner would clip off the coupon for that date and either cash it at his or her bank or mail it to the company's paying agent, who would then mail back a check for the interest. For example, a 30-year, semiannual bond would start with 60 coupons. Today, most new bonds are *registered*—no physical coupons are involved, and interest checks are mailed automatically to the registered owners.

is issued its coupon payment is set at a level that will enable the bond to be issued at or near its par value.

In some cases, a bond's coupon payment will vary over time. For these **floating-rate bonds,** the coupon rate is set for, say, the initial six-month period, after which it is adjusted every six months based on some market rate. Some corporate issues are tied to the Treasury bond rate, while other issues are tied to other rates, such as LIBOR. Many additional provisions can be included in floating-rate issues. For example, some are convertible to fixed-rate debt, whereas others have upper and lower limits ("caps" and "floors") on how high or low the rate can go.

Floating-rate debt is popular with investors who are worried about the risk of rising interest rates, since the interest paid on such bonds increases whenever market rates rise. This causes the market value of the debt to be stabilized, and it also provides institutional buyers, such as banks, with income that is better geared to their own obligations. Banks' deposit costs rise with interest rates, so the income on floating-rate loans that they have made rises at the same time their deposit costs are rising. The savings and loan industry was almost destroyed as a result of its former practice of making fixed-rate mortgage loans but borrowing on floating-rate terms. If you are earning 6% fixed but paying 10% floating—which they were—you soon go bankrupt—which they did. Moreover, floating-rate debt appeals to corporations that want to issue long-term debt without committing themselves to paying a historically high interest rate for the entire life of the loan.

Some bonds pay no coupons at all, but are offered at a substantial discount below their par values and hence provide capital appreciation rather than interest income. These securities are called **zero coupon bonds** ("zeros"). Other bonds pay some coupon interest but not enough to be issued at par. In general, any bond originally offered at a price significantly below its par value is called an **original issue discount (OID) bond.** Corporations first used zeros in a major way in 1981. In recent years IBM, Alcoa, JCPenney, ITT, Cities Service, GMAC, and Lockheed Martin have used zeros to raise billions of dollars.

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For more on zero coupon bonds, including U.S. Treasury STRIP bonds, see ***Web Extension 5A*** at the textbook's Web site.

Some bonds don't pay cash coupons but pay coupons consisting of additional bonds (or a percentage of an additional bond). These are called **payment-in-kind bonds,** or just **PIK bonds.** PIK bonds are usually issued by companies with cash flow problems, which makes them risky.

Some bonds have a step-up provision: If the company's bond rating is downgraded, then it must increase the bond's coupon rate. Step-ups are more popular in Europe than in the United States, but that is beginning to change. Note that a step-up is quite dangerous from the company's standpoint. The downgrade means that it is having trouble servicing its debt, and the step-up will exacerbate the problem. This has led to a number of bankruptcies.

Maturity Date

Bonds generally have a specified **maturity date** on which the par value must be repaid. MicroDrive's bonds, which were issued on January 5, 2008, will mature on January 5, 2023; thus, they had a 15-year maturity at the time they were issued. Most bonds have **original maturities** (the maturity at the time the bond is issued) ranging from 10 to 40 years, but any maturity is legally permissible.[3] Of course, the

[3]In July 1993, Walt Disney Co., attempting to lock in a low interest rate, issued the first 100-year bonds to be sold by any borrower in modern times. Soon after, Coca-Cola became the second company to stretch the meaning of "long-term bond" by selling $150 million of 100-year bonds.

effective maturity of a bond declines each year after it has been issued. Thus, MicroDrive's bonds had a 15-year original maturity, but in 2009, a year later, they will have a 14-year maturity, and so on.

Provisions to Call or Redeem Bonds

Most corporate bonds contain a **call provision,** which gives the issuing corporation the right to call the bonds for redemption.[4] The call provision generally states that the company must pay the bondholders an amount greater than the par value if they are called. The additional sum, which is termed a **call premium,** is often set equal to one year's interest if the bonds are called during the first year, and the premium declines at a constant rate of INT/N each year thereafter, where INT = annual interest and N = original maturity in years. For example, the call premium on a $1,000 par value, 10-year, 10% bond would generally be $100 if it were called during the first year, $90 during the second year (calculated by reducing the $100, or 10%, premium by one-tenth), and so on. However, bonds are often not callable until several years (generally 5 to 10) after they are issued. This is known as a **deferred call,** and the bonds are said to have **call protection.**

Suppose a company sold bonds when interest rates were relatively high. Provided the issue is callable, the company could sell a new issue of low-yielding securities if and when interest rates drop. It could then use the proceeds of the new issue to retire the high-rate issue and thus reduce its interest expense. This process is called a **refunding operation.**

A call provision is valuable to the firm but potentially detrimental to investors. If interest rates go up, the company will not call the bond, and the investor will be stuck with the original coupon rate on the bond, even though interest rates in the economy have risen sharply. However, if interest rates fall, the company *will* call the bond and pay off investors, who then must reinvest the proceeds at the current market interest rate, which is lower than the rate they were getting on the original bond. In other words, the investor loses when interest rates go up, but he or she doesn't reap the gains when rates fall. To induce an investor to take this type of risk, a new issue of callable bonds must provide a higher interest rate than an otherwise similar issue of noncallable bonds. For example, Pacific Timber Company issued bonds yielding 9.5%; these bonds were callable immediately. On the same day, Northwest Milling Company sold an issue with similar risk and maturity that yielded 9.2%, but these bonds were noncallable for 10 years. Investors were willing to accept a 0.3% lower interest rate on Northwest's bonds for the assurance that the 9.2% interest rate would be earned for at least 10 years. Pacific, on the other hand, had to incur a 0.3% higher annual interest rate to obtain the option of calling the bonds in the event of a subsequent decline in rates.

Bonds that are **redeemable at par** at the holder's option protect investors against a rise in interest rates. If rates rise, the price of a fixed-rate bond declines. However, if holders have the option of turning their bonds in and having them redeemed at par, they are protected against rising rates. Examples of such debt include Transamerica's $50 million issue of 25-year, 8½% bonds. The bonds are not callable by the company, but holders can turn them in for redemption at par 5 years after the date of issue. If interest rates have risen, holders will turn in the

[4]A majority of municipal bonds also contain call provisions. Although the U.S. Treasury no longer issues callable bonds, some past Treasury issues were callable.

bonds and reinvest the proceeds at a higher rate. This feature enabled Transamerica to sell the bonds with an 8½% coupon at a time when other similarly rated bonds had yields of 9%.

In late 1988, the corporate bond markets were sent into turmoil by the leveraged buyout of RJR Nabisco. RJR's bonds dropped in value by 20% within days of the LBO announcement, and the prices of many other corporate bonds also plunged, because investors feared that a boom in LBOs would load up many companies with excessive debt, leading to lower bond ratings and declining bond prices. All this led to a resurgence of concern about **event risk,** which is the risk that some sudden event, such as an LBO, will occur and increase the credit risk of the company, hence lowering the firm's bond rating and the value of its outstanding bonds. Investors' concern over event risk meant that those firms deemed most likely to face events that could harm bondholders had to pay dearly to raise new debt capital, if they could raise it at all. In an attempt to control debt costs, a new type of protective covenant was devised to minimize event risk. This covenant, called a **super poison put,** enables a bondholder to turn in, or "put" a bond back to the issuer at par in the event of a takeover, merger, or major recapitalization.

Poison puts have actually been around since 1986, when the leveraged buyout trend took off. However, the earlier puts proved to be almost worthless because they allowed investors to "put" their bonds back to the issuer at par value only in the event of an unfriendly takeover. But because almost all takeovers are eventually approved by the target firm's board, mergers that started as hostile generally ended as friendly. Also, the earlier poison puts failed to protect investors from voluntary recapitalizations, in which a company sells a big issue of bonds to pay a big, one-time dividend to stockholders or to buy back its own stock. The "super" poison puts that were used following the RJR buyout announcement protected against both of these actions. This is a good illustration of how quickly the financial community reacts to changes in the marketplace.

Finally, some bonds have a **make-whole call provision.** This allows a company to call the bond, but it must pay a call price that is essentially equal to the market value of a similar noncallable bond. This provides companies with an easy way to repurchase bonds as part of a financial restructuring, such as a merger.

Sinking Funds

Some bonds also include a **sinking fund provision** that facilitates the orderly retirement of the bond issue. On rare occasions the firm may be required to deposit money with a trustee, which invests the funds and then uses the accumulated sum to retire the bonds when they mature. Usually, though, the sinking fund is used to buy back a certain percentage of the issue each year. A failure to meet the sinking fund requirement causes the bond to be thrown into default, which may force the company into bankruptcy. Obviously, a sinking fund can constitute a significant cash drain on the firm.

In most cases, the firm is given the right to handle the sinking fund in either of two ways:

1. The company can call in for redemption (at par value) a certain percentage of the bonds each year; for example, it might be able to call 5% of the total original amount of the issue at a price of $1,000 per bond. The bonds are numbered

serially, and those called for redemption are determined by a lottery administered by the trustee.
2. The company may buy the required number of bonds on the open market.

The firm will choose the least-cost method. If interest rates have risen, causing bond prices to fall, it will buy bonds in the open market at a discount; if interest rates have fallen, it will call the bonds. Note that a call for sinking fund purposes is quite different from a refunding call as discussed above. A sinking fund call typically requires no call premium, but only a small percentage of the issue is normally callable in any one year.[5]

Although sinking funds are designed to protect bondholders by ensuring that an issue is retired in an orderly fashion, you should recognize that sinking funds can work to the detriment of bondholders. For example, suppose the bond carries a 10% interest rate, but yields on similar bonds have fallen to 7.5%. A sinking fund call at par would require an investor to give up a bond that pays $100 of interest and then to reinvest in a bond that pays only $75 per year. This obviously harms those bondholders whose bonds are called. On balance, however, bonds that have a sinking fund are regarded as being safer than those without such a provision, so at the time they are issued sinking fund bonds have lower coupon rates than otherwise similar bonds without sinking funds.

Other Features

Several other types of bonds are used sufficiently often to warrant mention. First, **convertible bonds** are bonds that are convertible into shares of common stock, at a fixed price, at the option of the bondholder. Convertibles have a lower coupon rate than nonconvertible debt, but they offer investors a chance for capital gains in exchange for the lower coupon rate. Bonds issued with **warrants** are similar to convertibles. Warrants are options that permit the holder to buy stock for a stated price, thereby providing a capital gain if the price of the stock rises. Bonds that are issued with warrants, like convertibles, carry lower coupon rates than straight bonds.

Another type of bond is an **income bond,** which pays interest only if the interest is earned. These securities cannot bankrupt a company, but from an investor's standpoint they are riskier than "regular" bonds. Yet another bond is the **indexed,** or **purchasing power, bond,** which first became popular in Brazil, Israel, and a few other countries plagued by high inflation rates. The interest rate paid on these bonds is based on an inflation index such as the consumer price index, so the interest paid rises automatically when the inflation rate rises, thus protecting the bondholders against inflation. In January 1997, the U.S. Treasury began issuing indexed bonds, and they currently pay a rate that is roughly 1 to 4% plus the rate of inflation during the past year.

Bond Markets

Corporate bonds are traded primarily in the over-the-counter market rather than in organized exchanges. Most bonds are owned by and traded among the large financial institutions (for example, life insurance companies, mutual funds, and pension funds, all of which deal in very large blocks of securities), and it is rela-

[5]Some sinking funds require the issuer to pay a call premium.

tively easy for the over-the-counter bond dealers to arrange the transfer of large blocks of bonds among the relatively few holders of the bonds.

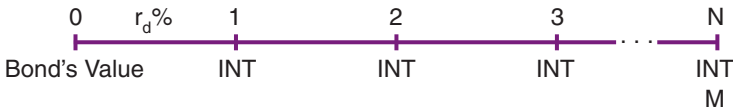
Information on bond trades in the over-the-counter market is not widely published, but a representative group of bonds is listed and traded on the bond division of the NYSE and is reported on the bond market page of *The Wall Street Journal*. Bond data are also available on the Internet, at sites such as **http://www.bondpage.com** and **http://finance.yahoo.com.**

SELF-TEST

Define "floating-rate bonds" and "zero coupon bonds."
Why is a call provision advantageous to a bond issuer?
What are the two ways a sinking fund can be handled? Which method will be chosen by the firm if interest rates have risen? If interest rates have fallen?
Are securities that provide for a sinking fund regarded as being riskier than those without this type of provision? Explain.
What are income bonds and indexed bonds?
Why do bonds with warrants and convertible bonds have lower coupons than similarly rated bonds that do not have these features?

5.3 Bond Valuation

The value of any financial asset—a stock, a bond, a lease, or even a physical asset such as an apartment building or a piece of machinery—is simply the present value of the cash flows the asset is expected to produce. The cash flows from a specific bond depend on its contractual features as described above. For a standard coupon-bearing bond such as the one issued by MicroDrive, the cash flows consist of interest payments during the life of the bond, plus the amount borrowed when the bond matures (usually a $1,000 par value). In the case of a floating-rate bond, the interest payments vary over time. In the case of a zero coupon bond, there are no interest payments, only the face amount when the bond matures. For a "regular" bond with a fixed coupon rate, here is the situation:



The notation in the time line is explained below:

r_d = The bond's required rate of return, which is the market rate of interest for that type of bond. This is the discount rate that is used to calculate the present value of the bond's cash flows. It is also called the "yield" or "going rate of interest." Note that r_d is *not* the coupon interest rate. It is equal to the coupon rate only if (as in this case) the bond is selling at par. Generally, most coupon bonds are issued at par, which implies that the coupon rate is set at r_d. Thereafter, interest rates, as measured by r_d, will fluctuate, but the coupon rate is fixed, so r_d will equal the coupon rate only by chance. We use the term "i" or "I" to designate the interest rate for many calculations because those terms are used on financial calculators but "r," with the subscript "d" to designate the rate on a debt security, is normally used in finance.[6]

[6]The appropriate interest rate on a bond depends on its risk, liquidity, and years to maturity, as well as supply and demand conditions in the capital markets.

N = Number of years before the bond matures. Note that N declines each year after the bond was issued, so a bond that had a maturity of 15 years when it was issued (original maturity = 15) will have N = 14 after 1 year, N = 13 after 2 years, and so on. Note also that at this point we assume that the bond pays interest once a year, or annually, so N is measured in years. Later on, we will deal with semiannual payment bonds, which pay interest each 6 months.

INT = Dollars of interest paid each year = Coupon rate × Par value. For a bond with a 10% coupon and a $1,000 par value, the annual interest is 0.10($1,000) = $100. In calculator terminology, INT = PMT = 100. If the bond had been a semiannual payment bond, the payment would have been $50 every 6 months. The payment would vary if the bond was a "floater."

M = Par, or maturity, value of the bond. This amount must be paid off at maturity, and it is often equal to $1,000.

The following general equation, written in several forms, can be used to find the value of any bond, V_B:

$$\begin{aligned} V_B &= \frac{INT}{(1+r_d)^1} + \frac{INT}{(1+r_d)^2} + \cdots + \frac{INT}{(1+r_d)^N} + \frac{M}{(1+r_d)^N} \\ &= \sum_{t=1}^{N} \frac{INT}{(1+r_d)^t} + \frac{M}{(1+r_d)^N} \\ &= INT\left[\frac{1}{r_d} - \frac{1}{r_d(1+r_d)^N}\right] + \frac{M}{(1+r_d)^N}. \end{aligned} \tag{5-1}$$

Notice that the cash flows consist of an annuity of N years plus a lump sum payment at the end of Year N, and this fact is reflected in Equation 5-1. Further, Equation 5-1 can be solved by one of three procedures: (1) with a formula, (2) with a financial calculator, and (3) with a spreadsheet.

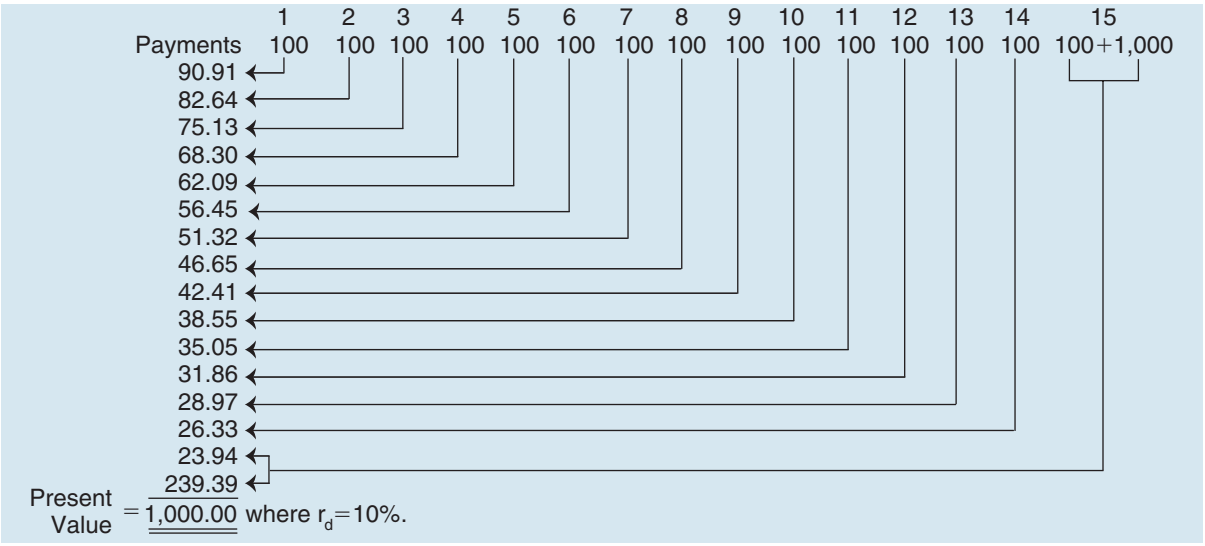
Solving for the Bond Price

Recall that MicroDrive issued a 15-year bond with an annual coupon rate of 10% and a par value of $1,000. To find the value of MicroDrive's bond with a formula, we insert values for MicroDrive's bond into Equation 5-1:

$$\begin{aligned} V_B &= \sum_{t=1}^{15} \frac{\$100}{(1+0.10)^t} + \frac{\$1{,}000}{(1+0.10)^{15}} \\ &= \$100\left[\frac{1}{0.10} - \frac{1}{0.10(1+0.10)^{15}}\right] + \frac{\$1{,}000}{(1+0.10)^{15}} \\ &= \$1{,}000. \end{aligned} \tag{5-1a}$$

We could use the first row of Equation 5-1 to discount each cash flow back to the present and then sum these PVs to find the bond's value; see Figure 5-1. This procedure is not very efficient, especially if the bond has many years to maturity.

Figure 5-1 Time Line for MicroDrive Inc.'s Bonds, 10% Interest Rate



Alternatively, you could use the formula in the second row of Equation 5-1a with a simple or scientific calculator, although this would still be somewhat cumbersome.

A financial calculator is ideally suited for finding bond values. Here is the setup for MicroDrive's bond:

Inputs:	15	10		100	1000
	N	I/YR	PV	PMT	FV
Output:			= −1,000		

Input N = 15, I/YR = r_d = 10, INT = PMT = 100, M = FV = 1000, and then press the PV key to find the value of the bond, $1,000. Since the PV is an outflow to the investor, it is shown with a negative sign. The calculator is programmed to solve Equation 5-1: It finds the PV of an annuity of $100 per year for 15 years, discounted at 10%, then it finds the PV of the $1,000 maturity payment, and then it adds these two PVs to find the value of the bond. Notice that even though the time line in Figure 5-1 shows a total of $1,100 at Year 15, you should not enter FV = 1100! When you entered N = 15 and PMT = 100, you told the calculator that there is a $100 payment at Year 15. Thus, the FV = 1000 accounts for any *extra* payment at Year 15, above and beyond the $100 payment.

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See ***FM12 Ch 05 Tool Kit.xls*** at the textbook's Web site.

With *Excel*, it is easiest to use the same PV function that we used in Chapter 2: **=PV(I,N,PMT,FV,0).** For MicroDrive's bond, the function is **=PV(0.10,15,100,1000,0)** with a result of −$1,000. Like the financial calculator solution, the bond value is negative because PMT and FV are positive.

Excel also provides specialized functions for bond prices based on actual dates. For example, in *Excel* you could find the MicroDrive bond value as of the date it was issued by using the function wizard to enter this formula:

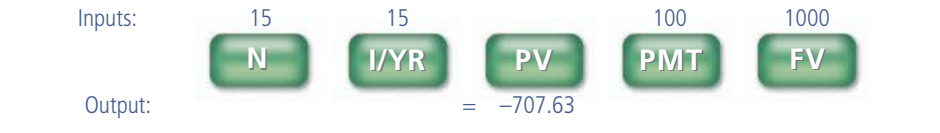
=PRICE(DATE(2008,1,5),DATE(2023,1,5),10%,10%,100,1,0)

The first two arguments in the function are *Excel's* DATE function. The DATE function takes the year, month, and date as inputs and converts them into a date. The first argument is the date on which you want to find the price, and the second argument is the maturity date. The third argument in the PRICE function is the bond's coupon rate, followed by the required return on the bond, r_d. The fifth argument, 100, is the redemption value of the bond at maturity per $100 of face value; entering "100" means that the bond pays 100% of its face value when it matures. The sixth argument is the number of payments per year. The last argument, 1, tells the program to base the price on the actual number of days in each month and year. This function produces a result based upon a face value of $100. In other words, if the bond pays $100 of face value at maturity, then the PRICE function result is the price of the bond. Because MicroDrive's bond pays $1,000 of face value at maturity, we must multiply the PRICE function's result by 10. In this example, the PRICE function returns a result of $100. When we multiply it by 10, we get the actual price of $1,000. This function is essential if a bond is being evaluated between coupon payment dates. See ***FM12 Ch 05 Tool Kit.xls*** at the textbook's Web site for the actual *Excel* spreadsheet.[7]

Interest Rate Changes and Bond Prices

In this example the bond is selling at a price equal to its par value. Whenever the going market rate of interest, r_d, is equal to the coupon rate, a *fixed-rate* bond will sell at its par value. Normally, the coupon rate is set at the going rate when a bond is issued, causing it to sell at par initially.

The coupon rate remains fixed after the bond is issued, but interest rates in the market move up and down. Looking at Equation 5-1, we see that an *increase* in the market interest rate (r_d) will cause the price of an outstanding bond to *fall*, whereas a *decrease* in rates will cause the bond's price to *rise*. For example, if the market interest rate on MicroDrive's bond increased to 15% immediately after it was issued, we would recalculate the price with the new market interest rate as follows:



The price would fall to $707.63. Notice that the bond would then sell at a price below its par value. Whenever the going rate of interest *rises above* the coupon rate, a fixed-rate bond's price will fall *below* its par value, and it is called a **discount bond.**

[7]The bond prices quoted by brokers are calculated as described. However, if you bought a bond between interest payment dates, you would have to pay the basic price plus accrued interest. Thus, if you purchased a MicroDrive bond 6 months after it was issued, your broker would send you an invoice stating that you must pay $1,000 as the basic price of the bond plus $50 interest, representing one-half the annual interest of $100. The seller of the bond would receive $1,050. If you bought the bond the day before its interest payment date, you would pay $1,000 + (364/365)($100) = $1,099.73. Of course, you would receive an interest payment of $100 at the end of the next day. For more on the valuation of bonds between payment dates, see Richard Taylor, "The Valuation of Semiannual Bonds between Interest Payment Dates," *The Financial Review*, August 1988, pp. 365–368, and K. S. Maurice Tse and Mark A. White, "The Valuation of Semiannual Bonds between Interest Payment Dates: A Correction," *Financial Review*, November 1990, pp. 659–662.

On the other hand, bond prices rise when market interest rates fall. For example, if the market interest rate on MicroDrive's bond decreased to 5%, we would once again recalculate its price:

Inputs:	15	5		100	1000
	N	I/YR	PV	PMT	FV
Output:			= –1,518.98		

In this case the price rises to $1,518.98. In general, whenever the going interest rate *falls below* the coupon rate, a fixed-rate bond's price will rise *above* its par value, and it is called a **premium bond.**

SELF-TEST

Why do the prices of fixed-rate bonds fall if expectations for inflation rise?
What is a "discount bond?" A "premium bond?"
A bond that matures in 6 years has a par value of $1,000, an annual coupon payment of $80, and a market interest rate of 9%. What is its price? ($955.14)
A bond that matures in 18 years has a par value of $1,000, an annual coupon of 10%, and a market interest rate of 7%. What is its price? ($1,301.77)

5.4 Bond Yields

Unlike the coupon interest rate, which is fixed, the bond's *yield* varies from day to day depending on current market conditions. Moreover, the yield can be calculated in three different ways, and three "answers" can be obtained. These different yields are described in the following sections.

Yield to Maturity

Suppose you were offered a 14-year, 10% annual coupon, $1,000 par value bond at a price of $1,494.93. What rate of interest would you earn on your investment if you bought the bond and held it to maturity? This rate is called the bond's **yield to maturity (YTM),** and it is the interest rate generally discussed by investors when they talk about rates of return. The yield to maturity is usually the same as the market rate of interest, r_d, and to find it, all you need to do is solve Equation 5-1 for r_d:

$$V_B = \$1{,}494.93 = \frac{\$100}{(1 + r_d)^1} + \cdots + \frac{\$100}{(1 + r_d)^{14}} + \frac{\$1{,}000}{(1 + r_d)^{14}}.$$

You can substitute values for r_d until you find a value that "works" and forces the sum of the PVs on the right side of the equal sign to equal $1,494.93. Alternatively, you can substitute values of r_d into the third form of Equation 5-1 until you find a value that works.

Finding r_d = YTM by trial-and-error would be a tedious, time-consuming process, but as you might guess, it is easy with a financial calculator. Here is the setup:

Inputs:	14		–1494.93	100	1000
	N	I/YR	PV	PMT	FV
Output:		= 5			

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See ***FM12 Ch 05 Tool Kit.xls*** at the textbook's Web site.

Simply enter N = 14, PV = −1494.93, PMT = 100, and FV = 1000, and then press the I/YR key. The answer, 5%, will then appear.

You could also find the YTM with a spreadsheet. In *Excel*, you would use the RATE function for this bond, inputting N = 14, PMT = 100, PV = −1494.93, FV = 1000, 0 for Type, and leave Guess blank: =**RATE(14,100,−1494.93,1000,0)**. The result is 5%. The RATE function only works if the current date is immediately after either the issue date or a coupon payment date. To find bond yields on other dates, use *Excel's* YIELD function. See the ***FM12 Ch 05 Tool Kit.xls*** file for an example.

The yield to maturity can be viewed as the bond's *promised rate of return*, which is the return that investors will receive if all the promised payments are made. However, the yield to maturity equals the *expected rate of return* only if (1) the probability of default is zero and (2) the bond cannot be called. If there is some default risk, or if the bond may be called, then there is some probability that the promised payments to maturity will not be received, in which case the calculated yield to maturity will differ from the expected return.

The YTM for a bond that sells at par consists entirely of an interest yield, but if the bond sells at a price other than its par value, the YTM will consist of the interest yield plus a positive or negative capital gains yield. Note also that a bond's yield to maturity changes whenever interest rates in the economy change, and this is almost daily. One who purchases a bond and holds it until it matures will receive the YTM that existed on the purchase date, but the bond's calculated YTM will change frequently between the purchase date and the maturity date.

Yield to Call

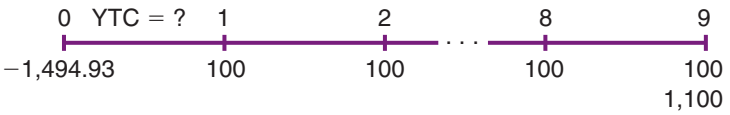
If you purchased a bond that was callable and the company called it, you would not have the option of holding the bond until it matured. Therefore, the yield to maturity would not be earned. For example, if MicroDrive's 10% coupon bonds were callable, and if interest rates fell from 10% to 5%, then the company could call in the 10% bonds, replace them with 5% bonds, and save $100 − $50 = $50 interest per bond per year. This would be beneficial to the company, but not to its bondholders.

If current interest rates are well below an outstanding bond's coupon rate, then a callable bond is likely to be called, and investors will estimate its expected rate of return as the **yield to call (YTC)** rather than as the yield to maturity. To calculate the YTC, solve this equation for r_d:

$$\text{Price of bond} = \sum_{t=1}^{N} \frac{\text{INT}}{(1 + r_d)^t} + \frac{\text{Call price}}{(1 + r_d)^N}. \tag{5-2}$$

Here N is the number of years until the company can call the bond; call price is the price the company must pay in order to call the bond (it is often set equal to the par value plus one year's interest); and r_d is the YTC.

To illustrate, suppose MicroDrive's bonds had a provision that permitted the company, if it desired, to call the bonds 10 years after the issue date at a price of $1,100. Suppose further that interest rates had fallen, and one year after issuance the going interest rate had declined, causing the price of the bonds to rise to $1,494.93. Here is the time line and the setup for finding the bond's YTC with a financial calculator:



The YTC is 4.21%—this is the return you would earn if you bought the bond at a price of $1,494.93 and it was called 9 years from today. (The bond could not be called until 10 years after issuance, and 1 year has gone by, so there are 9 years left until the first call date.)

Do you think MicroDrive *will* call the bonds when they become callable? MicroDrive's actions would depend on what the going interest rate is when the bonds become callable. If the going rate remains at $r_d = 5\%$, then MicroDrive could save 10% − 5% = 5%, or $50 per bond per year, by calling them and replacing the 10% bonds with a new 5% issue. There would be costs to the company to refund the issue, but the interest savings would probably be worth the cost, so MicroDrive would probably refund the bonds. Therefore, you would probably earn YTC = 4.21% rather than YTM = 5% if you bought the bonds under the indicated conditions.

In the balance of this chapter, we assume that bonds are not callable unless otherwise noted, but some of the end-of-chapter problems deal with yield to call.

Current Yield

If you examine brokerage house reports on bonds, you will often see reference to a bond's **current yield.** The current yield is the annual interest payment divided by the bond's current price. For example, if MicroDrive's bonds with a 10% coupon were currently selling at $985, the bond's current yield would be 10.15% ($100/$985).

Unlike the yield to maturity, the current yield does not represent the rate of return that investors should expect on the bond. The current yield provides information regarding the amount of cash income that a bond will generate in a given year, but since it does not take account of capital gains or losses that will be realized if the bond is held until maturity (or call), it does not provide an accurate measure of the bond's total expected return.

The fact that the current yield does not provide an accurate measure of a bond's total return can be illustrated with a zero coupon bond. Since zeros pay no annual income, they always have a current yield of zero. This indicates that the bond will not provide any cash interest income, but since the bond will appreciate in value over time, its total rate of return clearly exceeds zero.

SELF-TEST

Explain the difference between the yield to maturity and the yield to call.
How does a bond's current yield differ from its total return?
Could the current yield exceed the total return?
A bond currently sells for $850. It has an 8-year maturity, an annual coupon of $80, and a par value of $1,000. What is its yield to maturity? (10.90%) What is its current yield? (9.41%)
A bond currently sells for $1,250. It pays a $110 annual coupon and has a 20-year maturity, but it can be called in 5 years at $1,110. What are its YTM and its YTC? (8.38%, 6.85%) Is it likely to be called if interest rates don't change?

5.5 Changes in Bond Values Over Time

At the time a coupon bond is issued, the coupon is generally set at a level that will cause the market price of the bond to equal its par value. If a lower coupon were

set, investors would not be willing to pay $1,000 for the bond, while if a higher coupon were set, investors would clamor for the bond and bid its price up over $1,000. Investment bankers can judge quite precisely the coupon rate that will cause a bond to sell at its $1,000 par value.

A bond that has just been issued is known as a **new issue.** (Investment bankers classify a bond as a new issue for about one month after it has first been issued. New issues are usually actively traded, and are called "on-the-run" bonds.) Once the bond has been on the market for a while, it is classified as an **outstanding bond,** also called a **seasoned issue.** Newly issued bonds generally sell very close to par, but the prices of seasoned bonds vary widely from par. Except for floating-rate bonds, coupon payments are constant, so when economic conditions change, a bond with a $100 coupon that sold at par when it was issued will sell for more or less than $1,000 thereafter.

MicroDrive's bonds with a 10% coupon rate were originally issued at par. If r_d remained constant at 10%, what would the value of the bond be 1 year after it was issued? Now the term to maturity is only 14 years—that is, N = 14. With a financial calculator, just override N = 15 with N = 14, press the PV key, and you find a value of $1,000. If we continued, setting N = 13, N = 12, and so forth, we would see that the value of the bond will remain at $1,000 as long as the going interest rate remains constant at the coupon rate, 10%.

Now suppose interest rates in the economy fell after the MicroDrive bonds were issued, and, as a result, r_d *fell below the coupon rate*, decreasing from 10 to 5%. Both the coupon interest payments and the maturity value remain constant, but now 5% would have to be used for r_d in Equation 5-1. The value of the bond at the end of the first year would be $1,494.93:

$$V_B = \sum_{t=1}^{14} \frac{\$100}{(1 + 0.05)^t} + \frac{\$1,000}{(1 + 0.10)^{14}}$$

$$= \$100\left[\frac{1}{0.05} - \frac{1}{0.05(1 + 0.05)^{14}}\right] + \frac{\$1,000}{(1 + 0.05)^{14}}$$

$$= \$1,494.93.$$

With a financial calculator, just change r_d = I/YR from 10 to 5, and then press the PV key to get the answer, $1,494.93. Thus, if r_d fell *below* the coupon rate, the bond would sell above par, or at a **premium.**

The arithmetic of the bond value increase should be clear, but what is the logic behind it? The fact that r_d has fallen to 5% means that if you had $1,000 to invest, you could buy new bonds like MicroDrive's (every day some 10 to 12 companies sell new bonds), except that these new bonds would pay $50 of interest each year rather than $100. Naturally, you would prefer $100 to $50, so you would be willing to pay more than $1,000 for a MicroDrive bond to obtain its higher coupons. All investors would react similarly, and as a result, the MicroDrive bonds would be bid up in price to $1,494.93, at which point they would provide the same 5% rate of return to a potential investor as the new bonds.

Assuming that interest rates remain constant at 5% for the next 14 years, what would happen to the value of a MicroDrive bond? It would fall gradually from $1,494.93 at present to $1,000 at maturity, when MicroDrive will redeem each bond for $1,000. This point can be illustrated by calculating the value of the bond 1 year later, when it has 13 years remaining to maturity. With a financial calculator, simply input the values for N, I, PMT, and FV, now using N = 13, and press the PV key to find the value of the bond, $1,469.68. Thus, the value of the

bond will have fallen from $1,494.93 to $1,469.68, or by $25.25. If you were to calculate the value of the bond at other future dates, the price would continue to fall as the maturity date approached.

Note that if you purchased the bond at a price of $1,494.93 and then sold it 1 year later with r_d still at 5%, you would have a capital loss of $25.25, or a total return of $100.00 − $25.25 = $74.75. Your percentage rate of return would consist of an **interest yield** (also called a **current yield**) plus a **capital gains yield,** calculated as follows:

$$\begin{aligned}
\text{Interest, or current, yield} &= \$100/\$1{,}494.93 = 0.0669 = 6.69\% \\
\text{Capital gains yield} &= -\$25.25/\$1{,}494.93 = -0.0169 = -1.69\% \\
\text{Total rate of return, or yield} &= \$74.75/\$1{,}494.93 = 0.0500 = 5.00\%
\end{aligned}$$

Had interest rates risen from 10 to 15% during the first year after issue rather than fallen from 10 to 5%, then you would enter N = 14, I/YR = 15, PMT = 100, and FV = 1000, and then press the PV key to find the value of the bond, $713.78. In this case, the bond would sell below its par value, or at a discount. The total expected future return on the bond would again consist of a current yield and a capital gains yield, but now the capital gains yield would be *positive*. The total return would be 15%. To see this, calculate the price of the bond with 13 years left to maturity, assuming that interest rates remain at 15%. With a calculator, enter N = 13, I = 15, PMT = 100, and FV = 1000, and then press PV to obtain the bond's value, $720.84.

Note that the capital gain for the year is the difference between the bond's value at Year 2 (with 13 years remaining) and the bond's value at Year 1 (with 14 years remaining), or $720.84 − $713.78 = $7.06. The interest yield, capital gains yield, and total yield are calculated as follows:

$$\begin{aligned}
\text{Interest, or current, yield} &= \$100/\$713.78 = 0.1401 = 14.01\% \\
\text{Capital gains yield} &= \$7.06/\$713.78 = 0.0099 = 0.99\% \\
\text{Total rate of return, or yield} &= \$107.06/\$713.78 = 0.1500 = 15.00\%
\end{aligned}$$

Figure 5-2 graphs the value of the bond over time, assuming that interest rates in the economy (1) remain constant at 10%, (2) fall to 5% and then remain constant at that level, or (3) rise to 15% and remain constant at that level. Of course, if interest rates do *not* remain constant, then the price of the bond will fluctuate. However, regardless of what future interest rates do, the bond's price will approach $1,000 as it nears the maturity date (barring bankruptcy, in which case the bond's value might fall dramatically).

Figure 5-2 illustrates the following key points:

1. Whenever the going rate of interest, r_d, is equal to the coupon rate, a *fixed-rate* bond will sell at its par value. Normally, the coupon rate is set equal to the going rate when a bond is issued, causing it to sell at par initially.
2. Interest rates do change over time, but the coupon rate remains fixed after the bond has been issued. Whenever the going rate of interest *rises above* the coupon rate, a fixed-rate bond's price will *fall below* its par value. Such a bond is called a discount bond.
3. Whenever the going rate of interest *falls below* the coupon rate, a fixed-rate bond's price will *rise above* its par value. Such a bond is called a premium bond.
4. Thus, an *increase* in interest rates will cause the prices of outstanding bonds to *fall*, whereas a *decrease* in rates will cause bond prices to *rise*.

Drinking Your Coupons

In 1996 Chateau Teyssier, an English vineyard, was looking for some cash to purchase additional vines and to modernize its production facilities. Their solution? With the assistance of a leading underwriter, Matrix Securities, the vineyard issued 375 bonds, each costing 2,650 British pounds. The issue raised nearly 1 million pounds, or roughly $1.5 million.

What makes these bonds interesting is that, instead of getting paid with something boring like money, these bonds paid their investors back with wine. Each June until 2002, when the bond matured, investors received their "coupons." Between 1997 and 2001, each bond provided six cases of the vineyard's rosé or claret. Starting in 1998 and continuing through maturity in 2002, investors also received four cases of its prestigious Saint Emilion Grand Cru. Then, in 2002, they got their money back.

The bonds were not without risk. The vineyard's owner, Jonathan Malthus, acknowledges that the quality of the wine "is at the mercy of the gods."

Source: Steven Irvine, "My Wine Is My Bond, and I Drink My Coupons," *Euromoney*, July 1996, p. 7.

5. The market value of a bond will always approach its par value as its maturity date approaches, provided the firm does not go bankrupt.

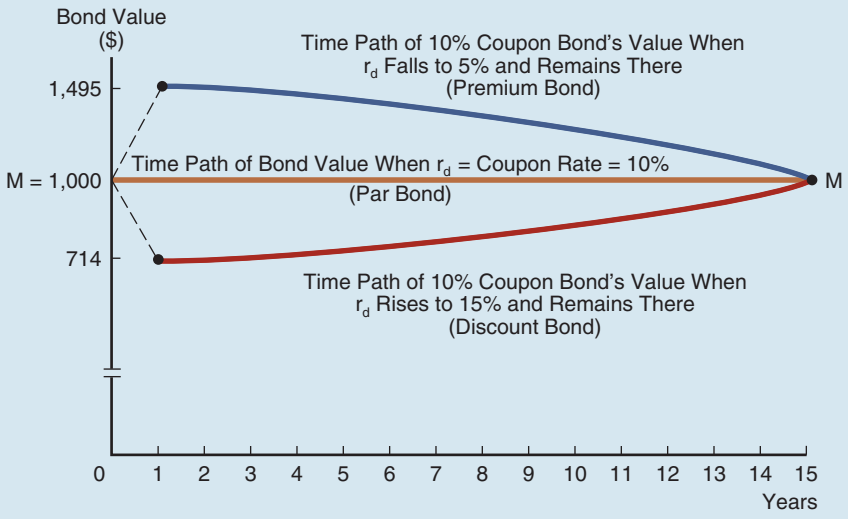
These points are very important, for they show that bondholders may suffer capital losses or make capital gains, depending on whether interest rates rise or fall after the bond is purchased.

SELF-TEST

What is meant by the terms "new issue" and "seasoned issue"?
Last year a firm issued 30-year, 8% annual coupon bonds at a par value of $1,000. (1) Suppose that one year later the going rate drops to 6%. What is the new price of the bonds, assuming that they now have 19 years to maturity? ($1,271.81) (2) Suppose instead that one year after issue the going interest rate increases to 10% (rather than falling to 6%). What is the price? ($812.61)

Figure 5-2

Time Path of the Value of a 10% Coupon, $1,000 Par Value Bond When Interest Rates Are 5%, 10%, and 15%



Note: The curves for 5% and 15% have a slight bow.

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See ***FM12 Ch 05 Tool Kit.xls*** for all calculations.

5.6 Bonds with Semiannual Coupons

Although some bonds pay interest annually, the vast majority actually pay interest semiannually. To evaluate semiannual payment bonds, we must modify the valuation model as follows:

1. Divide the annual coupon interest payment by 2 to determine the dollars of interest paid each 6 months.
2. Multiply the years to maturity, N, by 2 to determine the number of semiannual periods.
3. Divide the nominal (quoted) interest rate, r_d, by 2 to determine the periodic (semiannual) interest rate.

By making these changes, we obtain the following equation for finding the value of a bond that pays interest semiannually:

$$V_B = \sum_{t=1}^{2N} \frac{INT/2}{(1 + r_d/2)^t} + \frac{M}{(1 + r_d/2)^{2N}}. \quad \textbf{(5-3)}$$

To illustrate, assume now that MicroDrive's bonds pay $50 interest each 6 months rather than $100 at the end of each year. Thus, each interest payment is only half as large, but there are twice as many of them. The coupon rate is thus "10%, semiannual payments." This is the nominal, or quoted, rate.[8]

When the going (nominal) rate of interest is 5% with semiannual compounding, the value of this 15-year bond is found as follows:

Inputs:	30	2.5		50	1000
	N	I/YR	PV	PMT	FV
Output:			= −1,523.26		

Enter N = 30, r_d = I/YR = 2.5, PMT = 50, FV = 1000, and then press the PV key to obtain the bond's value, $1,523.26. The value with semiannual interest payments is slightly larger than $1,518.98, the value when interest is paid annually. This higher value occurs because interest payments are received somewhat faster under semiannual compounding.

SELF-TEST

Describe how the annual bond valuation formula is changed to evaluate semiannual coupon bonds. Then, write out the revised formula.

A bond has a 25-year maturity, an 8% annual coupon paid semiannually, and a face value of $1,000. The going nominal annual interest rate (r_d) is 6%. What is the bond's price? ($1,257.30)

[8] In this situation, the coupon rate of "10% paid semiannually," is the rate that bond dealers, corporate treasurers, and investors generally would discuss. Of course, if this bond were issued at par, its effective annual rate would be higher than 10%:

$$EAR = EFF\% = \left(1 + \frac{r_{NOM}}{M}\right)^M - 1 = \left(1 + \frac{0.10}{2}\right)^2 - 1 = (1.05)^2 - 1 = 10.25\%.$$

Since 10% with annual payments is quite different from 10% with semiannual payments, we have assumed a change in effective rates in this section from the situation in Section 5.3, where we assumed 10% with annual payments.

5.7 The Determinants of Market Interest Rates

Up until now we have given you r_d, the going market rate. But as we showed in Chapter 1, different debt securities often have very different market rates. What explains these differences? In general, the quoted (or nominal) interest rate on a debt security, r_d, is composed of a real risk-free rate of interest, r*, plus several premiums that reflect inflation, the risk of the security, and the security's marketability (or liquidity). A conceptual framework is shown below:

$$\text{Quoted market interest rate} = r_d = r^* + IP + DRP + LP + MRP. \quad \textbf{(5-4)}$$

Here are definitions of the variables in Equation 5-4:

r_d = Quoted, or nominal, rate of interest on a given security.[9] There are many different securities, hence many different quoted interest rates.

r* = Real risk-free rate of interest. r* is pronounced "r-star," and it is the rate that would exist on a riskless security if zero inflation were expected.

IP = Inflation premium. IP is equal to the average expected inflation rate over the life of the security. The expected future inflation rate is not necessarily equal to the current inflation rate, so IP is not necessarily equal to current inflation.

r_{RF} = r* + IP, and it is the quoted risk-free rate of interest on a security such as a U.S. Treasury bill, which is very liquid and also free of most risks. Note that r_{RF} includes the premium for expected inflation, because $r_{RF} = r^* + IP$.

DRP = Default risk premium. This premium reflects the possibility that the issuer will not pay interest or principal at the stated time and in the stated amount. DRP is zero for U.S. Treasury securities, but it rises as the riskiness of issuers increases.

LP = Liquidity, or marketability, premium. This is a premium charged by lenders to reflect the fact that some securities cannot be converted to cash on short notice at a "reasonable" price. LP is very low for Treasury securities and for securities issued by large, strong firms, but it is relatively high on securities issued by very small firms.

MRP = Maturity risk premium. As we will explain later, longer-term bonds, even Treasury bonds, are exposed to a significant risk of price declines, and a maturity risk premium is charged by lenders to reflect this risk.

See **http://www.bloomberg.com** and select MARKET DATA. Select RATES AND BONDS for a partial listing of indexed Treasury bonds and their interest rates. See **http://online.wsj.com** for a complete set of Treasury quotes. See **http://www.publicdebt.treas.gov/opd/opddload.htm** for a complete listing of all Treasury securities.

We discuss the components whose sum makes up the quoted, or nominal, rate on a given security in the following sections.

SELF-TEST Write out an equation for the nominal interest rate on any debt security.

[9]The term *nominal* as it is used here means the *stated* rate as opposed to the real rate, which is adjusted to remove inflation effects. Suppose you bought a 10-year Treasury bond with a quoted, or nominal, rate of about 4.6%. If inflation averages 2.5% over the next 10 years, the real rate would be about 4.6% − 2.5% = 2.1%. To be technically correct, we should find the real rate by solving for r* in the following equation: (1 + r*)(1 + 0.025) = (1 + 0.046). Solving the equation, we find r* = 2.05%. Since this is very close to the 2.1% calculated above, we will continue to approximate the real rate in this chapter by subtracting inflation from the nominal rate.

5.8 The Real Risk-Free Rate of Interest, r*

The **real risk-free rate of interest, r*,** is defined as the interest rate that would exist on a riskless security if no inflation were expected, and it may be thought of as the rate of interest on *short-term* U.S. Treasury securities in an inflation-free world. The real risk-free rate is not static—it changes over time depending on economic conditions, especially (1) on the rate of return corporations and other borrowers expect to earn on productive assets and (2) on people's time preferences for current versus future consumption.[10]

In addition to its regular bond offerings, in 1997 the U.S. Treasury began issuing **indexed bonds,** with payments linked to inflation. These bonds are called **TIPS,** short for **Treasury Inflation-Protected Securities.** Because the payments (including the principal) are tied to inflation, the yield on a TIPS is a good estimate of the risk-free rate. In June 2006, the TIPS with a 7-month remaining maturity had a 2.64% yield. This is a pretty good estimate of the real risk-free rate, r*, although ideally we would prefer a TIPS with an even shorter time until maturity. We will have more to say about how to use TIPS when we discuss the inflation premium in the next section. For details on how TIPS are adjusted, see ***Web Extension 5B*** at the textbook's Web site.

SELF-TEST

What security provides a good estimate of the real risk-free rate?

5.9 The Inflation Premium (IP)

Inflation has a major effect on interest rates because it erodes the purchasing power of the dollar and lowers the real rate of return on investments. To illustrate, suppose you saved $1,000 and invested it in a Treasury bill that matures in 1 year and pays a 5% interest rate. At the end of the year, you will receive $1,050—your original $1,000 plus $50 of interest. Now suppose the inflation rate during the year is 10%, and it affects all items equally. If gas had cost $1 per gallon at the beginning of the year, it would cost $1.10 at the end of the year. Therefore, your $1,000 would have bought $1,000/$1 = 1,000 gallons at the beginning of the year, but only $1,050/$1.10 = 955 gallons at the end. In *real terms*, you would be worse off—you would receive $50 of interest, but it would not be sufficient to offset inflation. You would thus be better off buying 1,000 gallons of gas (or some other storable asset) than buying the Treasury bill.

Investors are well aware of inflation's effects on interest rates, so when they lend money, they build in an **inflation premium (IP)** equal to the average expected inflation rate over the life of the security. For a short-term, default-free U.S. Treasury bill, the actual interest rate charged, $r_{T\text{-bill}}$, would be the real risk-free rate, r*, plus the inflation premium (IP):

$$r_{T\text{-bill}} = r_{RF} = r^* + IP.$$

[10]The real rate of interest as discussed here is different from the *current* real rate as often discussed in the press. The current real rate is often estimated as the current interest rate minus the current (or most recent) inflation rate, while the real rate, as used here (and in the fields of finance and economics generally) without the word "current," is the current interest rate minus the *expected future* inflation rate over the life of the security. For example, suppose the current quoted rate for a one-year Treasury bill is 5%, inflation during the latest year was 2%, and inflation expected for the coming year is 4%. Then the *current* real rate would be approximately 5% − 2% = 3%, but the *expected* real rate would be approximately 5% − 4% = 1%.

Therefore, if the real short-term risk-free rate of interest were r* = 0.6%, and if inflation were expected to be 1.0% (and hence IP = 1.0%) during the next year, then the quoted rate of interest on 1-year T-bills would be 0.6% + 1.0% = 1.6%.

It is important to note that the inflation rate built into interest rates is *the inflation rate expected in the future*, not the rate experienced in the past. Thus, the latest reported figures might show an annual inflation rate of 2%, but that is for the *past* year. If people on average expect a 6% inflation rate in the future, then 6% would be built into the current interest rate.

Note also that the inflation rate reflected in the quoted interest rate on any security is the *average rate of inflation expected over the security's life*. Thus, the inflation rate built into a 1-year bond is the expected inflation rate for the next year, but the inflation rate built into a 30-year bond is the average rate of inflation expected over the next 30 years. If I_t is the expected inflation during year t, the inflation premium for an N-year bond's yield can be approximated as

$$IP_N = \frac{I_1 + I_2 + \cdots + I_N}{N}. \tag{5-5}$$

For example, if investors expect inflation to average 3% during Year 1 and 5% during Year 2, then the inflation premium built into a 2-year bond's yield can be approximated by

$$IP_2 = \frac{I_1 + I_2}{2} = \frac{3\% + 5\%}{2} = 4\%.$$

In the previous section we saw that the yield on an inflation-indexed Treasury bond (TIPS) is a good estimate of the real interest rate. We can also use TIPS to estimate inflation premiums. For example, in June 2006, the yield on a 5-year nonindexed T-bond was 5.18% and the yield on a 5-year TIPS was 2.50%. Thus, the 5-year inflation premium was 5.18% − 2.50% = 2.68%, implying that investors expected inflation to average 2.68% over the next 5 years.[11] Similarly, the rate on a 22-year nonindexed T-bond was 5.33% and the rate on a 22-year indexed T-bond was 2.56%. Thus, the long-term inflation premium was approximately 5.33% − 2.56% = 2.77%, implying that investors expected inflation to average 2.77% over the next three decades.[12] These calculations are summarized below:

	Maturity	
	5 Years	22 Years
Nonindexed U.S. Treasury bond	5.18%	5.33%
TIPS	2.50	2.56
Inflation premium	2.68%	2.77%

Expectations for future inflation are closely, but not perfectly, correlated with rates experienced in the recent past. Therefore, if the inflation rate reported for last month increases, people often raise their expectations for future inflation, and this change in expectations will cause an increase in interest rates.

[11] To be theoretically precise, we should use a *geometric average* by solving the following equation: $(1 + IP)^5(1.0518)^5 = 1.0250^5$. Solving for IP gives IP = 2.55%, which is very close to our approximation.

[12] There are several other sources for the estimated inflation premium. The Congressional Budget Office regularly updates the estimates of inflation that it uses in its forecasted budgets; see **http://www.cbo.gov/**, select Current Economic Projections. A second source is the University of Michigan's Institute for Social Research, which regularly polls consumers regarding their expectations for price increases during the next year; see **http://www.isr.umich.edu/src/projects.html,** select the Surveys of Consumers, and then select the table for Expected Change in Prices. We prefer using inflation premiums derived from indexed and nonindexed Treasury securities, as described in the text, since these are based on how investors actually spend their money, not on theoretical models or opinions.

Note that Germany, Japan, and Switzerland have, over the past several years, had lower inflation rates than the United States, so their interest rates have generally been lower than ours. South Africa and most South American countries have experienced higher inflation, and that is reflected in their interest rates.

SELF-TEST

Explain how a TIPS and a nonindexed Treasury security can be used to estimate the inflation premium. The yield on a 15-year TIPS is 3% and the yield on a 15-year Treasury bond is 5%. What is the inflation premium for a 15-year security? (2%)

5.10 The Nominal, or Quoted, Risk-Free Rate of Interest, r_{RF}

The **nominal,** or **quoted, risk-free rate, r_{RF},** is the real risk-free rate plus a premium for expected inflation: $r_{RF} = r^* + IP$. To be strictly correct, the risk-free rate should mean the interest rate on a totally risk-free security—one that has no risk of default, no maturity risk, no liquidity risk, no risk of loss if inflation increases, and no risk of any other type. There is no such security, so there is no observable truly risk-free rate. If the term "risk-free rate" is used without either the modifier "real" or the modifier "nominal," people generally mean the quoted (nominal) rate, and we will follow that convention in this book. Therefore, when we use the term "risk-free rate, r_{RF}," we mean the nominal risk-free rate, which includes an inflation premium equal to the average expected inflation rate over the life of the security. In general, we use the T-bill rate to approximate the short-term risk-free rate, and the T-bond rate to approximate the long-term risk-free rate (even though it also includes a maturity premium). So, whenever you see the term "risk-free rate," assume that we are referring either to the quoted U.S. T-bill rate or to the quoted T-bond rate.

Since $r_{RF} = r^* + IP$, we can rewrite Equation 5-4 as follows:

$$\text{Nominal, or quoted, rate} = r_d = r_{RF} + DRP + LP + MRP. \quad (5\text{-}6)$$

Therefore, when discussing the rate on a bond, we often start with the short-term risk-free rate and make adjustments for the default risk premium, the liquidity premium, and the maturity risk premium.

SELF-TEST

What security is a good approximation of the nominal risk-free rate?

5.11 The Default Risk Premium (DRP)

If the issuer defaults on a payment, investors receive less than the promised return on the bond. The quoted interest rate includes a default risk premium (DRP)—the greater the default risk, the higher the bond's yield to maturity.[13] The default risk on Treasury securities is zero, but default risk can be substantial for corporate and municipal bonds. In this section we consider some issues related to default risk.

[13]Suppose two bonds have the same promised cash flows, coupon rate, maturity, liquidity, and inflation exposure, but one bond has more default risk than the other. Investors will naturally pay less for the bond with the greater chance of default. As a result, bonds with higher default risk will have higher interest rates.

Bond Contract Provisions That Influence Default Risk

Default risk is affected by both the financial strength of the issuer and the terms of the bond contract, especially whether collateral has been pledged to secure the bond. Several types of contract provisions are discussed below.

Bond Indentures An **indenture** is a legal document that spells out the rights of both bondholders and the issuing corporation, and a **trustee** is an official (usually a bank) who represents the bondholders and makes sure the terms of the indenture are carried out. The indenture may be several hundred pages in length, and it will include **restrictive covenants** that cover such points as the conditions under which the issuer can pay off the bonds prior to maturity, the levels at which certain ratios must be maintained if the company is to issue additional debt, and restrictions against the payment of dividends unless earnings meet certain specifications.

The Securities and Exchange Commission (1) approves indentures and (2) makes sure that all indenture provisions are met before allowing a company to sell new securities to the public. A firm will have different indentures for each of the major types of bonds it issues, but a single indenture covers all bonds of the same type. For example, one indenture will cover a firm's first mortgage bonds, another its debentures, and a third its convertible bonds.

Mortgage Bonds Under a **mortgage bond,** the corporation pledges certain assets as security for the bond. To illustrate, in 2007 Billingham Corporation needed $10 million to build a major regional distribution center. Bonds in the amount of $4 million, secured by a *first mortgage* on the property, were issued. (The remaining $6 million was financed with equity capital.) If Billingham defaults on the bonds, the bondholders can foreclose on the property and sell it to satisfy their claims.

If Billingham were to choose, it could issue *second mortgage bonds* secured by the same $10 million of assets. In the event of liquidation, the holders of these second mortgage bonds would have a claim against the property, but only after the first mortgage bondholders had been paid off in full. Thus, second mortgages are sometimes called *junior mortgages*, because they are junior in priority to the claims of *senior mortgages*, or *first mortgage bonds*.

All mortgage bonds are subject to an indenture. The amount of new bonds that can be issued is virtually always limited to a specified percentage of the firm's total "bondable property," which generally includes all land, plant, and equipment.

Debentures and Subordinated Debentures A **debenture** is an unsecured bond, and as such it provides no lien against specific property as security for the obligation. Debenture holders are, therefore, general creditors whose claims are protected by property not otherwise pledged. In practice, the use of debentures depends both on the nature of the firm's assets and on its general credit strength. Extremely strong companies often use debentures; they simply do not need to put up property as security for their debt. Debentures are also issued by weak companies that have already pledged most of their assets as collateral for mortgage loans. In this latter case, the debentures are quite risky, and they will bear a high interest rate.

The term *subordinate* means "below," or "inferior to," and, in the event of bankruptcy, subordinated debt has claims on assets only after senior debt has been paid off. **Subordinated debentures** may be subordinated either to designated notes payable (usually bank loans) or to all other debt. In the event of liquidation or reorganization, holders of subordinated debentures cannot be paid until all senior debt, as named in the debentures' indentures, has been paid.

Table 5-1

Moody's and S&P Bond Ratings

	Investment Grade				Junk Bonds			
Moody's	Aaa	Aa	A	Baa	Ba	B	Caa	C
S&P	AAA	AA	A	BBB	BB	B	CCC	D

Note: Both Moody's and S&P use "modifiers" for bonds rated below triple-A. S&P uses a plus and minus system; thus, A+ designates the strongest A-rated bonds and A− the weakest. Moody's uses a 1, 2, or 3 designation, with 1 denoting the strongest and 3 the weakest; thus, within the double-A category, Aa1 is the best, Aa2 is average, and Aa3 is the weakest.

Development Bonds Some companies may be in a position to benefit from the sale of either **development bonds** or **pollution control bonds.** State and local governments may set up both *industrial development agencies* and *pollution control agencies*. These agencies are allowed, under certain circumstances, to sell **tax-exempt bonds,** then to make the proceeds available to corporations for specific uses deemed (by Congress) to be in the public interest. Thus, an industrial development agency in Florida might sell bonds to provide funds for a paper company to build a plant in the Florida Panhandle, where unemployment is high. Similarly, a Detroit pollution control agency might sell bonds to provide Ford with funds to be used to purchase pollution control equipment. In both cases, the income from the bonds would be tax exempt to the holders, so the bonds would sell at relatively low interest rates. Note, however, that these bonds are guaranteed by the corporation that will use the funds, not by a governmental unit, so their rating reflects the credit strength of the corporation using the funds.

Municipal Bond Insurance Municipalities can have their bonds insured, which means that an insurance company guarantees to pay the coupon and principal payments should the issuer default. This reduces risk to investors, who will thus accept a lower coupon rate for an insured bond vis-à-vis an uninsured one. Even though the municipality must pay a fee to get its bonds insured, its savings due to the lower coupon rate often make insurance cost effective. Keep in mind that the insurers are private companies, and the value added by the insurance depends on the creditworthiness of the insurer. However, the larger ones are strong companies, and their own ratings are AAA. Therefore, the bonds they insure are also rated AAA, regardless of the credit strength of the municipal issuer. Bond ratings are discussed in the next section.

Bond Ratings

Since the early 1900s, bonds have been assigned quality ratings that reflect their probability of going into default. The three major rating agencies are Moody's Investors Service (Moody's), Standard & Poor's Corporation (S&P), and Fitch Investors Service. Moody's and S&P's rating designations are shown in Table 5-1.[14] The triple- and double-A bonds are extremely safe. Single-A and triple-B bonds are also strong enough to be called **investment grade bonds,** and they are the

[14]In the discussion to follow, reference to the S&P code is intended to imply the Moody's and Fitch's codes as well. Thus, triple-B bonds mean both BBB and Baa bonds; double-B bonds mean both BB and Ba bonds; and so on.

lowest-rated bonds that many banks and other institutional investors are permitted by law to hold. Double-B and lower bonds are speculative, or **junk bonds.** These bonds have a significant probability of going into default. A later section discusses junk bonds in more detail.

Bond ratings are based on both qualitative and quantitative factors, some of which are listed below:

1. *Various ratios*, including the debt ratio, the times-interest-earned ratio, and the EBITDA coverage ratio. The better the ratios, the higher the rating.
2. *Mortgage provisions:* Is the bond secured by a mortgage? If it is, and if the property has a high value in relation to the amount of bonded debt, the bond's rating is enhanced.
3. *Subordination provisions:* Is the bond subordinated to other debt? If so, it will be rated at least one notch below the rating it would have if it were not subordinated. Conversely, a bond with other debt subordinated to it will have a somewhat higher rating.
4. *Guarantee provisions:* Some bonds are guaranteed by other firms. If a weak company's debt is guaranteed by a strong company (usually the weak company's parent), the bond will be given the strong company's rating.
5. *Sinking fund:* Does the bond have a sinking fund to ensure systematic repayment? This feature is a plus factor to the rating agencies.
6. *Maturity:* Other characteristics the same, a bond with a shorter maturity will be judged less risky than a longer-term bond, and this will be reflected in the ratings.
7. *Stability:* Are the issuer's sales and earnings stable?
8. *Regulation:* Is the issuer regulated, and could an adverse regulatory climate cause the company's economic position to decline? Regulation is especially important for utilities and telephone companies.
9. *Antitrust:* Are any antitrust actions pending against the firm that could erode its position?
10. *Overseas operations:* What percentage of the firm's sales, assets, and profits are from overseas operations, and what is the political climate in the host countries?
11. *Environmental factors:* Is the firm likely to face heavy expenditures for pollution control equipment?
12. *Product liability:* Are the firm's products safe? The tobacco companies today are under pressure, and so are their bond ratings.
13. *Pension liabilities:* Does the firm have unfunded pension liabilities that could pose a future problem?
14. *Labor unrest:* Are there potential labor problems on the horizon that could weaken the firm's position? As this is written, a number of airlines face this problem, and it has caused their ratings to be lowered.
15. *Accounting policies:* If a firm uses relatively conservative accounting policies, its reported earnings will be of "higher quality" than if it uses less conservative procedures. Thus, conservative accounting policies are a plus factor in bond ratings.

Representatives of the rating agencies have consistently stated that no precise formula is used to set a firm's rating; all the factors listed, plus others, are taken into account, but not in a mathematically precise manner. Nevertheless, as we see in Table 5-2, there is a strong correlation between bond ratings and many of the ratios

Table 5-2

Bond Rating Criteria: Median Financial Ratios for Different Bond Rating Classifications

Ratios	AAA	AA	A	BBB	BB	B	CCC
EBIT interest coverage (EBIT/Interest)	23.83	13.63	6.93	4.23	2.33	0.93	0.43
EBITDA interest coverage (EBITDA/Interest)	25.33	17.13	9.43	5.93	3.13	1.63	0.93
Funds from operations/Total debt	167.8%	77.5%	43.2%	34.6%	20.0%	10.1%	2.9%
Free operating cash flow/Total debt	104.1%	41.1%	25.4%	16.9%	7.9%	2.6%	20.9%
Total debt/EBITDA	0.23	1.13	1.73	2.43	3.83	5.63	7.43
Return on capital	35.1%	26.9%	16.8%	13.4%	10.3%	6.7%	2.3%
Total debt/Total capital	6.23%	34.83%	39.83%	45.63%	57.23%	74.23%	101.23%

Source: Standard & Poor's 2004 Corporate Ratings Criteria, October 28, 2004. For ratio definitions and updates, go to **http://www.standardandpoors.com;** select Credit Ratings, then Industrials (under Browse By Sector), then Criteria and Definitions, then the Corporate Criteria Book. Scroll down until you come to the Ratings and Ratios; Ratio Medians; Ratio Guidelines link. The ratios require a free registration.

described in Chapter 4. Not surprisingly, companies with lower debt ratios, higher cash flow to debt, higher returns on capital, higher EBITDA interest coverage ratios, and EBIT interest coverage ratios typically have higher bond ratings.

Bond Ratings and the Default Risk Premium

Bond ratings are important both to firms and to investors. First, most bonds are purchased by institutional investors rather than individuals, and many institutions are restricted to investment-grade securities. Thus, if a firm's bonds fall below BBB, it will have a difficult time selling new bonds because many potential purchasers will not be allowed to buy them. Second, many bond covenants stipulate that the coupon rate on the bond automatically increases if the rating falls below a specified level. Third, because a bond's rating is an indicator of its default risk, the rating has a direct, measurable influence on the bond's yield. A **bond spread** is the difference between a bond's yield and the yield on some other security of the same maturity, as shown in Table 5-3. Unless specified differently, the term "spread" generally means the difference between a bond's yield and the yield on a similar maturity Treasury bond.

Notice in Column (1) of Table 5-3 that yields increase monotonically as ratings become lower. In other words, investors demand higher required rates of return, r_d, as risk increases. Column (2) shows the spread of each bond's yield above that of the U.S. Treasury bond. Notice the AAA spread is about 1.01% above a T-bond. The two bonds are very similar except with respect to default risk and liquidity (which we discuss in the next section). Because AAA bonds often have good liquidity, this spread is a pretty good estimate of the default risk premium for AAA bonds. Even though lower-rated bonds usually have less liquidity (and therefore higher liquidity premiums), the spread between a bond and a Treasury bond of a similar maturity is often used as an approximation of the default risk premium for the bond. Therefore, it would be reasonable to estimate the default risk premium for a BBB bond as about 1.35%.

Table 5-3 Bond Spreads

Long-Term Bonds	Yield (1)	Spread above a: T-Bond (2)	AAA (3)	BBB (4)
Investment grade:				
U.S. Treasury	5.25%			
AAA	6.26	1.01%		
AA	6.42	1.17	0.16%	
A	6.54	1.29	0.28	
BBB	6.60	1.35	0.34	
Junk bonds:				
BB	7.80	2.55	1.54	1.20%
B	8.42	3.17	2.16	1.82
CCC	10.53	5.28	4.27	3.93

Source Adapted from Yahoo!, June 23, 2006.

Note: The spreads in Column (2) are found by taking the yields in Column (1) and subtracting the yield on the U.S. Treasury bond. The spreads in Column (3) are found by taking the yields in Column (1) and subtracting the yield on the AAA bond. The spreads in Column (4) are found by taking the yields in Column (1) and subtracting the yield on the BBB bond.

For updates, find the yields for AAA, AA, and A bonds at **http://finance.yahoo.com/bonds/composite_bond_rates.** Representative yields for BBB, BB, B, and CCC bonds can be found using the bond screener at **http://screen.yahoo .com/bonds.html.** Also, Vanguard has a table of yields for selected bonds at **http://flagship2.vanguard.com/VGApp/hnw/FundsBondsMarketSummaryTable.**

Just as we talk about the spread of a bond relative to a T-bond, we can also talk about the spread between any two corporate bonds. For example, Column (3) shows the spreads above a AAA bond and Column (4) shows the spreads above a BBB bond. Notice that spreads increase dramatically for junk bonds, which reflects their risk and the fact that institutional investors are not allowed to hold junk bonds.

Not only do spreads vary with the rating of the security, but they vary with respect to maturity. For example, a 5-year AAA bond had a spread of only 0.55% while the 20-year AAA bond in Table 5-3 had a spread of 1.01%. As this illustrates, spreads increase as maturity increases. This should make sense. If a bond matures soon, investors are able to forecast the company's performance fairly well. But if a bond has a long time until it matures, investors have a difficult time forecasting the likelihood that the company will fall into financial distress, so investors demand a higher required return.

Spreads also vary over time. As shown in Column (2), the spread of a AAA bond was about 1.01% in June 2006. This is close to the historical average of about 1%. But at times the spread has fallen to 0.20% and at times it has risen to 2.06%. As explained in Chapter 1, investors are risk averse, and their risk aversion can change over time. As investors become more risk averse, spreads increase. For example, spreads were quite large after the 9/11/2001 terrorist attacks. In contrast, spreads were quite narrow in the early 1990s as the U.S. economy was beginning a long period of growth.

As you might expect, changes in a firm's bond rating affect the default risk premium on its debt and the ability of the firm to borrow long-term capital. Rating agencies review outstanding bonds on a periodic basis, occasionally upgrading or downgrading a bond as a result of its issuer's changed circumstances. For example,

See the Standard & Poor's Web site, **http://www.standardandpoors.com,** or the Moody's, Web site, **http://www.moodys.com,** for updates on changes in ratings.

Verizon Wireless's long-term debt was upgraded to an A2 by Moody's in June 2006. Moody's stated that the reason was strong operating results and growing cash flows.

Ratings agencies generally do a good job of measuring the average credit risk of bonds, and they do their best to change ratings whenever they perceive a change in credit quality. At the same time, it is important to understand that ratings do not adjust immediately to changes in credit quality, and in some cases there can be a considerable lag between a change in credit quality and a change in rating. For example, the rating agencies were caught off guard by Enron's rapid decline. Enron declared bankruptcy on a Sunday in December 2001, and the preceding Friday its bonds still carried an investment-grade rating.

SELF-TEST

Differentiate between mortgage bonds and debentures.
Name the major rating agencies, and list some factors that affect bond ratings.
What is a bond spread?
How do bond ratings affect the default risk premium?
A 10-year T-bond has a yield of 6%. A corporate bond with a rating of AA has a yield of 4.5%. If the corporate bond has excellent liquidity, what is an estimate of the corporate bond's default risk premium? (1.5%)

5.12 The Liquidity Premium (LP)

A "liquid" asset can be converted to cash quickly and at a "fair market value." Financial assets are generally more liquid than real assets. Because liquidity is important, investors include **liquidity premiums (LPs)** when market rates of securities are established. Although it is difficult to accurately measure liquidity premiums, a differential of at least two and probably four or five percentage points exists between the least liquid and the most liquid financial assets of similar default risk and maturity. Corporate bonds issued by small companies are traded less frequently than those issued by large companies, so small company bonds tend to have a higher liquidity premium.

SELF-TEST

Which bond usually will have a higher liquidity premium, one issued by a large company or one issued by a small company?

5.13 The Maturity Risk Premium (MRP)

All bonds, even Treasury bonds, are exposed to two additional sources of risk: interest rate risk and reinvestment risk. The net effect of these two sources of risk upon a bond's yield is called the **maturity risk premium, MRP.** The following sections explain how interest rate risk and reinvestment risk affect a bond's yield.

Interest Rate Risk

Interest rates go up and down over time, and an increase in interest rates leads to a decline in the value of outstanding bonds. This risk of a decline in bond values due to rising interest rates is called **interest rate risk.** To illustrate, suppose you bought some 10% MicroDrive bonds at a price of $1,000, and interest rates in the following year rose to 15%. As we saw earlier, the price of the bonds would fall to

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For more on bond risk, including duration analysis, see ***Web Extension 5C*** at the textbook's Web site.

$713.78, so you would have a loss of $286.22 per bond.[15] Interest rates can and do rise, and rising rates cause a loss of value for bondholders. Thus, people or firms who invest in bonds are exposed to risk from changing interest rates.

One's exposure to interest rate risk is higher on bonds with long maturities than on those maturing in the near future.[16] This point can be demonstrated by showing how the value of a 1-year bond with a 10% annual coupon fluctuates with changes in r_d, and then comparing these changes with those on a 25-year bond. The 1-year bond's value for $r_d = 5\%$ is shown below:

Inputs:	1	5		100	1000
	N	I/YR	PV	PMT	FV
Output (Bond Value):			= −1047.62		

Using either a calculator or a spreadsheet, you could calculate the bond values for a 1-year and 25-year bond at several current market interest rates; these results are summarized and plotted in Figure 5-3. Note how much more sensitive the price of the 25-year bond is to changes in interest rates. At a 10% interest rate, both the 25-year and the 1-year bonds are valued at $1,000. When rates rise to 15%, the 25-year bond falls to $676.79, but the 1-year bond falls only to $956.52.

For bonds with similar coupons, this differential sensitivity to changes in interest rates always holds true—the longer the maturity of the bond, the more its price changes in response to a given change in interest rates. Thus, even if the risk of default on two bonds is exactly the same, the one with the longer maturity is exposed to more risk from a rise in interest rates.

The explanation for this difference in interest rate risk is simple. Suppose you bought a 25-year bond that yielded 10%, or $100 a year. Now suppose interest rates on comparable-risk bonds rose to 15%. You would be stuck with only $100 of interest for the next 25 years. On the other hand, had you bought a 1-year bond, you would have a low return for only 1 year. At the end of the year, you would get your $1,000 back, and you could then reinvest it and receive a 15% return ($150) for the next year. Thus, interest rate risk reflects the length of time one is committed to a given investment.

Reinvestment Rate Risk

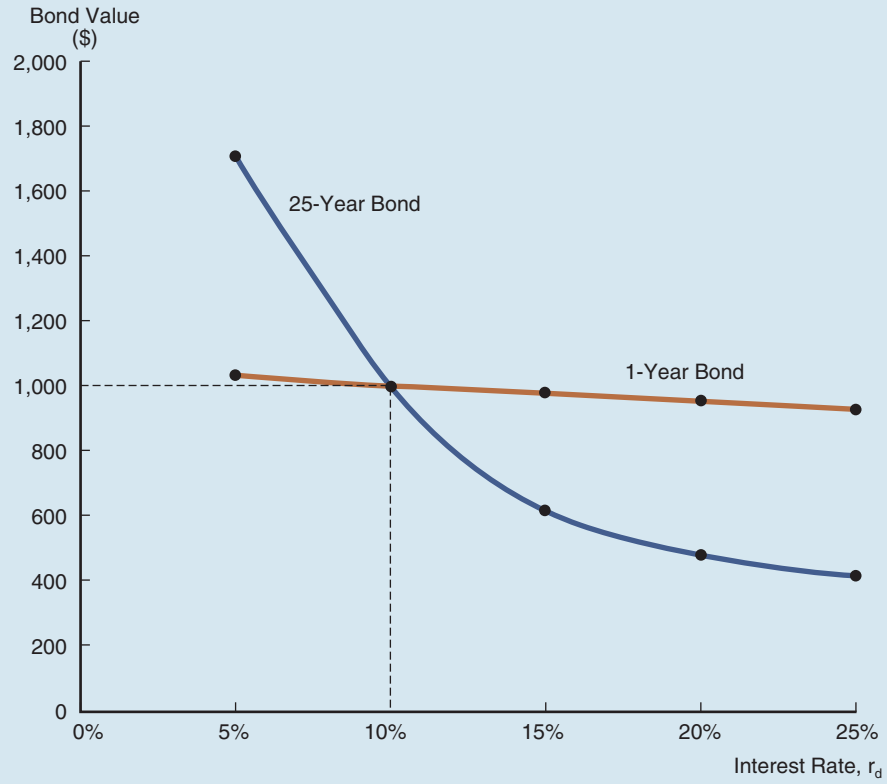
As we saw in the preceding section, an *increase* in interest rates will hurt bondholders because it will lead to a decline in the value of a bond portfolio. But can a *decrease* in interest rates also hurt bondholders? The answer is yes, because if interest rates fall, a bondholder will probably suffer a reduction in his or her income. For example, consider a retiree who has a portfolio of bonds and lives off the income they produce. The bonds, on average, have a coupon rate of 10%. Now

[15]You would have an *accounting* (and tax) loss only if you sold the bond; if you held it to maturity, you would not have such a loss. However, even if you did not sell, you would still have suffered a *real economic loss in an opportunity cost sense* because you would have lost the opportunity to invest at 15% and would be stuck with a 10% bond in a 15% market. In an economic sense, "paper losses" are just as bad as realized accounting losses.

[16]Actually, a bond's maturity and coupon rate both affect interest rate risk. Low coupons mean that most of the bond's return will come from repayment of principal, whereas on a high coupon bond with the same maturity, more of the cash flows will come in during the early years due to the relatively large coupon payments. A measurement called "duration," which finds the average number of years the bond's PV of cash flows remains outstanding, has been developed to combine maturity and coupons. A zero coupon bond, which has no interest payments and whose payments all come at maturity, has a duration equal to the bond's maturity. Coupon bonds all have durations that are shorter than maturity, and the higher the coupon rate, the shorter the duration. Bonds with longer duration are exposed to more interest rate risk. *Excel*'s DURATION function provides an easy way to calculate a bond's duration. See ***Web Extension 5C*** and ***FM12 Ch 05 Tool Kit.xls*** for more on duration.

Figure 5-3

Value of Long- and Short-Term 10% Annual Coupon Bonds at Different Market Interest Rates



Current Market Interest Rate, r_d	Value of: 1-Year Bond	25-Year Bond
5%	$1,047.62	$1,704.70
10	1,000.00	1,000.00
15	956.52	676.79
20	916.67	505.24
25	880.00	402.27

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See ***FM12 Ch 05 Tool Kit.xls*** for all calculations.

suppose interest rates decline to 5%. Many of the bonds will be called, and as calls occur, the bondholder will have to replace 10% bonds with 5% bonds. Even bonds that are not callable will mature, and when they do, they will have to be replaced with lower-yielding bonds. Thus, our retiree will suffer a reduction of income.

The risk of an income decline due to a drop in interest rates is called **reinvestment rate risk.** Reinvestment rate risk is obviously high on callable bonds. It is also high on short maturity bonds, because the shorter the maturity of a bond, the fewer the years when the relatively high old interest rate will be earned, and the sooner the funds will have to be reinvested at the new low rate. Thus, retirees whose primary holdings are short-term securities, such as bank CDs and short-term bonds, are hurt badly by a decline in rates, but holders of long-term bonds continue to enjoy their old high rates.

Comparing Interest Rate and Reinvestment Rate Risk: The Maturity Risk Premium

Note that interest rate risk relates to the *value* of the bonds in a portfolio, while reinvestment rate risk relates to the *income* the portfolio produces. If you hold long-term bonds, you will face a lot of interest rate risk because the value of your bonds will decline if interest rates rise, but you will not face much reinvestment rate risk, so your income will be stable. On the other hand, if you hold short-term bonds, you will not be exposed to much interest rate risk because the value of your portfolio will be stable, but you will be exposed to considerable reinvestment rate risk because your income will fluctuate with changes in interest rates. We see, then, that no fixed-rate bond can be considered totally riskless—even most Treasury bonds are exposed to both interest rate and reinvestment rate risk.[17]

Bond prices reflect the trading activities of the marginal investors, defined as those who trade often enough and with large enough sums to determine bond prices. Although one particular investor might be more averse to reinvestment risk than to interest rate risk, the data suggest that the marginal investor is more averse to interest rate risk than to reinvestment risk. To induce the marginal investor to take on interest rate risk, long-term bonds must have a higher expected rate of return than short-term bonds. Holding all else equal, this additional return is the maturity risk premium (MRP).

SELF-TEST

Differentiate between interest rate risk and reinvestment rate risk.
To which type of risk are holders of long-term bonds more exposed? Short-term bondholders?
Assume that the real risk-free rate is $r^* = 3\%$ and the average expected inflation rate is 2.5% for the foreseeable future. The DRP and LP for a bond are each 1%, and the applicable MRP is 2%. What is the bond's yield? (9.5%)

5.14 The Term Structure of Interest Rates

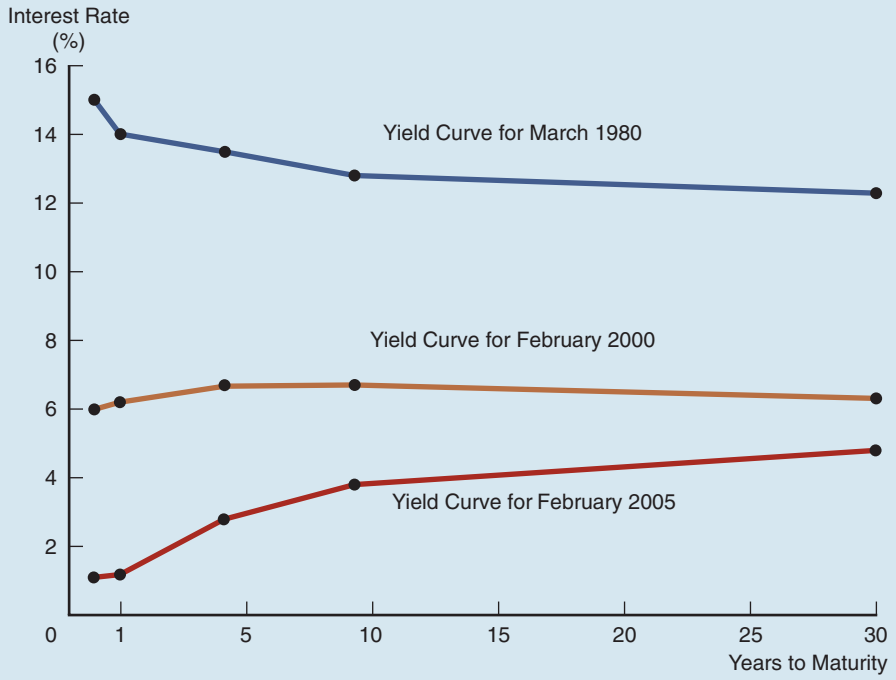
The **term structure of interest rates** describes the relationship between long- and short-term rates. The term structure is important both to corporate treasurers deciding whether to borrow by issuing long- or short-term debt and to investors who are deciding whether to buy long- or short-term bonds.

Interest rates for bonds with different maturities can be found in a variety of publications, including *The Wall Street Journal* and the *Federal Reserve Bulletin*, and on a number of Web sites, including Bloomberg, Yahoo!, CNN Financial, and the Federal Reserve Board. Using interest rate data from these sources, we can determine the term structure at any given point in time. For example, the tabular section below Figure 5-4 presents interest rates for different maturities on three different dates. The set of data for a given date, when plotted on a graph such as Figure 5-4, is called the **yield curve** for that date.

As the figure shows, the yield curve changes both in position and in slope over time. In March 1980, all rates were quite high because high inflation was expected. However, the rate of inflation was expected to decline, so the inflation premium (IP) was larger for short-term bonds than for long-term bonds. This caused short-

[17]Note, though, that indexed Treasury bonds are almost riskless, but they pay a relatively low real rate. Also, risks have not disappeared—they are simply transferred from bondholders to taxpayers.

Figure 5-4 U.S. Treasury Bond Interest Rates on Different Dates



	INTEREST RATE		
TERM TO MATURITY	MARCH 1980	FEBRUARY 2000	FEBRUARY 2005
6 months	15.0%	6.0%	2.9%
1 year	14.0	6.2	3.1
5 years	13.5	6.7	3.8
10 years	12.8	6.7	4.2
30 years	12.3	6.3	4.6

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term yields to be higher than long-term yields, resulting in a *downward-sloping* yield curve. By February 2000, inflation had indeed declined and thus all rates were lower. The yield curve had become **humped**—medium-term rates were higher than either short- or long-term rates. By February 2005, all rates had fallen below the 2000 levels, and because short-term rates had dropped below long-term rates, the yield curve was *upward sloping*. As we write this in June 2006, the term structure was virtually flat at about 5.2%.

Figure 5-4 shows yield curves for U.S. Treasury securities, but we could have constructed curves for bonds issued by GE, IBM, Delta Airlines, or any other company that borrows money over a range of maturities. Had we constructed such corporate yield curves and plotted them on Figure 5-4, they would have been above those for Treasury securities because corporate yields include default risk premiums and somewhat higher liquidity premiums than Treasury bonds. However, the corporate yield curves would have had the same general shape as the Treasury curves. Also, the riskier the corporation, the higher its yield curve, so Delta, which is in bankruptcy, would have a higher yield curve than GE or IBM.

Historically, long-term rates are generally above short-term rates because of the maturity risk premium, so the yield curve usually slopes upward. For this reason, people often call an upward-sloping yield curve a **"normal" yield curve** and a yield curve that slopes downward an **inverted**, or **"abnormal" curve.** Thus, in Figure 5-4 the yield curve for March 1980 was inverted, while the yield curve in February 2005 was normal. As stated above, the February 2000 curve was humped.

A few academics and practitioners contend that large bond traders who buy and sell securities of different maturities each day dominate the market. According to this view, a bond trader is just as willing to buy a 30-year bond to pick up a short-term profit as to buy a 3-month security. Strict proponents of this view argue that the shape of the yield curve is therefore determined only by market expectations about future interest rates, a position that is called the **pure expectations theory,** or sometimes just the **expectations theory.** If this were true, then the maturity risk premium (MRP) would be zero, and long-term interest rates would simply be a weighted average of current and expected future short-term interest rates. See ***Web Extension 5D*** for a more detailed discussion of the expectations theory.

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Go to the textbook's Web site for a discussion of the expectations theory in ***Web Extension 5D.***

SELF-TEST

What is a yield curve, and what information would you need to draw this curve? Distinguish among the shapes of a "normal" yield curve, an "abnormal" curve, and a "humped" curve. If the interest rates on 1-, 5-, 20-, and 30-year bonds are 4%, 5%, 6%, and 7%, respectively, how would you describe the yield curve? If the rates were reversed, how would you describe it?

5.15 Junk Bonds

Prior to the 1980s, fixed-income investors such as pension funds and insurance companies were generally unwilling to buy risky bonds, so it was almost impossible for risky companies to raise capital in the public bond markets. Then, in the late 1970s, Michael Milken of the investment banking firm Drexel Burnham Lambert, relying on historical studies that showed that risky bonds yielded more than enough to compensate for their risk, began to convince institutional investors of the merits of purchasing risky debt. Thus was born the junk bond, a high-risk, high-yield bond issued to finance a leveraged buyout, a merger, or a troubled company.[18] For example, Public Service of New Hampshire financed construction of its troubled Seabrook nuclear plant with junk bonds, and junk bonds were used by Ted Turner to finance the development of CNN and Turner Broadcasting. In junk bond deals, the debt ratio is generally extremely high, so the bondholders must bear as much risk as stockholders normally would. The bonds' yields reflect this fact—a promised return of 25% per annum was required to sell some Public Service of New Hampshire bonds.

The emergence of junk bonds as an important type of debt is another example of how the investment banking industry adjusts to and facilitates new developments in capital markets. In the 1980s, mergers and takeovers increased dramatically. People like T. Boone Pickens and Henry Kravis thought that certain old-line, established companies were run inefficiently and were financed too conservatively, and they wanted to take these companies over and restructure them. Michael Milken and his staff at Drexel Burnham Lambert began an active campaign to persuade certain institutions (often S&Ls) to purchase high-yield bonds. Milken

[18]Another type of junk bond is one that was highly rated when it was issued but whose rating has fallen because the issuing corporation has fallen on hard times. Such bonds are called "fallen angels."

developed expertise in putting together deals that were attractive to the institutions yet feasible in the sense that projected cash flows were sufficient to meet the required interest payments. The fact that interest on the bonds was tax deductible, combined with the much higher debt ratios of the restructured firms, also increased after-tax cash flows and helped make the deals feasible.

The development of junk bond financing has done much to reshape the U.S. financial scene. The existence of these securities contributed to the loss of independence of Gulf Oil and hundreds of other companies, and it led to major shakeups in such companies as CBS, Union Carbide, and USX (formerly U.S. Steel). It also caused Drexel Burnham Lambert to leap from essentially nowhere in the 1970s to become the most profitable investment banking firm during the 1980s.

The phenomenal growth of the junk bond market was impressive, but controversial. In 1989, Drexel Burnham Lambert was forced into bankruptcy, and "junk bond king" Michael Milken, who had earned $500 million 2 years earlier, was sent to jail. Those events led to the collapse of the junk bond market in the early 1990s. Since then, however, the junk bond market has rebounded, and junk bonds are here to stay as an important form of corporate financing for many companies.

SELF-TEST What are junk bonds?

5.16 Bankruptcy and Reorganization

During recessions, bankruptcies normally rise, and recent recessions are no exception. The 2001 recession claimed WorldCom, Enron, Conseco, Global Crossing, United Airlines, Adelphia Communications, Pacific Gas and Electric, Kmart, and the FINOVA Group. The total assets of these companies, prior to filing for bankruptcy, were about $355 billion! The recessions didn't end in 2001, with some giant companies, such as Delta Airlines, recently filing for bankruptcy. A brief discussion of bankruptcy follows, while a more detailed discussion appears in Chapter 24.

When a business becomes *insolvent*, it does not have enough cash to meet its interest and principal payments. A decision must then be made whether to dissolve the firm through *liquidation* or to permit it to *reorganize* and thus stay alive. These issues are addressed in Chapters 7 and 11 of the federal bankruptcy statutes, and the final decision is made by a federal bankruptcy court judge.

The decision to force a firm to liquidate versus permit it to reorganize depends on whether the value of the reorganized firm is likely to be greater than the value of the firm's assets if they are sold off piecemeal. In a reorganization, the firm's creditors negotiate with management on the terms of a potential reorganization. The reorganization plan may call for a *restructuring* of the firm's debt, in which case the interest rate may be reduced, the term to maturity lengthened, or some of the debt may be exchanged for equity. The point of the restructuring is to reduce the financial charges to a level that the firm's cash flows can support. Of course, the common stockholders also have to give up something—they often see their position diluted as a result of additional shares being given to debtholders in exchange for accepting a reduced amount of debt principal and interest. In fact, the original common stockholders often end up with nothing. A trustee may be appointed by the court to oversee the reorganization, but generally the existing management is allowed to retain control.

Liquidation occurs if the company is deemed to be too far gone to be saved—if it is worth more dead than alive. If the bankruptcy court orders a liquidation,

assets are sold off and the cash obtained is distributed as specified in Chapter 7 of the Bankruptcy Act. Here is the priority of claims:

1. Past-due property taxes.
2. Secured creditors are entitled to the proceeds from the sale of the specific property that was used to support their loans.
3. The trustee's costs of administering and operating the bankrupt firm are next in line.
4. Expenses incurred after bankruptcy was filed come next.
5. Wages due workers, up to a limit of $2,000 per worker, follow.
6. Claims for unpaid contributions to employee benefit plans are next. This amount, together with wages, cannot exceed $2,000 per worker.
7. Unsecured claims for customer deposits up to $900 per customer are next.
8. Federal, state, and local taxes due come next.
9. Unfunded pension plan liabilities are next although some limitations exist.
10. General unsecured creditors are tenth on the list.
11. Preferred stockholders come next, up to the par value of their stock.
12. Common stockholders are finally paid, if anything is left, which is rare.

The key points for you to know are (1) the federal bankruptcy statutes govern both reorganization and liquidation, (2) bankruptcies occur frequently, and (3) a priority of the specified claims must be followed when distributing the assets of a liquidated firm.

SELF-TEST

Differentiate between a Chapter 7 liquidation and a Chapter 11 reorganization.
List the priority of claims for the distribution of a liquidated firm's assets.

Summary

This chapter described the different types of bonds governments and corporations issue, explained how bond prices are established, and discussed how investors estimate the rates of return they can expect to earn. We also discussed the various types of risks that investors face when they buy bonds. The key concepts covered are summarized below.

- A **bond** is a long-term promissory note issued by a business or governmental unit. The issuer receives money in exchange for promising to make interest payments and to repay the principal on a specified future date.
- Some recent innovations in long-term financing include **zero coupon bonds**, which pay no annual interest, but are issued at a discount; **floating-rate debt**, whose interest payments fluctuate with changes in the general level of interest rates; and **junk bonds**, which are high-risk, high-yield instruments issued by firms that use a great deal of financial leverage.
- A **call provision** gives the issuing corporation the right to redeem the bonds prior to maturity under specified terms, usually at a price greater than the maturity value (the difference is a **call premium**). A firm will typically call a bond if interest rates fall substantially below the coupon rate.
- A **redeemable bond** gives the investor the right to sell the bond back to the issuing company at a previously specified price. This is a useful feature (for investors) if interest rates rise or if the company engages in unanticipated risky activities.

- A **sinking fund** is a provision that requires the corporation to retire a portion of the bond issue each year. The purpose of the sinking fund is to provide for the orderly retirement of the issue. A sinking fund typically requires no call premium.
- There are many different types of bonds with different sets of features. These include **convertible bonds, bonds with warrants, income bonds, purchasing power (indexed) bonds, mortgage bonds, debentures, subordinated debentures, junk bonds, development bonds,** and **insured municipal bonds**. The return required on each type of bond is determined by the bond's riskiness.
- The **value of a bond** is found as the present value of an **annuity** (the interest payments) plus the present value of a lump sum (the **principal**). The bond is evaluated at the appropriate periodic interest rate over the number of periods for which interest payments are made.
- The equation used to find the value of an annual coupon bond is

$$V_B = \sum_{t=1}^{N} \frac{INT}{(1 + r_d)^t} + \frac{M}{(1 + r_d)^N}.$$

- An adjustment to the formula must be made if the bond pays interest **semiannually:** divide INT and r_d by 2, and multiply N by 2.
- The return earned on a bond held to maturity is defined as the bond's **yield to maturity (YTM)**. If the bond can be redeemed before maturity, it is **callable**, and the return investors receive if it is called is defined as the **yield to call (YTC)**. The YTC is found as the present value of the interest payments received while the bond is outstanding plus the present value of the call price (the par value plus a call premium).
- The **nominal** (or **quoted**) **interest rate** on a debt security, $\mathbf{r_d}$, is composed of the real risk-free rate, r*, plus premiums that reflect inflation (IP), default risk (DRP), liquidity (LP), and maturity risk (MRP):

$$r_d = r^* + IP + DRP + LP + MRP.$$

- The **risk-free rate of interest,** $\mathbf{r_{RF}}$, is defined as the real risk-free rate, r*, plus an inflation premium, IP: $r_{RF} = r^* + IP$.
- The longer the maturity of a bond, the more its price will change in response to a given change in interest rates; this is called **interest rate risk**. However, bonds with short maturities expose investors to high **reinvestment rate risk**, which is the risk that income from a bond portfolio will decline because cash flows received from bonds will be rolled over at lower interest rates.
- Corporate and municipal bonds have **default risk**. If an issuer defaults, investors receive less than the promised return on the bond. Therefore, investors should evaluate a bond's default risk before making a purchase.
- Bonds are assigned **ratings** that reflect the probability of their going into default. The highest rating is AAA, and they go down to D. The higher a bond's rating, the lower its risk and therefore its interest rate.
- The relationship between the yields on securities and the securities' maturities is known as the **term structure of interest rates**, and the **yield curve** is a graph of this relationship.
- The shape of the yield curve depends on two key factors: (1) **expectations about future inflation** and (2) **perceptions about the relative risk of securities with different maturities**.
- The yield curve is normally **upward sloping**—this is called a **normal yield curve**. However, the curve can slope downward (an **inverted yield curve**) if the inflation rate is expected to decline. The yield curve also can be **humped**,

which means that interest rates on medium-term maturities are higher than rates on both short- and long-term maturities.

Questions

(5-1) Define each of the following terms:

a. Bond; Treasury bond; corporate bond; municipal bond; foreign bond
b. Par value; maturity date; coupon payment; coupon interest rate
c. Floating-rate bond; zero coupon bond; original issue discount bond (OID)
d. Call provision; redeemable bond; sinking fund
e. Convertible bond; warrant; income bond; indexed, or purchasing power, bond
f. Premium bond; discount bond
g. Current yield (on a bond); yield to maturity (YTM); yield to call (YTC)
h. Reinvestment risk; interest rate risk; default risk
i. Indentures; mortgage bond; debenture; subordinated debenture
j. Development bond; municipal bond insurance; junk bond; investment-grade bond
k. Real risk-free rate of interest, r*; nominal risk-free rate of interest, r_{RF}
l. Inflation premium (IP); default risk premium (DRP); liquidity; liquidity premium (LP)
m. Interest rate risk; maturity risk premium (MRP); reinvestment rate risk
n. Term structure of interest rates; yield curve
o. "Normal" yield curve; inverted ("abnormal") yield curve

(5-2) "The values of outstanding bonds change whenever the going rate of interest changes. In general, short-term interest rates are more volatile than long-term interest rates. Therefore, short-term bond prices are more sensitive to interest rate changes than are long-term bond prices." Is this statement true or false? Explain.

(5-3) The rate of return you would get if you bought a bond and held it to its maturity date is called the bond's yield to maturity. If interest rates in the economy rise after a bond has been issued, what will happen to the bond's price and to its YTM? Does the length of time to maturity affect the extent to which a given change in interest rates will affect the bond's price?

(5-4) If you buy a *callable* bond and interest rates decline, will the value of your bond rise by as much as it would have risen if the bond had not been callable? Explain.

(5-5) A sinking fund can be set up in one of two ways:

(1) The corporation makes annual payments to the trustee, who invests the proceeds in securities (frequently government bonds) and uses the accumulated total to retire the bond issue at maturity.
(2) The trustee uses the annual payments to retire a portion of the issue each year, either calling a given percentage of the issue by a lottery and paying a specified price per bond or buying bonds on the open market, whichever is cheaper.

Discuss the advantages and disadvantages of each procedure from the viewpoint of both the firm and its bondholders.

Self-Test Problem Solution Appears in Appendix A

(ST-1) Bond Valuation

The Pennington Corporation issued a new series of bonds on January 1, 1984. The bonds were sold at par ($1,000), had a 12% coupon, and matured in 30 years, on December 31, 2013. Coupon payments are made semiannually (on June 30 and December 31).

a. What was the YTM on January 1, 1984?
b. What was the price of the bonds on January 1, 1989, 5 years later, assuming that interest rates had fallen to 10%?
c. Find the current yield, capital gains yield, and total return on January 1, 1989, given the price as determined in part b.
d. On July 1, 2007, 5½ years before maturity, Pennington's bonds sold for $916.42. What were the YTM, the current yield, the capital gains yield, and the total return at that time?
e. Now, assume that you plan to purchase an outstanding Pennington bond on March 1, 2007, when the going rate of interest given its risk is 15.5%. How large a check must you write to complete the transaction? This is a hard question.

Problems Answers Appear in Appendix B

Easy Problems 1–6

(5-1) Bond Valuation with Annual Payments

Jackson Corporation's bonds have 12 years remaining to maturity. Interest is paid annually, the bonds have a $1,000 par value, and the coupon interest rate is 8%. The bonds have a yield to maturity of 9%. What is the current market price of these bonds?

(5-2) Yield to Maturity for Annual Payments

Wilson Wonders' bonds have 12 years remaining to maturity. Interest is paid annually, the bonds have a $1,000 par value, and the coupon interest rate is 10%. The bonds sell at a price of $850. What is their yield to maturity?

(5-3) Current Yield for Annual Payments

Heath Foods' bonds have 7 years remaining to maturity. The bonds have a face value of $1,000 and a yield to maturity of 8%. They pay interest annually and have a 9% coupon rate. What is their current yield?

(5-4) Determinant of Interest Rates

The real risk-free rate of interest is 4%. Inflation is expected to be 2% this year and 4% during the next 2 years. Assume that the maturity risk premium is zero. What is the yield on 2-year Treasury securities? What is the yield on 3-year Treasury securities?

(5-5) Default Risk Premium

A Treasury bond that matures in 10 years has a yield of 6%. A 10-year corporate bond has a yield of 9%. Assume that the liquidity premium on the corporate bond is 0.5%. What is the default risk premium on the corporate bond?

(5-6) Maturity Risk Premium

The real risk-free rate is 3%, and inflation is expected to be 3% for the next 2 years. A 2-year Treasury security yields 6.3%. What is the maturity risk premium for the 2-year security?

Intermediate Problems 7–20

(5-7) Bond Valuation with Semiannual Payments

Renfro Rentals has issued bonds that have a 10% coupon rate, payable semiannually. The bonds mature in 8 years, have a face value of $1,000, and a yield to maturity of 8.5%. What is the price of the bonds?

(5-8) Yield to Maturity and Call with Semiannual Payments

Thatcher Corporation's bonds will mature in 10 years. The bonds have a face value of $1,000 and an 8% coupon rate, paid semiannually. The price of the bonds is $1,100. The bonds are callable in 5 years at a call price of $1,050. What is their yield to maturity? What is their yield to call?

(5-9) Bond Valuation and Interest Rate Risk

The Garraty Company has two bond issues outstanding. Both bonds pay $100 annual interest plus $1,000 at maturity. Bond L has a maturity of 15 years, and Bond S a maturity of 1 year.

a. What will be the value of each of these bonds when the going rate of interest is (1) 5%, (2) 8%, and (3) 12%? Assume that there is only one more interest payment to be made on Bond S.
b. Why does the longer-term (15-year) bond fluctuate more when interest rates change than does the shorter-term bond (1 year)?

(5-10) Yield to Maturity and Required Returns

The Brownstone Corporation bonds have 5 years remaining to maturity. Interest is paid annually; the bonds have a $1,000 par value; and the coupon interest rate is 9%.

a. What is the yield to maturity at a current market price of (1) $829 or (2) $1,104?
b. Would you pay $829 for one of these bonds if you thought that the appropriate rate of interest was 12%—that is, if $r_d = 12\%$? Explain your answer.

(5-11) Yield to Call and Realized Rates of Return

Seven years ago, Goodwynn & Wolf Incorporated sold a 20-year bond issue with a 14% annual coupon rate and a 9% call premium. Today, G&W called the bonds. The bonds originally were sold at their face value of $1,000. Compute the realized rate of return for investors who purchased the bonds when they were issued and who surrender them today in exchange for the call price.

(5-12) Bond Yields and Rates of Return

A 10-year, 12% semiannual coupon bond with a par value of $1,000 may be called in 4 years at a call price of $1,060. The bond sells for $1,100. (Assume that the bond has just been issued.)

a. What is the bond's yield to maturity?
b. What is the bond's current yield?
c. What is the bond's capital gain or loss yield?
d. What is the bond's yield to call?

(5-13) Yield to Maturity and Current Yield

You just purchased a bond that matures in 5 years. The bond has a face value of $1,000 and has an 8% annual coupon. The bond has a current yield of 8.21%. What is the bond's yield to maturity?

(5-14) Current Yield with Semiannual Payments

A bond that matures in 7 years sells for $1,020. The bond has a face value of $1,000 and a yield to maturity of 10.5883%. The bond pays coupons semiannually. What is the bond's current yield?

(5-15) Yield to Call, Yield to Maturity, and Market Rates

Absolom Motors' 14% coupon rate, semiannual payment, $1,000 par value bonds that mature in 30 years are callable 5 years from now at a price of $1,050. The bonds sell at a price of $1,353.54, and the yield curve is flat. Assuming that interest rates in the economy are expected to remain at their current level, what is the best estimate of the nominal interest rate on new bonds?

(5-16) Interest Rate Sensitivity

A bond trader purchased each of the following bonds at a yield to maturity of 8%. Immediately after she purchased the bonds, interest rates fell to 7%. What is the percentage change in the price of each bond after the decline in interest rates? Fill in the following table:

	Price @ 8%	Price @ 7%	Percentage Change
10-year, 10% annual coupon	_____	_____	_____
10-year zero	_____	_____	_____
30-year zero	_____	_____	_____
$100 perpetuity	_____	_____	_____

(5-17) Bond Value as Maturity Approaches

An investor has two bonds in his portfolio. Each bond matures in 4 years, has a face value of $1,000, and has a yield to maturity equal to 9.6%. One bond, Bond C, pays an annual coupon of 10%; the other bond, Bond Z, is a zero coupon bond. Assuming that the yield to maturity of each bond remains at 9.6% over the next 4 years, what will be the price of each of the bonds at the following time periods? Fill in the following table:

t	Price of Bond C	Price of Bond Z
0	_____	_____
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____

(5-18) Determinants of Interest Rates

The real risk-free rate is 2%. Inflation is expected to be 3% this year, 4% next year, and then 3.5% thereafter. The maturity risk premium is estimated to be $0.0005 \times (t - 1)$, where t = number of years to maturity. What is the nominal interest rate on a 7-year Treasury security?

(5-19) Maturity Risk Premiums

Assume that the real risk-free rate, r*, is 3% and that inflation is expected to be 8% in Year 1, 5% in Year 2, and 4% thereafter. Assume also that all Treasury securities are highly liquid and free of default risk. If 2-year and 5-year Treasury notes both yield 10%, what is the difference in the maturity risk premiums (MRPs) on the two notes; that is, what is MRP_5 minus MRP_2?

(5-20) Inflation Risk Premiums

Due to a recession, the inflation rate expected for the coming year is only 3%. However, the inflation rate in Year 2 and thereafter is expected to be constant at some level above 3%. Assume that the real risk-free rate is $r^* = 2\%$ for all maturities and that there are no maturity premiums. If 3-year Treasury notes yield 2 percentage points more than 1-year notes, what inflation rate is expected after Year 1?

Challenging Problems 21–23

(5-21) Bond Valuation and Changes in Maturity and Required Returns

Suppose Hillard Manufacturing sold an issue of bonds with a 10-year maturity, a $1,000 par value, a 10% coupon rate, and semiannual interest payments.

a. Two years after the bonds were issued, the going rate of interest on bonds such as these fell to 6%. At what price would the bonds sell?
b. Suppose that, 2 years after the initial offering, the going interest rate had risen to 12%. At what price would the bonds sell?

c. Suppose that the conditions in part a existed—that is, interest rates fell to 6% 2 years after the issue date. Suppose further that the interest rate remained at 6% for the next 8 years. What would happen to the price of the bonds over time?

(5-22) Yield to Maturity and Yield to Call

Arnot International's bonds have a current market price of $1,200. The bonds have an 11% annual coupon payment, a $1,000 face value, and 10 years left until maturity. The bonds may be called in 5 years at 109% of face value (call price = $1,090).

a. What is the yield to maturity?
b. What is the yield to call, if they are called in 5 years?
c. Which yield might investors expect to earn on these bonds, and why?
d. The bond's indenture indicates that the call provision gives the firm the right to call them at the end of each year beginning in Year 5. In Year 5, they may be called at 109% of face value, but in each of the next 4 years the call percentage will decline by 1 percentage point. Thus, in Year 6 they may be called at 108% of face value, in Year 7 they may be called at 107% of face value, and so on. If the yield curve is horizontal and interest rates remain at their current level, when is the latest that investors might expect the firm to call the bonds?

(5-23) Determinants of Interest Rates

Suppose you and most other investors expect the inflation rate to be 7% next year, to fall to 5% during the following year, and then to remain at a rate of 3% thereafter. Assume that the real risk-free rate, r*, will remain at 2% and that maturity risk premiums on Treasury securities rise from zero on very short-term securities (those that mature in a few days) to a level of 0.2 percentage point for 1-year securities. Furthermore, maturity risk premiums increase 0.2 percentage point for each year to maturity, up to a limit of 1.0 percentage point on 5-year or longer-term T-notes and T-bonds.

a. Calculate the interest rate on 1-, 2-, 3-, 4-, 5-, 10-, and 20-year Treasury securities, and plot the yield curve.
b. Now suppose ExxonMobil's bonds, rated AAA, have the same maturities as the Treasury bonds. As an approximation, plot an ExxonMobil yield curve on the same graph with the Treasury bond yield curve. (Hint: Think about the default risk premium on ExxonMobil's long-term versus its short-term bonds.)
c. Now plot the approximate yield curve of Long Island Lighting Company, a risky nuclear utility.

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Spreadsheet Problem

(5-24) Build a Model: Bond Valuation

Start with the partial model in the file ***FM12 Ch 05 P24 Build a Model.xls*** from the textbook's Web site. Rework Problem 5-12. After completing parts a through d, answer the following related questions.

e. How would the price of the bond be affected by changing interest rates? (Hint: Conduct a sensitivity analysis of price to changes in the yield to maturity, which is also the going market interest rate for the bond. Assume that the

bond will be called if and only if the going rate of interest *falls below* the coupon rate. That is an oversimplification, but assume it anyway for purposes of this problem.)

f. Now assume that the date is October 25, 2007. Assume further that our 12%, 10-year bond was issued on July 1, 2007, is callable on July 1, 2011, at $1,060, will mature on June 30, 2017, pays interest semiannually (January 1 and July 1), and sells for $1,100. Use your spreadsheet to find (1) the bond's yield to maturity and (2) its yield to call.

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Cyberproblem

Please go to the textbook's Web site to access any Cyberproblems.

Mini Case

Sam Strother and Shawna Tibbs are vice presidents of Mutual of Seattle Insurance Company and codirectors of the company's pension fund management division. An important new client, the North-Western Municipal Alliance, has requested that Mutual of Seattle present an investment seminar to the mayors of the represented cities, and Strother and Tibbs, who will make the actual presentation, have asked you to help them by answering the following questions. Because the Boeing Company operates in one of the league's cities, you are to work Boeing into the presentation.

a. What are the key features of a bond?

b. What are call provisions and sinking fund provisions? Do these provisions make bonds more or less risky?

c. How is the value of any asset whose value is based on expected future cash flows determined?

d. How is the value of a bond determined? What is the value of a 10-year, $1,000 par value bond with a 10% annual coupon if its required rate of return is 10%?

e. (1) What would be the value of the bond described in part d if, just after it had been issued, the expected inflation rate rose by 3 percentage points, causing investors to require a 13% return? Would we now have a discount or a premium bond?

(2) What would happen to the bond's value if inflation fell, and r_d declined to 7%? Would we now have a premium or a discount bond?

(3) What would happen to the value of the 10-year bond over time if the required rate of return remained at 13%, or if it remained at 7%? [Hint: With a financial calculator, enter PMT, I/YR, FV, and N, and then change (override) N to see what happens to the PV as the bond approaches maturity.]

f. (1) What is the yield to maturity on a 10-year, 9%, annual coupon, $1,000 par value bond that sells for $887.00? That sells for $1,134.20? What does the fact that a bond sells at a discount or at a premium tell you about the relationship between r_d and the bond's coupon rate?
   (2) What are the total return, the current yield, and the capital gains yield for the discount bond? (Assume the bond is held to maturity and the company does not default on the bond.)

g. How does the equation for valuing a bond change if semiannual payments are made? Find the value of a 10-year, semiannual payment, 10% coupon bond if nominal $r_d = 13\%$.

h. Suppose a 10-year, 10%, semiannual coupon bond with a par value of $1,000 is currently selling for $1,135.90, producing a nominal yield to maturity of 8%. However, the bond can be called after 5 years for a price of $1,050.
   (1) What is the bond's *nominal yield to call (YTC)?*
   (2) If you bought this bond, do you think you would be more likely to earn the YTM or the YTC? Why?

i. Write a general expression for the yield on any debt security (r_d) and define these terms: real risk-free rate of interest (r*), inflation premium (IP), default risk premium (DRP), liquidity premium (LP), and maturity risk premium (MRP).

j. Define the nominal risk-free rate (r_{RF}). What security can be used as an estimate of r_{RF}?

k. Describe a way to estimate the inflation premium (IP) for a T-Year bond.

l. What is a bond spread and how is it related to the default risk premium? How are bond ratings related to default risk? What factors affect a company's bond rating?

m. What is *interest rate (or price) risk?* Which bond has more interest rate risk, an annual payment 1-year bond or a 10-year bond? Why?

n. What is *reinvestment rate risk?* Which has more reinvestment rate risk, a 1-year bond or a 10-year bond?

o. How are interest rate risk and reinvestment rate risk related to the maturity risk premium?

p. What is the term structure of interest rates? What is a yield curve?

q. At any given time, how would the yield curve facing a AAA-rated company compare with the yield curve for U.S. Treasury securities? At any given time, how would the yield curve facing a BB-rated company compare with the yield curve for U.S. Treasury securities?

r. Briefly describe bankruptcy law. If a firm were to default on the bonds, would the company be immediately liquidated? Would the bondholders be assured of receiving all of their promised payments?

Selected Additional Cases

The following cases from Textchoice, *Thomson Learning's online library, cover many of the concepts discussed in this chapter and are available at* ***http://www.textchoice2.com***.

Klein-Brigham Series:
Case 3, "Peachtree Securities, Inc. (B)."
Case 72, "Swan Davis."
Case 78, "Beatrice Peabody."

Brigham-Buzzard Series:
Case 3, "Powerline Network Corporation (Bonds and Preferred Stock)."