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 $5.7 trillion of outstanding U.S. Treasury securities, more than $2.6 trillion of municipal securities, $3.7 trillion of corporate bonds, and more than $1.4 billion of foreign bonds held in the United States. Not only is the dollar amount mind-boggling, but so is the variety. Bonds come in many shapes and flavors, and one even has a negative interest rate.*

How can a bond have a negative rate? First, consider a bond that makes no payments before it comes due. For example, an investor might buy 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.

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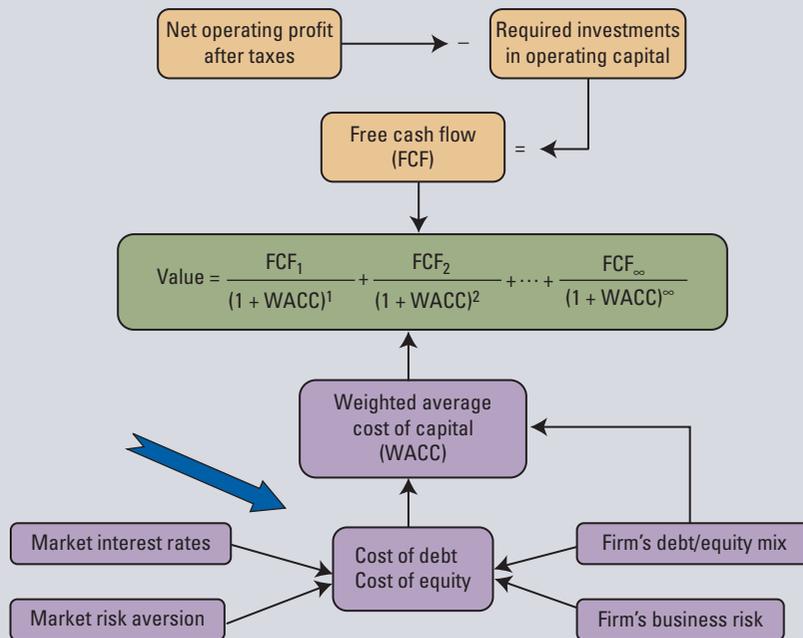
Think about the implications of these and other bonds as you read this chapter.

Intrinsic Value and the Cost of Debt

This chapter explains bond pricing and bond risk, which affect the return demanded by a firm's bondholders. A bondholder's return is a cost from the company's point of view. This cost of debt affects the firm's weighted average cost of capital (WACC), which in turn affects the company's intrinsic value. Therefore, it is important for all managers to understand the cost of debt, which we explain in this chapter.

$$\text{Value} = \frac{\text{FCF}_1}{(1 + \text{WACC})^1} + \frac{\text{FCF}_2}{(1 + \text{WACC})^2} + \cdots + \frac{\text{FCF}_\infty}{(1 + \text{WACC})^\infty}$$

Net operating profit after taxes

Required investments in operating capital

Free cash flow (FCF)

Weighted average cost of capital (WACC)

Market interest rates

Market risk aversion

Cost of debt
Cost of equity

Firm's debt/equity mix

Firm's business risk

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 that 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.

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, 2011, 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 almost no default risk. However, Treasury bond prices decline when interest rates rise, so they are not free of all risks.

Federal agencies and other government-sponsored entities (GSEs) include the Tennessee Valley Authority, the Small Business Administration, Fannie Mae, Freddie Mac, and the Federal Home Loan Bank System, among others. **Agency debt** and **GSE debt** are not officially backed by the full faith and credit of the U.S. government, but investors assume that the government implicitly guarantees this debt, so these bonds carry interest rates only slightly higher than Treasury bonds. In 2008, the implicit guarantee became much more explicit as the government placed several GSEs into conservatorship, including Fannie Mae and Freddie Mac.

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 is often referred to as "credit risk," and the larger the 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: 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 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 if 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.

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[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, the security 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, T-bills are sold initially at a discount to their face, or maturity, value.

THE GLOBAL ECONOMIC CRISIS

Betting With or Against the U.S. Government: The Case of Treasury Bond Credit Default Swaps

It might be hard to believe, but there is actually a market for U.S. Treasury bond insurance. In early 2009, a credit default swap (CDS) on a 5-year T-bond was selling for 71 basis points (a basis point is 1 percentage point). This means that you could pay $7.10 a year to a counterparty who would promise to insure $1,000 of T-bond principal against default. Considering that the T-bond pays only $18.75 a year in interest, the insurance would eat up a lot of the annual interest for an investor who owned the bond. However, most of the trading in this CDS is by speculators and hedgers who don't even own the T-bond but are simply betting for or against the financial soundness of the U.S. government.

But it does make you wonder: "If the United States fails, who will be around to pay off the CDS?"!

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. In practice, some bonds have par values that are multiples of $1,000 (for example, $5,000) and some have par values of less than $1,000 (Treasury bonds can be purchased in multiples of $100). 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 every year (or, more typically, every 6 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 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 6-month period, after which it is adjusted every 6 months based on some market rate. Some corporate issues are tied to the Treasury bond rate; other issues are tied to other rates, such as LIBOR (the London Interbank Offered Rate). 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

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[2]At one time, bonds literally had a number of small 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 the 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.

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 they have made rises at the same time as their deposit costs rise. 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 will 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"). Most zero coupon bonds are Treasury bonds, although a few corporations, such as Coca-Cola, have zero coupon bonds outstanding. Some bonds are issued with a coupon rate too low for the bond to be issued at par, so the bond is issued at a price less than its par value. In general, any bond originally offered at a price significantly below its par value is called an **original issue discount (OID) bond**.

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 combination has led to a number of bankruptcies.

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

Maturity Date

Bonds generally have a specified **maturity date** on which the par value must be repaid. MicroDrive bonds issued on January 5, 2011, will mature on January 5, 2026; thus, they have a 15-year maturity at the time they are 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 effective maturity of a bond declines each year after it has been issued. Thus, MicroDrive's bonds have a 15-year original maturity, but in 2012, 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 1 year's interest if the bonds are called during the first year, and the

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[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.

[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.
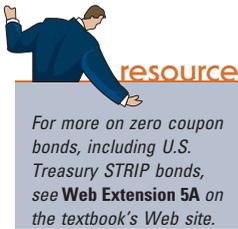
premium declines at a constant rate of INT/N each year thereafter (where INT = annual interest and N = original maturity in years). For example, the call premium on a $1,000 par value, 10-year, 10% bond would generally be $100 if it were called during the first year, $90 during the second year (calculated 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 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 coupon rate than an otherwise similar issue of noncallable bonds.

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, then they are protected against rising rates. If interest rates have risen, holders will turn in the bonds and reinvest the proceeds at a higher rate.

Event risk is the chance that some sudden event will occur and increase the credit risk of a company, hence lowering the firm's bond rating and the value of its outstanding bonds. Investors' concern over event risk means that those firms deemed most likely to face events that could harm bondholders must pay extremely high interest rates. To reduce this interest rate, some bonds have a covenant called a **super poison put,** which 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.

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 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.

In most cases, the firm is given the right to administer 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, then 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 previously. 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 that the bond carries a 10% interest rate but that 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 Provisions and Features

Owners of **convertible bonds** have the option to convert the bonds into a fixed number of shares of common stock. Convertibles offer investors the chance to share in the upside if a company does well, so investors are willing to accept a lower coupon rate on convertibles than on an otherwise identical but nonconvertible bond.

Warrants are options that permit the holder to buy stock at a fixed price, thereby providing a gain if the price of the stock rises. Some bonds are issued with warrants. As with convertibles, bonds with warrants have lower coupon rates than straight bonds.

An **income bond** is required to pay interest only if earnings are high enough to cover the interest expense. If earnings are not sufficient, then the company is not required to pay interest and the bondholders do not have the right to force the company into bankruptcy. Therefore, from an investor's standpoint, income bonds are riskier than "regular" bonds.

Indexed bonds, also called **purchasing power bonds,** first became popular in Brazil, Israel, and a few other countries plagued by high inflation rates. The interest payments and maturity payment rise automatically when the inflation rate rises, thus protecting the bondholders against inflation. In January 1997, the U.S. Treasury began issuing indexed bonds called TIPS, short for Treasury Inflation-Protected Securities. Later in this chapter we show how TIPS can be used to estimate the risk-free rate.

Bond Markets

Corporate bonds are traded primarily in electronic/telephone markets rather than in organized exchanges. Most bonds are owned by and traded among a relatively small

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

number of very large financial institutions, including banks, investment banks, life insurance companies, mutual funds, and pension funds. Although these institutions buy and sell very large blocks of bonds, it is relatively easy for bond dealers to arrange transactions because there are relatively few players in this market as compared with stock markets.

Information on bond trades 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://finance.yahoo.com**.

Self-Test	Define "floating-rate bonds" and "zero coupon bonds."

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?
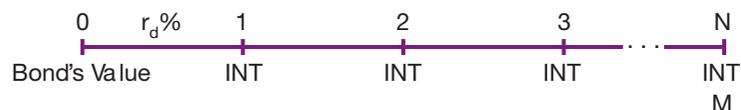
Are securities that provide for a sinking fund regarded as being riskier than those without this type of provision? Explain.

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 in the previous section. 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):

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        0    r_d%     1           2           3              N
        ├──────────┼───────────┼───────────┼────── · · · ──┤
    Bond's Value      INT         INT         INT            INT
                                                              M
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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.

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 for the sake of simplicity we assume the bond pays interest once a year, or annually, so N is measured in years. We consider bonds with semiannual payment bonds later in the chapter.

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.

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:

$$V_B = \frac{INT}{(1+r_d)^1} + \frac{INT}{(1+r_d)^2} + \cdots + \frac{INT}{(1+r_d)^N} + \frac{M}{(1+r_d)^N}$$

$$= \sum_{t=1}^{N} \frac{INT}{(1+r_d)^t} + \frac{M}{(1+r_d)^N} \qquad (5\text{-}1)$$

$$= INT\left[\frac{1}{r_d} - \frac{1}{r_d(1+r_d)^N}\right] + \frac{M}{(1+r_d)^N}$$

Observe that the cash flows consist of an annuity of N years plus a lump-sum payment at the end of Year N. Equation 5-1 can be solved by using (1) a formula, (2) a financial calculator, or (3) 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 by using a formula, insert values for MicroDrive's bond into Equation 5-1:

$$V_B = \sum_{t=1}^{15} \frac{\$100}{(1+0.10)^t} + \frac{\$1,000}{(1+0.10)^{15}}$$

$$= \$100\left[\frac{1}{0.10} - \frac{1}{0.10(1+0.10)^{15}}\right] + \frac{\$1,000}{(1+0.10)^{15}} \qquad (5\text{-}1a)$$

$$= \$1,000$$

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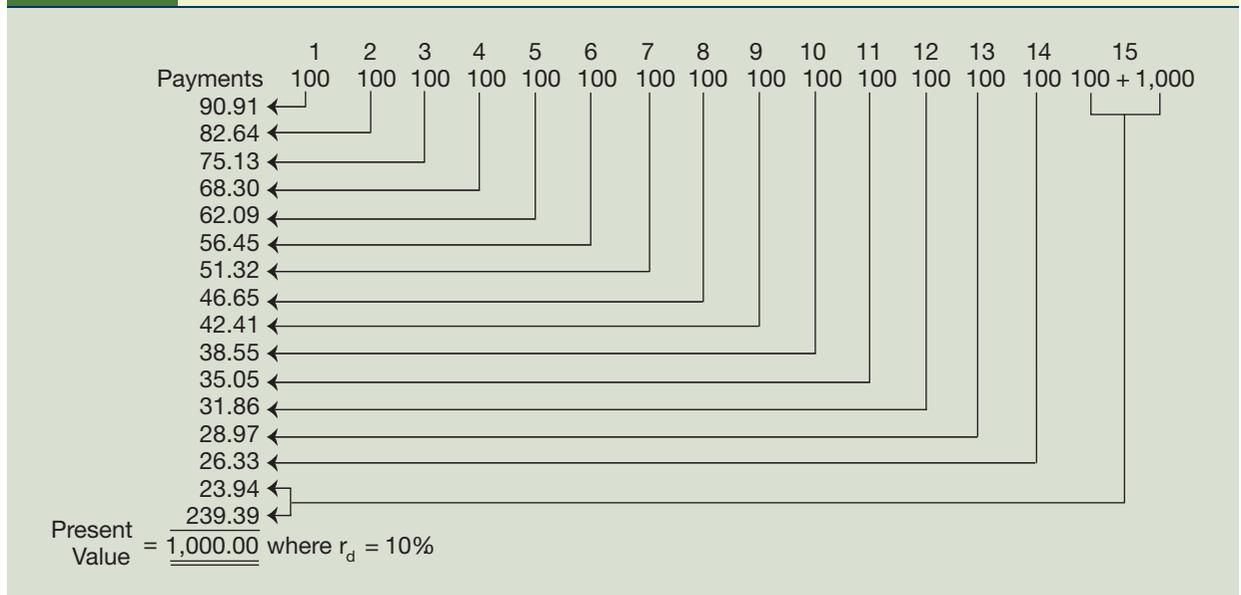
Alternatively, you could use the formula in the second line of Equation 5-1a with a simple or scientific calculator, although this would still be somewhat cumbersome.

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

Input N = 15, I/YR = r_d = 10, INT = PMT = 100, and M = FV = 1000; 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, setting FV = 1000 accounts for any *extra* payment at Year 15, above and beyond the $100 payment.

With *Excel*, it is easiest to use the PV function: =**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:

$$= \textbf{PRICE}(\textbf{DATE}(\textbf{2011},\textbf{1},\textbf{5}),\textbf{DATE}(\textbf{2026},\textbf{1},\textbf{5}),\textbf{10\%},\textbf{10\%},\textbf{100},\textbf{1},\textbf{1})$$

See **Ch05 Tool Kit.xls** *on the textbook's Web site.*

The first two arguments in the function are *Excel*'s DATE function. The DATE function takes the year, month, and day 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 ***Ch05 Tool Kit.xls*** on the textbook's Web site for an example.[6]

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:

Inputs:	15	15		100	1000
	N	**I/YR**	**PV**	**PMT**	**FV**
Output:			−707.63		

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.**

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[6]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%, then we would once again recalculate its price:

Inputs:	15	5		100	1000
	N	**I/YR**	**PV**	**PMT**	**FV**
Output:			−1518.98		

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.**

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 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 then investors would not be willing to pay $1,000 for the bond, and if a higher coupon were set then 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 a 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 10% coupon 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:

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

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

$$= \$1,494.93$$

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? Because r_d has fallen to 5%, with $1,000 to invest you could buy new bonds like MicroDrive's (every day some ten to twelve 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; 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/YR, 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 the rate of return due to the interest payment (called the **current yield**) and the rate of return due to the price change (called the **capital gains yield**). This total rate of return is often called the bond yield, and it is calculated as follows:

$$\text{Interest, or current, yield} = \quad \$100/\$1,494.93 = \quad 0.0669 = \quad 6.69\%$$

$$\text{Capital gains yield} = -\$25.25/\$1,494.93 = -0.0169 = \underline{-1.69\%}$$

$$\text{Total rate of return, or yield} = \quad \$74.75/\$1,494.93 = \quad 0.0500 = \underline{\underline{5.00\%}}$$

Had interest rates risen from 10% to 15% during the first year after issue (rather than falling 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 an expected return due to interest and an expected return due to capital gains or capital losses. In this situation, 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/YR = 15, PMT = 100, and FV = 1000; 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:

$$\text{Interest, or current, yield} = \$100/\$713.78 = 0.1401 = 14.01\%$$

$$\text{Capital gains yield} = \$7.06/\$713.78 = 0.0099 = \underline{0.99\%}$$

$$\text{Total rate of return, or yield} = \$107.06/\$713.78 = 0.1500 = \underline{\underline{15.00\%}}$$

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).
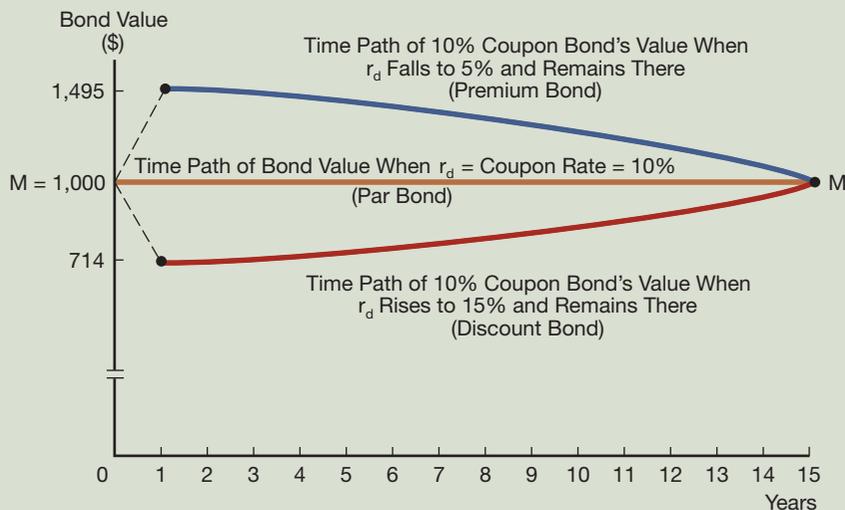
Figure 5-2 illustrates the following key points.

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*.

resource

See **Ch05 Tool Kit.xls** *for all calculations.*

| 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% |

Bond Value ($)

1,495 — Time Path of 10% Coupon Bond's Value When r_d Falls to 5% and Remains There (Premium Bond)

M = 1,000 — Time Path of Bond Value When r_d = Coupon Rate = 10% (Par Bond) — M

714 — Time Path of 10% Coupon Bond's Value When r_d Rises to 15% and Remains There (Discount Bond)

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Years

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

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 paying with something boring like money, they 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, acknowledged 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.

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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 1 year later the going rate drops to 6%. What is the new price of the bonds, assuming that they now have 29 years to maturity? **($1,271.81)** (2) Suppose instead that 1 year after issue the going interest rate increases to 10% (rather than dropping to 6%). What is the price? **($812.61)**

5.5 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 every 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:

$$V_B = \sum_{t=1}^{2N} \frac{INT/2}{(1 + r_d/2)^t} + \frac{M}{(1 + r_d/2)^{2N}} \qquad (5\text{-}2)$$

To illustrate, assume now that MicroDrive's bonds pay $50 interest every 6 months rather than $100 at the end of each year. Each semiannual interest payment is only

half as large, but there are twice as many of them. The nominal, or quoted, coupon rate is "10%, semiannual payments."[7]

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:			−1523.26		

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. 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)**

5.6 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. To find the YTM for a bond with annual interest payments, you must solve Equation 5-1 for r_d:[8]

$$\text{Bond price} = \sum_{t=1}^{N} \frac{\text{INT}}{(1 + \text{YTM})^t} + \frac{M}{(1 + \text{YTM})^N} \qquad (5\text{-}3)$$

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[7]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, then its *effective annual rate* would be higher than 10%:

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

Because 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 described in Section 5.3, where we assumed 10% with annual payments.

[8]If the bond has semiannual payments, you must solve Equation 5-2 for r_d.

For MicroDrive's yield, you must solve this equation:

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

You could substitute values for r_d until you found a value that "works" and forces the sum of the PVs on the right side of the equal sign to equal $1,494.93, but this would be tedious and time-consuming.[9] As you might guess, it is much easier with a financial calculator. Here is the setup:

Inputs:	14		−1494.93	100	1000
	N	**I/YR**	**PV**	**PMT**	**FV**
Output:		5			

Simply enter N = 14, PV = –1494.93, PMT = 100, and FV = 1000, and then press the I/YR key for the answer of 5%.

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 works only 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 ***Ch05 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 then 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. If you purchase a bond and hold it until it matures, you 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.[10]

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[9]Alternatively, you can substitute values of r_d into the third form of Equation 5-1 until you find a value that works.

[10]We often are asked by students if the purchaser of a bond will receive the YTM if interest rates subsequently change. The answer is definitely "yes" provided the question means "Is the realized rate of return on the investment in the bond equal to the YTM?" This is because the realized rate of return on an investment is the rate that sets the present value of the realized cash flows equal to the price. If instead the question means "Is the realized rate of return on the investment in the bond and the subsequent reinvestment of the coupons equal to the YTM?" then the answer is definitely "no." Thus, the question really is one about strategy and timing. The bond, in combination with a reinvestment strategy, is really two investments, and clearly the realized rate on this combined strategy depends on the reinvestment rate (see **Web Extension 5C** for more on investing for a target future value). For the rest of the book, we assume that an investment in a bond is just that, an investment only in the bond, and not a combination of the bond and a reinvestment strategy; this means the investor earns the expected YTM if the bond is held to maturity.
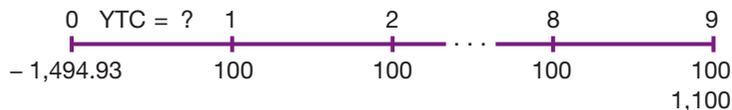
Yield to Call

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 good for the company but not for the 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:

$$\text{Price of callable bond} = \sum_{t=1}^{N} \frac{\text{INT}}{(1 + r_d)^t} + \frac{\text{Call price}}{(1 + r_d)^N} \tag{5-4}$$

Here N is the number of years until the company can call the bond, r_d is the YTC, and "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 1 year's interest).

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 1 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:

```
      0  YTC = ?   1           2          8           9
      ├──────────┼───────────┼── ... ──┼───────────┤
   – 1,494.93       100         100        100         100
                                                     1,100
```

Inputs:	9		–1494.93	100	1100
	N	**I/YR**	**PV**	**PMT**	**FV**
Output:		4.21 = YTC			

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 depend on the going interest rate 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. However, 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, then the bond's current yield would be $100/$985 = 0.1015 = 10.15%.

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 it does not provide an accurate measure of the bond's total expected return, the yield to maturity. In fact, here is the relation between current yield, capital gains yield (which can be negative for a capital loss), and the yield to maturity:

$$\text{Current yield} + \text{Capital gains yield} = \text{Yield to maturity} \qquad (5\text{-}5)$$

The Cost of Debt and Intrinsic Value

The "Intrinsic Value Box" at the beginning of this chapter highlights the cost of debt, which affects the weighted average cost of capital (WACC), which in turn affects the company's intrinsic value. The pre-tax cost of debt from the company's perspective is the required return from the debtholder's perspective. Therefore, the pre-tax cost of debt is the yield to maturity (or the yield to call if a call is likely). But why do different bonds have different yields to maturity? The following sections answer this question.

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 the bond likely to be called if interest rates don't change?

5.7 THE PRE-TAX COST OF DEBT: 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:

$$\begin{aligned} \text{Quoted market interest rate} = r_d &= r^* + IP + DRP + LP + MRP \\ &= r_{RF} + DRP + LP + MRP \end{aligned} \qquad (5\text{-}6)$$

Here are definitions of the variables in Equation 5-6:

r_d = Quoted, or nominal, rate of interest on a given security.[11] There are many different securities and hence many different quoted interest rates.

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

IP = Inflation premium, which 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. The 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. The 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.

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.

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

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[11]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, then 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% just calculated, we will continue to approximate the real rate in this chapter by subtracting inflation from the nominal rate.

conditions, especially (1) the rate of return corporations and other borrowers expect to earn on productive assets and (2) people's time preferences for current versus future consumption.[12]

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 TIPS is a good estimate of the risk-free rate. In early 2009, the TIPS with about 1 year remaining until maturity had a 1.54% yield.[13] 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 to protect against inflation, see **Web Extension 5B** on the textbook's Web site.

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 invest $3,000 in a default-free zero coupon bond that matures in 1 year and pays a 5% interest rate. At the end of the year, you will receive $3,150—your original $3,000 plus $150 of interest. Now suppose that the inflation rate during the year is 10% and that it affects all items equally. If gas had cost $3 per gallon at the beginning of the year, it would cost $3.30 at the end of the year. Therefore, your $3,000 would have bought $3,000/$3 = 1,000 gallons at the beginning of the year but only $3,150/$3.30 = 955 gallons at the end. In *real terms*, you would be worse off—you would receive $150 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 default-free bond.

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):

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

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[12]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, whereas 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 1-year Treasury bill is 5%, inflation during the previous 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%.

[13]Negative *nominal* rates are pretty much impossible—investors would just hold cash instead of investing in a negative-rate bond. But negative real rates are possible. In spring 2008, the combination of stagnant economic growth, a high level of investor uncertainty, fears of inflation, and the Federal Reserve's reduction in nominal short-term interest rates caused the real rate to fall below zero, as measured by negative yields on several short-term TIPS.

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, then the inflation premium for an N-year bond's yield (IP_N) can be approximated as

$$IP_N = \frac{I_1 + I_2 + \ldots + I_N}{N} \qquad (5\text{-}7)$$

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[14]

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

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 early 2009 the yield on a 5-year nonindexed T-bond was 1.91% and the yield on a 5-year TIPS was 1.41%. Thus, the 5-year inflation premium was 1.91% – 1.41% = 0.50%, implying that investors expected inflation to average 0.50% over the next 5 years.[15] Similarly, the rate on a 20-year nonindexed T-bond was 3.93% and the rate on a 20-year indexed T-bond was 2.44%. Thus, the 20-year inflation premium was approximately 3.93% – 2.44% = 1.49%, implying that investors expected inflation to average 1.49% over the long term.[16] These calculations are summarized below:

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[14]To be theoretically correct, we should take the *geometric average*: $(1 + IP_2)^2 = (1 + I_1)(1 + I_2)$. In this example, we have $(1 + IP_2)^2 = (1 + 0.03)(1 + 0.05)$. Solving for IP_2 yields 3.9952, which is close to our approximation of 4%.

[15]To be theoretically precise, we should use a *geometric average* by solving the following equation: $(1 + IP)(1.0141) = 1.0191$. Solving for IP gives IP = 0.493%, which is the same as our approximation.

Note, though, that the difference in yield between a T-bond and a TIPS of the same maturity reflects both the expected inflation *and* any risk premium for bearing inflation risk. So the difference in yields is really an upper limit on the expected inflation.

[16]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 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/home/**; select Inst for Social Research; then search for Consumers to get the survey.

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.

	Maturity	
	5 Years	20 Years
Yield on nonindexed U.S. Treasury bond	1.91%	3.93%
Yield on TIPS	1.41	2.44
Inflation premium	0.50%	1.49%

   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.

   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, Brazil, and most South American countries have experienced higher inflation, which 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. When 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 use 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 express the quoted rate as

$$\text{Nominal, or quoted, rate} = r_d = r_{RF} + DRP + LP + MRP$$

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.[17] The default risk

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[17]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.

on Treasury securities is virtually zero, but default risk can be substantial for corporate and municipal bonds. In this section, we consider some issues related to default risk.

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 next.

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.   A corporation pledges certain assets as security for a **mortgage bond**. The company might also choose to issue *second-mortgage bonds* secured by the same assets that were secured by a previously issued mortgage bond. 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 that usually limits the amount of new bonds that can be issued.

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.

The term *subordinate* means "below," or "inferior to"; thus, 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.

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** and then make the proceeds available to corporations for specific uses deemed (by Congress) to be in the public interest. For example, a Detroit pollution control agency might sell bonds to provide Ford with funds for purchasing pollution control equipment. Because the income from the bonds would be tax exempt, the bonds would have a relatively low interest rates. Note, how-

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Insuring with Credit Default Swaps: Let the Buyer Beware!

Recall that a credit default swap (CDS) is like an insurance policy. The purchaser of the CDS agrees to make annual payments to a counterparty that agrees to pay if a particular bond defaults. During the 2000s, investment banks often would purchase CDS for the mortgage-backed securities (MBS) they were creating in order to make the securities more attractive to investors. But how good was this type of insurance? As it turned out, not very. For example, Lehman Brothers might have bought a CDS from AIG in order to sell a Lehman-created MBS to an investor. But when the MBS began defaulting, neither Lehman nor AIG was capable of making full restitution to the investor.

ever, 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 than for a comparable but uninsured one. Even though the municipality must pay a fee to have 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. The larger insurers are strong companies, and their own ratings are AAA.

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 Ratings. As shown in Columns (3) and (4) of Table 5-1, triple-A and double-A bonds are extremely safe, rarely defaulting even within 5 years of being assigned a rating. Single-A and triple-B bonds are also strong enough to be called **investment-grade bonds**, and they are the 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 defaulting.

Bond Rating Criteria, Upgrades, and Downgrades

Bond ratings are based on both quantitative and qualitative factors, as we describe below.

1. **Financial Ratios**. Many ratios potentially are important, but the return on assets, debt ratio, and interest coverage ratio are particularly valuable for predicting financial distress. For example, Columns 5 and 6 in Table 5-1 show a strong relationship between ratings and the return on capital and the debt ratio.
2. **Bond Contract Terms**. Important provisions for determining the bond's rating include whether the bond is secured by a mortgage on specific assets, whether the bond is subordinated to other debt, any sinking fund provisions, guarantees by some other party with a high credit ranking, and *restrictive covenants* such as requirements that the firm keep its debt ratio below a given level or that it keep its times interest earned ratio above a given level.

| TABLE 5-1 | Bond Ratings, Default Risk, and Yields |

RATING AGENCY[a]		PERCENT DEFAULTING WITHIN:[b]		MEDIAN RATIOS[c]		PERCENT UPGRADED OR DOWNGRADED IN 2008[b]		
S&P AND FITCH (1)	MOODY'S (2)	1 YEAR (3)	5 YEARS (4)	RETURN ON CAPITAL (5)	TOTAL DEBT/ TOTAL CAPITAL (6)	DOWN (7)	UP (8)	YIELD[d] (9)
Investment-grade bonds								
AAA	Aaa	0.0%	0.0%	27.6%	12.4%	13.6%	NA	5.50%
AA	Aa	0.0	0.1	27.0	28.3	21.8	0.0	5.62
A	A	0.1	0.6	17.5	37.5	8.0	1.8	5.79
BBB	Baa	0.3	2.9	13.4	42.5	6.4	2.6	7.53
Junk bonds								
BB	Ba	1.4	8.2	11.3	53.7	15.1	6.8	11.62
B	B	1.8	9.2	8.7	75.9	10.8	5.6	13.70
CCC	Caa	22.3	36.9	3.2	113.5	26.1	8.7	26.30

Notes: [a]The ratings agencies also use "modifiers" for bonds rated below triple-A. S&P and Fitch use 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.
[b]Default data are from Fitch Ratings Global Corporate Finance 2008 Transition and Default Study, March 5, 2009: see **http://www.fitchratings.com/corporate/reports/report_frame.cfm?rpt_id=428182**.
[c]Median ratios are from Standard & Poor's 2006 Corporate Ratings Criteria, April 23, 2007: see **http://www2.standardand poors .com/spf/pdf/fixedincome/Corporate_Ratings_2006.pdf**.
[d]Composite yields for AAA, AA, and A bonds can be found 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**.

3. **Qualitative Factors**. Included here would be such factors as sensitivity of the firm's earnings to the strength of the economy, how it is affected by inflation, whether it is having or is likely to have labor problems, the extent of its international operations (including the stability of the countries in which it operates), potential environmental problems, potential antitrust problems, and so on. Today (2009), a critical factor is exposure to sub-prime loans, including the difficulty of determining the extent of this exposure owing to the complexity of the assets backed by such loans.

Rating agencies review outstanding bonds on a periodic basis and re-rate if necessary. Columns (7) and (8) in Table 5-1 show the percentages of companies in each rating category that were downgraded or upgraded in 2008 by Fitch Ratings. The year 2008 was a difficult one, as more bonds were downgraded than upgraded.

Over the long run, ratings agencies have done a reasonably good job of measuring the average credit risk of bonds and of changing ratings whenever there is a significant change in credit quality. However, 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, Enron's bonds still carried an investment-grade rating on a Friday in December 2001, but the company declared bankruptcy two days later, on Sunday. Many other abrupt downgrades occurred in 2007 and 2008, leading to calls by Congress and the SEC for changes in rating agencies and the way they rate bonds. Clearly, improvements can be made, but there will always be occasions when completely unexpected information about a company is released, leading to a sudden change in its rating.

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Might the U.S. Treasury Bond Be Downgraded?

The worsening recession that began at the end of 2007 led Congress to pass a huge economic stimulus package in early 2009. The combination of the stimulus package and the government's bailouts of financial institutions is causing the U.S. government to increase its borrowing. Moody's, the bond rating agency, projects that federal debt will rise from $5.8 trillion (41% of GDP) at the beginning of 2009 to $9 trillion (62% of GDP) by the end of 2010. This is a lot of money, even by Washington standards!

Moody's rates sovereign debt as well as corporate debt, and the United States has always ranked right at the top. However, Moody's essentially put America on "credit watch" starting February 13, 2009. Moody's predicted that the U.S. ranking will go from the strongest to near the bottom of the most developed nations' rankings (Canada, Britain, France, Germany, and the Scandinavian countries). It even stated that the U.S.'s "triple A rating isn't assured forever."

A downgrade might cause lenders in China and elsewhere around the globe to sell many of their T-bonds. Massive selling pressure would cause T-bond interest rates to go up, which would increase the government's cost of borrowing. The sellers would want to convert into their own currency the dollars they receive from selling T-bonds. This means they would "sell" dollars for their own currency, and this selling pressure would cause the value of the dollar to fall. If the Chinese and others didn't want to hold dollar denominated debt, who would buy the extra $3.2 trillion of bonds the United States must sell to fund the stimulus package?

A downgrading would also have a huge effect on the finance profession—we would no longer have a proxy for the riskless rate, which is an important element of financial theory and practice. Clearly, though, that would be a very small problem compared to the damage a downgrade would do to our economy.

Bond Ratings and the Default Risk Premium

Why are bond ratings so important? 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. Column (9) of Table 5-1 shows that a AAA bond has a yield of 5.50% and that yields increase as the rating falls. In fact, an investor would earn 26.3% on a CCC bond if it didn't default!

A **bond spread** is the difference between a bond's yield and the yield on some other security of the same maturity. Unless specified differently, the term "spread" generally means the difference between a bond's yield and the yield on a Treasury bond of similar maturity.

Figure 5-3 shows the spreads between an index of AAA bonds and a 10-year Treasury bond; it also shows spreads for an index of BBB bonds relative to the T-bond. Figure 5-3 illustrates three important points. First, the BAA spread always is greater than the AAA spread. This is because a BAA bond is riskier than an AAA bond, so BAA investors require extra compensation for their extra risk. The same is true for other ratings: Lower-rated bonds have higher yields.

FIGURE 5-3 Bond Spreads
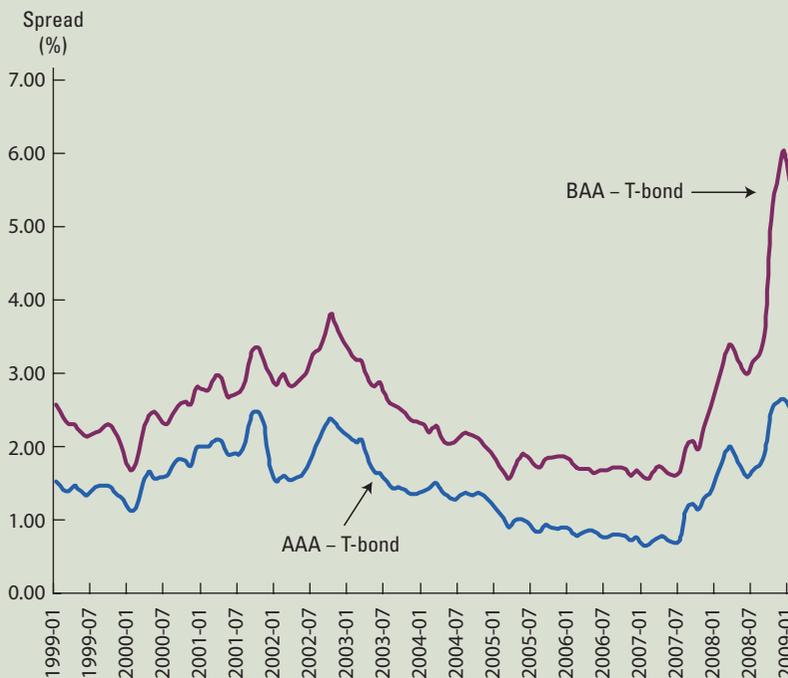
Note: All data are from the Federal Reserve Bank of St. Louis's Economic Database, FRED: **http://research.stlouisfed.org/fred2/**.
The spreads are defined as the yield on the risky bond (AAA or BAA) minus the yield on a 10-year Treasury bond.

Second, the spreads are not constant over time. For example, look at the AAA spread. It was exceptionally low during the boom years of 2005–2007 but rose dramatically as the economy subsequently declined.

Third, the difference between the BAA spread and the AAA spread isn't constant over time. The two spreads were quite close to one another in early 2000 but were very far apart in early 2009. In other words, BAA investors didn't require much extra return over that of an AAA bond to induce them to take on that extra risk for most of the decade, but now (2009) they are requiring a very large risk premium.

Not only do spreads vary with the rating of the security, they also usually 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. This extra uncertainty creates additional risk, so investors demand a higher required return.

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 10-year corporate bond with a rating of AA has a yield of 7.5%. If the corporate bond has excellent liquidity, what is an estimate of the corporate bond's default risk premium? **(1.5%)**

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Are Investors Rational?

The figure in this box shows the yield on junk bonds during the recent past. Observe that the yields were less than 10% from mid-2003 through the end of 2008. During this period, 10-year T-bonds yielded an average of about 4.4%. Thus, the spread on junk bonds over Treasuries was only about 5.4% during these boom years, which is exceptionally low by historic standards. In other words, investors had a voracious appetite for risk and simply didn't require much extra return to induce them to buy very risky securities—investors almost ignored risk during the boom years. But as the economy began to deteriorate in 2008, investors reversed course and became extremely risk averse, with junk-bond yields climbing as high as 25% and the spread exceeding 21%. Such drastic changes in investors' risk aversion are hard to reconcile with careful, deliberate, and rational behavior!

3/27/2009

Source: Financial Industry Regulatory Authority, March 27, 2009, High Yield Index (NBBH) Yields: see **http://cxa. marketwatch.com/finra/BondCenter/ActiveUSCorpBond. aspx.** Copyright © 2009 FINRA. All rights reserved. FINRA is a registered trademark of the Financial Industry Regulatory Authority, Inc. Reprinted with permission from FINRA.

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 measure liquidity premiums accurately, a differential of at least 2 percentage points (and perhaps up to 4 or 5 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.

As discussed in Chapter 1, liquidity in the market for mortgage-backed securities evaporated in 2008 and early 2009. The few transactions that occurred were priced such that the yields on these MBS were extremely high, which was partially due to a much higher liquidity premium caused by the extremely low liquidity of MBS.

| 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 then interest rates rose in the following year to 15%. As we saw earlier, the price of the bonds would fall to $713.78, so you would have a loss of $286.22 per bond.[18] Interest rates can and do rise, and rising rates cause a loss of value for bondholders. Thus, bond investors 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.[19] 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 a 25-year bond at several current market interest rates; these results are plotted in Figure 5-4. 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 bonds of comparable risk 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.

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[18]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.

[19]Actually, a bond's maturity and coupon rate each 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 because of the relatively large coupon payments. A measurement called "duration," which finds the average number of years that 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 **Ch05 Tool Kit.xls** for more on duration.

resource

See **Ch05 Tool Kit.xls**
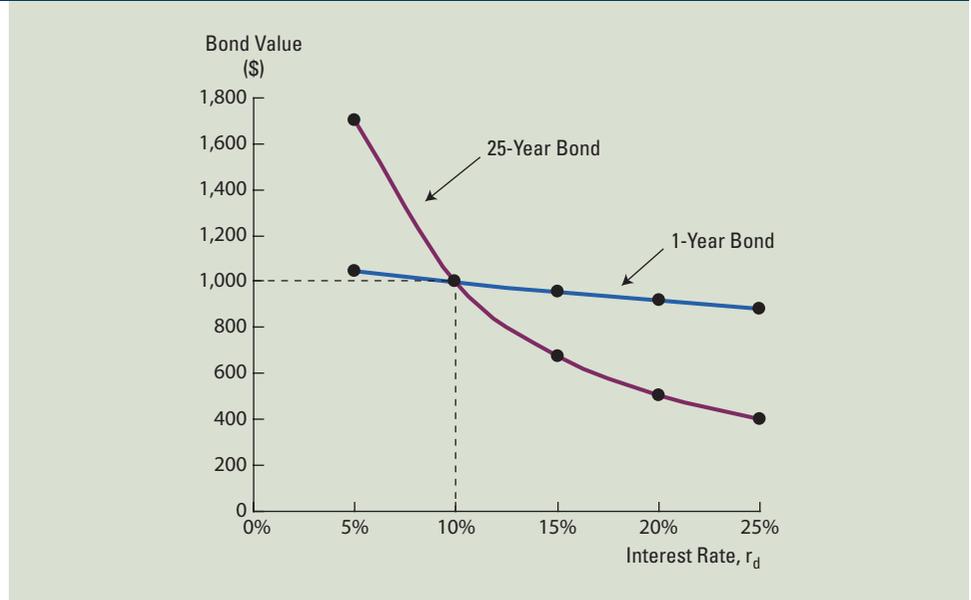
Reinvestment Rate Risk

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 then a bondholder may 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 suppose that interest rates decline to 5%. The short-term bonds will mature, and when they do, they will have to be replaced with lower-yielding bonds. In addition, many of the remaining long-term bonds may be called, and as calls occur, the bondholder will have to replace 10% bonds with 5% 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 Risk 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 then 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 risk and reinvestment rate risk.[20]

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 that 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-term and short-term rates. The term structure is important both to corporate treasurers deciding whether to borrow by issuing long-term or short-term debt and to investors who are deciding whether to buy long-term 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*, as well as 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, Figure 5-5 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 5-5, 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-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 March 2009, all rates had fallen below the 2000 levels. Because short-term rates had dropped below long-term rates, the yield curve was *upward sloping*.

Historically, long-term rates are generally higher than short-term rates owing to 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

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[20]Although indexed Treasury bonds are almost riskless, they pay a relatively low real rate. Note also that risks have not disappeared—they have simply been transferred from bondholders to taxpayers.

FIGURE 5-5 U.S. Treasury Bond Interest Rates on Different Dates
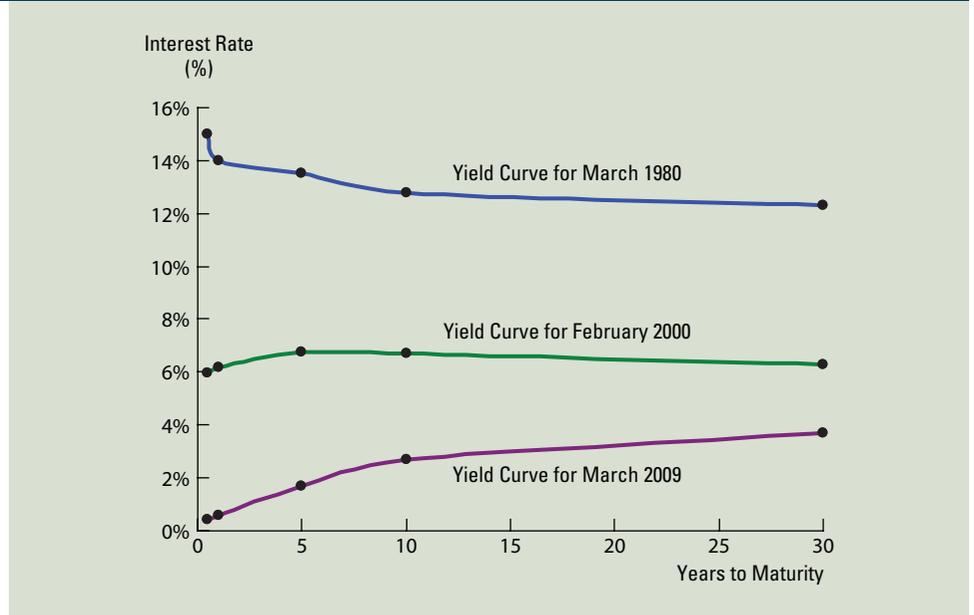
curve that slopes downward an **inverted**, or **"abnormal," curve**. Thus, in Figure 5-5 the yield curve for March 1980 was inverted whereas the yield curve in March 2009 was normal. As stated above, the February 2000 curve was humped.

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.
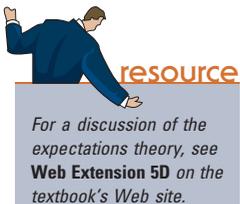
Self-Test

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 (respectively) 4%, 5%, 6%, and 7%, then how would you describe the yield curve? How would you describe it if the rates were reversed?

5.15 FINANCING WITH JUNK BONDS

Recall that bonds rated less than BBB are noninvestment-grade debt, also called junk bonds or high-yield debt. There are two ways that a bond can become a junk bond. First, the bond might have been investment-grade debt when it was issued but its rating declined because the issuing corporation had fallen on hard times. Such bonds are called "fallen angels," and there are many such bonds as we write this in 2009.

Some bonds are junk bonds at the time they are issued, but this was not always true. 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 risky bonds yielded more than enough to compensate for their risk, convinced institutional investors that junk bond yields were worth their risk. Thus was born the junk bond market.

In the 1980s, large investors like T. Boone Pickens and Henry Kravis thought that certain old-line, established companies were run inefficiently and were financed too conservatively. These corporate raiders were able to put in some of their own money, borrow the rest via junk bonds, and take over the target company, usually taking the company private. 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. Because these deal used lots of debt, they were called **leveraged buyouts (LBOs)**.

In recent years, private equity firms have conducted transactions very similar to the LBOs of the 1980s, taking advantage of historically low junk-bond rates to help finance their purchases. For example, in 2007 the private equity firm Kohlberg Kravis Roberts and Company (KKR) took the discount retailer Dollar General private in a $6.9 billion deal. As part of the transaction, Dollar General issued $1.9 billion in junk bonds. So KKR financed approximately 73% of the deal with its own cash (coming from its own equity and from money it had borrowed on its own account) and about 27% of the deal with money that Dollar General raised. Dollar General's sales have been soaring during the early part of the current recession, making KKR's purchase look like a winner.

Self-Test	What are junk bonds?

5.16 Bankruptcy and Reorganization

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 liquidation, then 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 who are entitled to the proceeds from the sale of collateral; (3) the trustee's costs of administering and operating the bankrupt firm; (4) expenses incurred after bankruptcy was filed; (5) wages due workers, up to a limit of $2,000 per worker; (6) claims for unpaid contributions to employee benefit plans (with wages and claims not to exceed $2,000 per worker); (7) unsecured claims for customer deposits up to $900 per customer; (8) federal, state, and local taxes due; (9) unfunded pension plan liabilities (although some limitations exist); (10) general unsecured creditors; (11) preferred stockholders (up to the par value of their stock); and (12) common stockholders (although usually nothing is left).

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 that governments and corporations issue, explained how bond prices are established, and discussed how investors estimate the rates of return they can expect to earn. The rate of return required by debtholders is the company's pre-tax cost of debt, and this rate depends on the risk that investors face when they buy bonds.

- 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 special types of long-term financing include **zero coupon bonds**, which pay no annual interest but are issued at a discount; see *Web Extension 5A* for more on zero coupon bonds. Other types are **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 **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.
- 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 expected rate of return on a bond held to maturity is defined as the bond's **yield to maturity (YTM)**:

$$\text{Bond price} = \sum_{t=1}^{N} \frac{\text{INT}}{(1 + \text{YTM})^t} + \frac{M}{(1 + \text{YTM})^N}$$

- The expected rate of return on a callable bond held to its call date is defined as the **yield to call (YTC)**.
- The **nominal** (or **quoted) interest rate** on a debt security, 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):

$$r_d = r^* + \text{IP} + \text{DRP} + \text{LP} + \text{MRP}$$

- The **risk-free rate of interest, r_{RF}**, is defined as the real risk-free rate, r^*, plus an inflation premium, IP: $r_{RF} = r^* + \text{IP}$.
- **Treasury Inflation-Protected Securities (TIPS)** are U.S. Treasury bonds that have no inflation risk. See *Web Extension 5B* for more discussion of TIPS.
- 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.
- **Duration** is a measure of interest rate risk. See *Web Extension 5C* for a discussion of duration.
- 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.
- The **expectations theory** states that yields on long-term bonds reflect expected future interest rates. *Web Extension 5D* discusses this theory.

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. Indentures; mortgage bond; debenture; subordinated debenture
i. Development bond; municipal bond insurance; junk bond; investment-grade bond
j. Real risk-free rate of interest, r*; nominal risk-free rate of interest, r_{RF}
k. Inflation premium (IP); default risk premium (DRP); liquidity; liquidity premium (LP)
l. Interest rate risk; maturity risk premium (MRP); reinvestment rate risk
m. Term structure of interest rates; yield curve
n. "Normal" yield curve; inverted ("abnormal") yield curve

(5–2)   "Short-term interest rates are more volatile than long-term interest rates, so 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. 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, 1987. The bonds were sold at par ($1,000), had a 12% coupon, and matured in 30 years on December 31, 2016. Coupon payments are made semiannually (on June 30 and December 31).

a. What was the YTM on the date the bonds were issued?
b. What was the price of the bonds on January 1, 1992 (5 years later), assuming that interest rates had fallen to 10%?
c. Find the current yield, capital gains yield, and total yield on January 1, 1992, given the price as determined in part b.
d. On July 1, 2010 (6.5 years before maturity), Pennington's bonds sold for $916.42. What are the YTM, the current yield, and the capital gains yield for that date?
e. Now assume that you plan to purchase an outstanding Pennington bond on March 1, 2010, when the going rate of interest given its risk is 15.5%. How large a check must you write to complete the transaction? (*Hint:* Don't forget the accrued interest.)

Problems

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'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 10%. The bonds sell at a price of $850. What is their yield to maturity?

(5–3)
Current Yield for
Annual Payments

Heath Foods's 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 has 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's 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

Absalom Motors's 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	_____	_____	_____
5-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 × (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

Because of 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, as in part a, that 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 points for 1-year securities. Furthermore, maturity risk premiums increase 0.2 percentage points 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.

SPREADSHEET PROBLEM

(5–24)

Build a Model: Bond
Valuation

resource

Start with the partial model in the file ***Ch05 P24 Build a Model.xls*** on the textbook's Web site. A 20-year, 8% semiannual coupon bond with a par value of $1,000 may be called in 5 years at a call price of $1,040. 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?
e. How would the price of the bond be affected by a change in the going market interest rate? (*Hint:* Conduct a sensitivity analysis of price to changes in 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. This is an oversimplification, but assume it anyway for purposes of this problem.)
f. Now assume the date is October 25, 2010. Assume further that a 12%, 10-year bond was issued on July 1, 2010, pays interest semiannually (on January 1 and July 1), and sells for $1,100. Use your spreadsheet to find the bond's yield.

Mini Case

Sam Strother and Shawna Tibbs are vice presidents of Mutual of Seattle Insurance Company and co-directors 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

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 does one determine the value of any asset whose value is based on expected future cash flows?

    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%? If it remained at 7%? (*Hint:* With a financial calculator, enter PMT, I/YR, FV, and N, and then change 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 the 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. Briefly describe bankruptcy law. If a firm were to default on its bonds, would the company be liquidated immediately? Would the bondholders be assured of receiving all of their promised payments?

SELECTED ADDITIONAL CASES

The following cases from Textchoice, *Cengage 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"; and Case 78, "Beatrice Peabody."

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