CHAPTER 14

Bond Prices and Yields

IN THE PREVIOUS chapters on risk and return relationships, we treated securities at a high level of abstraction. We assumed implicitly that a prior, detailed analysis of each security already had been performed, and that its risk and return features had been assessed.

We turn now to specific analyses of particular security markets. We examine valuation principles, determinants of risk and return, and portfolio strategies commonly used within and across the various markets.

We begin by analyzing **debt securities.** A debt security is a claim on a specified periodic stream of income. Debt securities are often called *fixed-income securities* because they promise either a fixed stream of income or a stream of income that is determined according to a specified formula. These securities have the advantage of being relatively easy to understand because the payment formulas are specified in advance. Risk considerations are minimal as long as the issuer of the security is sufficiently creditworthy. That makes these securities a convenient starting point for our analysis of the universe of potential investment vehicles.

The bond is the basic debt security, and this chapter starts with an overview of the universe of bond markets, including Treasury, corporate, and international bonds. We turn next to bond pricing, showing how bond prices are set in accordance with market interest rates and why bond prices change with those rates. Given this background, we can compare the myriad measures of bond returns such as yield to maturity, yield to call, holding-period return, or realized compound rate of return. We show how bond prices evolve over time, discuss certain tax rules that apply to debt securities, and show how to calculate after-tax returns. Finally, we consider the impact of default or credit risk on bond pricing and look at the determinants of credit risk and the default premium built into bond yields. Credit risk is central to both collateralized debt obligations and credit default swaps, so we examine these relatively new instruments as well.

14.1 Bond Characteristics

A **bond** is a security that is issued in connection with a borrowing arrangement. The borrower issues (i.e., sells) a bond to the lender for some amount of cash; the bond is the "IOU" of the borrower. The arrangement obligates the issuer to make specified payments to the bondholder on specified dates. A typical coupon bond obligates the issuer to make semiannual payments of interest to the bondholder for the life of the bond. These are called *coupon payments* because in precomputer days, most bonds had coupons that investors would clip off and present to claim the interest payment. When the bond matures, the issuer repays the debt by paying the bond's **par value** (equivalently, its **face value**). The **coupon rate** of the bond determines the interest payment: The annual payment is the coupon rate times the bond's par value. The coupon rate, maturity date, and par value of the bond are part of the **bond indenture,** which is the contract between the issuer and the bondholder.

To illustrate, a bond with par value of $1,000 and coupon rate of 8% might be sold to a buyer for $1,000. The bondholder is then entitled to a payment of 8% of $1,000, or $80 per year, for the stated life of the bond, say, 30 years. The $80 payment typically comes in two semiannual installments of $40 each. At the end of the 30-year life of the bond, the issuer also pays the $1,000 par value to the bondholder.

Bonds usually are issued with coupon rates set just high enough to induce investors to pay par value to buy the bond. Sometimes, however, **zero-coupon bonds** are issued that make no coupon payments. In this case, investors receive par value at the maturity date but receive no interest payments until then: The bond has a coupon rate of zero. These bonds are issued at prices considerably below par value, and the investor's return comes solely from the difference between issue price and the payment of par value at maturity. We will return to these bonds later.

U.S. Treasury Quotes

TREASURY NOTES & BONDS

GO TO: Bills

Friday, October 30, 2009 Find Historical Data WHAT'S THIS?

Treasury note and bond data are representative over-the-counter quotations as of 3pm Eastern time. Figures after colons in bid and ask quotes represent 32nds; 101:26 means 101 26/32, or 101.8125% of face value; 99:01 means 99 1/32, or 99.03125% of face value. For notes and bonds callable prior to maturity, yields are computed to the earliest call date for issues quoted above par and to the maturity date for issues below par.

MATURITY MO/YR	COUPON	BID	ASKED	CHG	ASK YLD	MATURITY MO/YR	COUPON	BID	ASKED	CHG	ASK YLD
Oct 10	1.500	101:03	101:03	+1	0.39	Oct 16	3.125	100:28	100:28	+43	2.99
Nov 10	4.500	104:07	104:08	unch.	0.37	Feb 17	4.625	110:17	110:18	+26	3.00
Apr 11	0.875	100:13	100:14	+3	0.58	May 17	4.500	109:17	109:19	+26	3.06
Oct 11	1.000	100:06	100:06	+5	0.90	Feb 18	3.500	101:29	101:30	+28	3.23
Feb 12	1.375	100:21	100:22	+7	1.07	Aug 20	8.750	145:27	145:31	+40	3.57
Jun 12	4.875	109:17	109:18	+7	1.21	Nov 22	7.625	138:06	138:11	+46	3.85
Nov 12	4.000	107:24	107:25	+10	1.37	Aug 25	6.875	132:18	132:22	+51	4.05
Dec 13	1.500	98:03	98:04	+15	1.97	Nov 27	6.125	124:23	124:29	+53	4.15
Jan 14	1.750	98:30	98:30	+17	2.01	Feb 36	4.500	104:13	104:19	+58	4.21
Oct 14	2.375	100:08	100:09	+18	2.32	May 39	4.250	100:07	100:09	+58	4.23
Sep 16	3.000	100:08	100:09	+23	2.95	Aug 39	4.500	104:14	104:15	+59	4.23

Figure 14.1 Listing of Treasury issues

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Treasury Bonds and Notes

Figure 14.1 is an excerpt from the listing of Treasury issues. Treasury notes are issued with original maturities ranging between 1 and 10 years, while Treasury bonds are issued with maturities ranging from 10 to 30 years. Both bonds and notes may be purchased directly from the Treasury in denominations of only $100, but denominations of $1,000 are far more common. Both make semiannual coupon payments.

The highlighted bond in Figure 14.1 matures in October 2014. Its coupon rate is 2.375%. Par value typically is $1,000; thus the bond pays interest of $23.75 per year in two semiannual payments of $11.875. Payments are made in October and April of each year. The bid and asked prices[1] are quoted in points plus fractions of 1/32 of a point (the numbers after the colons are the fractions of a point).

[1]Recall that the bid price is the price at which you can sell the bond to a dealer. The asked price, which is slightly higher, is the price at which you can buy the bond from a dealer.

Although bonds usually are sold in denominations of \$1,000, the prices are quoted as a percentage of par value. Therefore, the bid price of the bond is 100:08 = 100 8/32 = 100.25 of par value, or \$1,002.50, whereas the asked price is 100 9/32% of par, or \$1,002.81.

The last column, labeled "Asked yield," is the yield to maturity on the bond based on the asked price. The yield to maturity is a measure of the average rate of return to an investor who purchases the bond for the asked price and holds it until its maturity date. We will have much to say about yield to maturity below.

Accrued Interest and Quoted Bond Prices The bond prices that you see quoted in the financial pages are not actually the prices that investors pay for the bond. This is because the quoted price does not include the interest that accrues between coupon payment dates.

If a bond is purchased between coupon payments, the buyer must pay the seller for accrued interest, the prorated share of the upcoming semiannual coupon. For example, if 30 days have passed since the last coupon payment, and there are 182 days in the semiannual coupon period, the seller is entitled to a payment of accrued interest of 30/182 of the semiannual coupon. The sale, or *invoice,* price of the bond would equal the stated price plus the accrued interest.

In general, the formula for the amount of accrued interest between two dates is

$$\text{Accrued interest} = \frac{\text{Annual coupon payment}}{2} \times \frac{\text{Days since last coupon payment}}{\text{Days separating coupon payments}}$$

Example 14.1 Accrued Interest

Suppose that the coupon rate is 8%. Then the annual coupon is \$80 and the semiannual coupon payment is \$40. Because 30 days have passed since the last coupon payment, the accrued interest on the bond is \$40 × (30/182) = \$6.59. If the quoted price of the bond is \$990, then the invoice price will be \$990 + \$6.59 = \$996.59.

The practice of quoting bond prices net of accrued interest explains why the price of a maturing bond is listed at \$1,000 rather than \$1,000 plus one coupon payment. A purchaser of an 8% coupon bond 1 day before the bond's maturity would receive \$1,040 (par value plus semiannual interest) on the following day and so should be willing to pay a total price of \$1,040 for the bond. The bond price is quoted net of accrued interest in the financial pages and thus appears as \$1,000.[2]

Corporate Bonds

Like the government, corporations borrow money by issuing bonds. Figure 14.2 is a sample of listings for a few actively traded corporate bonds. Although some bonds trade electronically on the NYSE Bonds platform, most bonds are traded over-the-counter in a network of bond dealers linked by a computer quotation system. In practice, the bond market can be quite "thin," with few investors interested in trading a particular issue at any particular time.

[2]In contrast to bonds, stocks do not trade at flat prices with adjustments for "accrued dividends." Whoever owns the stock when it goes "ex-dividend" receives the entire dividend payment, and the stock price reflects the value of the upcoming dividend. The price therefore typically falls by about the amount of the dividend on the "ex-day." There is no need to differentiate between reported and invoice prices for stocks.

ISSUER NAME	SYMBOL	COUPON	MATURITY	RATING MOODY'S/S&P/ FITCH	HIGH	LOW	LAST	CHANGE	YIELD %
General Electric Capital	GE.HGW	3.000%	Dec 2011	Aaa/AAA/–	104.038	103.369	103.730	0.031	1.219
Citigroup Funding	C.HRU	1.375%	May 2011	Aaa/AAA/AAA	101.123	100.770	100.770	0.272	0.869
JPMorgan Chase & Co	JPM.LVC	6.300%	Apr 2019	Aa3/A+/AA–	111.753	109.459	111.045	1.600	4.836
Citigroup	C.GOS	5.500%	Oct 2014	A3/A/A+	103.497	101.580	101.792	0.425	5.086
Goldman Sachs Gp	GS.HRH	1.700%	Mar 2011	Aaa/AAA/AAA	101.412	101.412	101.412	0.112	0.685
Citigroup	C.HFV	8.125%	Jul 2039	A3/A/A+	117.308	113.188	116.961	1.711	6.789
General Electric Capital	GE.HJL	6.000%	Aug 2019	Aa2/AA+/–	107.390	103.161	105.010	1.415	5.335
Citigroup	C.HFF	6.000%	Aug 2017	A3/A/A+	102.250	99.784	100.107	0.536	5.981

Figure 14.2 Listing of corporate bonds

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The bond listings in Figure 14.2 include the coupon, maturity, price, and yield to maturity of each bond. The "rating" column is the estimation of bond safety given by the three major bond-rating agencies—Moody's, Standard & Poor's, and Fitch. Bonds with gradations of A ratings are safer than those with B ratings or below. As a general rule, safer bonds with higher ratings promise lower yields to maturity than other bonds with similar maturities. We will return to this topic toward the end of the chapter.

Call Provisions on Corporate Bonds Some corporate bonds are issued with call provisions allowing the issuer to repurchase the bond at a specified *call price* before the maturity date. For example, if a company issues a bond with a high coupon rate when market interest rates are high, and interest rates later fall, the firm might like to retire the high-coupon debt and issue new bonds at a lower coupon rate to reduce interest payments. This is called *refunding*. Callable bonds typically come with a period of call protection, an initial time during which the bonds are not callable. Such bonds are referred to as *deferred* callable bonds.

The option to call the bond is valuable to the firm, allowing it to buy back the bonds and refinance at lower interest rates when market rates fall. Of course, the firm's benefit is the bondholder's burden. Holders of called bonds must forfeit their bonds for the call price, thereby giving up the attractive coupon rate on their original investment. To compensate investors for this risk, callable bonds are issued with higher coupons and promised yields to maturity than noncallable bonds.

CONCEPT *Check* 1 ✓

Suppose that Verizon issues two bonds with identical coupon rates and maturity dates. One bond is callable, however, whereas the other is not. Which bond will sell at a higher price?

Convertible Bonds **Convertible bonds** give bondholders an option to exchange each bond for a specified number of shares of common stock of the firm. The *conversion ratio* is the number of shares for which each bond may be exchanged. Suppose a convertible bond is issued at par value of $1,000 and is convertible into 40 shares of a firm's stock. The current stock price is $20 per share, so the option to convert is not profitable now. Should the stock price later rise to $30, however, each bond may be converted profitably into $1,200 worth of stock. The *market conversion value* is the current value of the shares for which the bonds may be exchanged. At the $20 stock price, for example, the bond's conversion value is $800. The *conversion premium* is the excess of the bond value over its conversion value. If the bond were selling currently for $950, its premium would be $150.

Convertible bondholders benefit from price appreciation of the company's stock. Again, this benefit comes at a price: Convertible bonds offer lower coupon rates and stated or promised yields to maturity than do nonconvertible bonds. However, the actual return on the convertible bond may exceed the stated yield to maturity if the option to convert becomes profitable.

We discuss convertible and callable bonds further in Chapter 20.

Puttable Bonds While the callable bond gives the issuer the option to extend or retire the bond at the call date, the *extendable* or **put bond** gives this option to the bondholder. If the bond's coupon rate exceeds current market yields, for instance, the bondholder will choose to extend the bond's life. If the bond's coupon rate is too low, it will be optimal not to extend; the bondholder instead reclaims principal, which can be invested at current yields.

Floating-Rate Bonds **Floating-rate bonds** make interest payments that are tied to some measure of current market rates. For example, the rate might be adjusted annually to the current T-bill rate plus 2%. If the 1-year T-bill rate at the adjustment date is 4%, the bond's coupon rate over the next year would then be 6%. This arrangement means that the bond always pays approximately current market rates.

The major risk involved in floaters has to do with changes in the firm's financial strength. The yield spread is fixed over the life of the security, which may be many years. If the financial health of the firm deteriorates, then investors will demand a greater yield premium than is offered by the security. In this case, the price of the bond will fall. Although the coupon rate on floaters adjusts to changes in the general level of market interest rates, it does not adjust to changes in the financial condition of the firm.

Preferred Stock

Although preferred stock strictly speaking is considered to be equity, it often is included in the fixed-income universe. This is because, like bonds, preferred stock promises to pay a specified stream of dividends. However, unlike bonds, the failure to pay the promised dividend does not result in corporate bankruptcy. Instead, the dividends owed simply cumulate, and the common stockholders may not receive any dividends until the preferred stockholders have been paid in full. In the event of bankruptcy, preferred stockholders' claims to the firm's assets have lower priority than those of bondholders, but higher priority than those of common stockholders.

Preferred stock commonly pays a fixed dividend. Therefore, it is in effect a perpetuity, providing a level cash flow indefinitely. In the last two decades, however, adjustable or floating-rate preferred stock has become popular, in some years accounting for about half of new issues. Floating-rate preferred stock is much like floating-rate bonds. The dividend rate is linked to a measure of current market interest rates and is adjusted at regular intervals.

Unlike interest payments on bonds, dividends on preferred stock are not considered tax-deductible expenses to the firm. This reduces their attractiveness as a source of capital to issuing firms. On the other hand, in some countries there is an offsetting tax advantage to preferred stock. E.g., in the U.S., when one corporation buys the preferred stock of another corporation, it pays taxes on only 30% of the dividends received. For example, if the firm's tax bracket is 35%, and it receives $10,000 in preferred dividend payments, it will pay taxes on only $3,000 of that income: Total taxes owed on the income will be

.35 × \$3,000 = \$1,050. The firm's effective tax rate on preferred dividends is therefore only .30 × 35% = 10.5%. Given this tax rule, it is not surprising that most preferred stock is held by corporations.

Preferred stock rarely gives its holders full voting privileges in the firm. However, if the preferred dividend is skipped, the preferred stockholders may then be provided some voting power.

Other Issuers

There are, of course, several issuers of bonds in the U.S., in addition to the Treasury and private corporations. For example, state and local governments issue municipal bonds. The outstanding feature of these is that interest payments are tax-free. We examined municipal bonds and the value of the tax exemption in Chapter 2.

Some U.S. government agencies such as the Federal Home Loan Bank Board, the Farm Credit agencies, and the mortgage pass-through agencies Ginnie Mae, Fannie Mae, and Freddie Mac also issue considerable amounts of bonds. These too were reviewed in Chapter 2.

International Bonds

International bonds are commonly divided into two categories, *foreign bonds* and *Eurobonds*. Foreign bonds are issued by a borrower from a country other than the one in which the bond is sold. The bond is denominated in the currency of the country in which it is marketed. For example, if a German firm sells a dollar-denominated bond in the United States, the bond is considered a foreign bond. These bonds are given colorful names based on the countries in which they are marketed. For example, foreign bonds sold in the United States are called *Yankee bonds*. Like other bonds sold in the United States, they are registered with the Securities and Exchange Commission. Yen-denominated bonds sold in Japan by non-Japanese issuers are called *Samurai bonds*. British pound-denominated foreign bonds sold in the United Kingdom are called *bulldog bonds*.

In contrast to foreign bonds, Eurobonds are denominated in one currency, usually that of the issuer, but sold in other national markets. For example, the Eurodollar market refers to dollar-denominated bonds sold outside the United States (not just in Europe), although London is the largest market for Eurodollar bonds. Because the Eurodollar market falls outside U.S. jurisdiction, these bonds are not regulated by U.S. federal agencies. Similarly, Euroyen bonds are yen-denominated bonds selling outside Japan, Eurosterling bonds are pound-denominated Eurobonds selling outside the United Kingdom, and so on.

Innovation in the Bond Market

Issuers constantly develop innovative bonds with unusual features; these issues illustrate that bond design can be extremely flexible. Here are examples of some novel bonds. They should give you a sense of the potential variety in security design.

Inverse Floaters These are similar to the floating-rate bonds we described earlier, except that the coupon rate on these bonds *falls* when the general level of interest rates rises. Investors in these bonds suffer doubly when rates rise. Not only does the present value of each dollar of cash flow from the bond fall as the discount rate rises, but the level of those cash flows falls as well. Of course, investors in these bonds benefit doubly when rates fall.

Asset-Backed Bonds Walt Disney has issued bonds with coupon rates tied to the financial performance of several of its films. Similarly, "David Bowie bonds" have been issued with payments that will be tied to royalties on some of his albums. These are examples of asset-backed securities. The income from a specified group of assets is used to service the debt. More conventional asset-backed securities are mortgage-backed securities or securities backed by auto or credit card loans, as we discussed in Chapter 2.

Catastrophe Bonds Oriental Land Company, which manages Tokyo Disneyland, issued a bond in 1999 with a final payment that depended on whether there had been an earthquake near the park. The Swiss insurance firm Winterthur has issued a bond whose payments will be cut if a severe hailstorm in Switzerland results in extensive payouts on Winterthur policies. These bonds are a way to transfer "catastrophe risk" from the firm to the capital markets. Investors in these bonds receive compensation for taking on the risk in the form of higher coupon rates. But in the event of a catastrophe, the bondholders will give up all or part of their investments. "Disaster" can be defined by total insured losses or by criteria such as wind speed in a hurricane or Richter level in an earthquake. Issuance of catastrophe bonds has surged in recent years as insurers have sought ways to spread their risks across a wider spectrum of the capital market.

Indexed Bonds Indexed bonds make payments that are tied to a general price index or the price of a particular commodity. For example, Mexico has issued bonds with payments that depend on the price of oil. Some bonds are indexed to the general price level. The United States Treasury started issuing such inflation-indexed bonds in January 1997. They are called Treasury Inflation Protected Securities (TIPS). By tying the par value of the bond to the general level of prices, coupon payments as well as the final repayment of par value on these bonds increase in direct proportion to the Consumer Price Index. Therefore, the interest rate on these bonds is a risk-free real rate.

To illustrate how TIPS work, consider a newly issued bond with a 3-year maturity, par value of $1,000, and a coupon rate of 4%. For simplicity, we will assume the bond makes annual coupon payments. Assume that inflation turns out to be 2%, 3%, and 1% in the next 3 years. Table 14.1 shows how the bond cash flows will be calculated. The first payment comes at the end of the first year, at $t = 1$. Because inflation over the year was 2%, the par value of the bond increases from $1,000 to $1,020; because the coupon rate is 4%, the coupon payment is 4% of this amount, or $40.80. Notice that par value increases by the inflation rate, and because the coupon payments are 4% of par, they too increase in proportion to the general price level. Therefore, the cash flows paid by the bond are fixed in *real* terms. When the bond matures, the investor receives a final coupon payment of $42.44 plus the (price-level-indexed) repayment of principal, $1,061.11.[3]

Table 14.1

Principal and interest payments for a Treasury Inflation Protected Security

Time	Inflation in Year Just Ended	Par Value	Coupon Payment	+	Principal Repayment	=	Total Payment
0		$1,000.00					
1	2%	1,020.00	$40.80		$ 0		$ 40.80
2	3	1,050.60	42.02		0		42.02
3	1	1,061.11	42.44		1,061.11		1,103.55

[3] By the way, total nominal income (i.e., coupon plus that year's increase in principal) is treated as taxable income in each year.

The *nominal* rate of return on the bond in the first year is

$$\text{Nominal return} = \frac{\text{Interest} + \text{Price appreciation}}{\text{Initial price}} = \frac{40.80 + 20}{1000} = 6.08\%$$

The real rate of return is precisely the 4% real yield on the bond:

$$\text{Real return} = \frac{1 + \text{Nominal return}}{1 + \text{Inflation}} - 1 = \frac{1.0608}{1.02} - 1 = .04, \text{ or } 4\%$$

One can show in a similar manner (see Problem 18 in the end-of-chapter problems) that the rate of return in each of the 3 years is 4% as long as the real yield on the bond remains constant. If real yields do change, then there will be capital gains or losses on the bond. In early 2010, the real yield on long-term TIPS bonds was about 1.5%.

14.2 Bond Pricing

Because a bond's coupon and principal repayments all occur months or years in the future, the price an investor would be willing to pay for a claim to those payments depends on the value of dollars to be received in the future compared to dollars in hand today. This "present value" calculation depends in turn on market interest rates. As we saw in Chapter 5, the nominal risk-free interest rate equals the sum of (1) a real risk-free rate of return and (2) a premium above the real rate to compensate for expected inflation. In addition, because most bonds are not riskless, the discount rate will embody an additional premium that reflects bond-specific characteristics such as default risk, liquidity, tax attributes, call risk, and so on.

We simplify for now by assuming there is one interest rate that is appropriate for discounting cash flows of any maturity, but we can relax this assumption easily. In practice, there may be different discount rates for cash flows accruing in different periods. For the time being, however, we ignore this refinement.

To value a security, we discount its expected cash flows by the appropriate discount rate. The cash flows from a bond consist of coupon payments until the maturity date plus the final payment of par value. Therefore,

$$\text{Bond value} = \text{Present value of coupons} + \text{Present value of par value}$$

If we call the maturity date T and call the interest rate r, the bond value can be written as

$$\text{Bond value} = \sum_{t=1}^{T} \frac{\text{Coupon}}{(1+r)^t} + \frac{\text{Par value}}{(1+r)^T} \qquad (14.1)$$

The summation sign in Equation 14.1 directs us to add the present value of each coupon payment; each coupon is discounted based on the time until it will be paid. The first term on the right-hand side of Equation 14.1 is the present value of an annuity. The second term is the present value of a single amount, the final payment of the bond's par value.

You may recall from an introductory finance class that the present value of a $1 annuity that lasts for T periods when the interest rate equals r is $\frac{1}{r}\left[1 - \frac{1}{(1+r)^T}\right]$. We call this expression the T-period *annuity factor* for an interest rate of r.[4] Similarly, we call $\frac{1}{(1+r)^T}$ the *PV factor,* that is, the present value of a single payment of \$1 to be received in T periods. Therefore, we can write the price of the bond as

$$\text{Price} = \text{Coupon} \times \frac{1}{r}\left[1 - \frac{1}{(1+r)^T}\right] + \text{Par value} \times \frac{1}{(1+r)^T} \tag{14.2}$$

$$= \text{Coupon} \times \text{Annuity factor}(r, T) + \text{Par value} \times \text{PV factor}(r, T)$$

Example 14.2 Bond Pricing

We discussed earlier an 8% coupon, 30-year maturity bond with par value of \$1,000 paying 60 semiannual coupon payments of \$40 each. Suppose that the interest rate is 8% annually, or $r = 4\%$ per 6-month period. Then the value of the bond can be written as

$$\text{Price} = \sum_{t=1}^{60} \frac{\$40}{(1.04)^t} + \frac{\$1{,}000}{(1.04)^{60}} \tag{14.3}$$

$$= \$40 \times \text{Annuity factor}(4\%, 60) + \$1{,}000 \times \text{PV factor}(4\%, 60)$$

It is easy to confirm that the present value of the bond's 60 semiannual coupon payments of \$40 each is \$904.94 and that the \$1,000 final payment of par value has a present value of \$95.06, for a total bond value of \$1,000. You can calculate the value directly from Equation 14.2, perform these calculations on any financial calculator,[5] use a spreadsheet program (see the Excel Applications box), or use a set of present value tables.

In this example, the coupon rate equals the market interest rate, and the bond price equals par value. If the interest rate were not equal to the bond's coupon rate, the bond would not sell at par value. For example, if the interest rate were to rise to 10% (5% per 6 months), the bond's price would fall by \$189.29 to \$810.71, as follows:

$$\$40 \times \text{Annuity factor}(5\%, 60) + \$1{,}000 \times \text{PV factor}(5\%, 60)$$

$$= \$757.17 + \$53.54 = \$810.71$$

[4]Here is a quick derivation of the formula for the present value of an annuity. An annuity lasting T periods can be viewed as equivalent to a perpetuity whose first payment comes at the end of the current period *less* another perpetuity whose first payment comes at the end of the $(T+1)^{st}$ period. The immediate perpetuity net of the delayed perpetuity provides exactly T payments. We know that the value of a \$1 per period perpetuity is \$1/r. Therefore, the present value of the delayed perpetuity is \$1/r discounted for T additional periods, or $\frac{1}{r} \times \frac{1}{(1+r)^T}$. The present value of the annuity is the present value of the first perpetuity minus the present value of the delayed perpetuity, or $\frac{1}{r}\left[1 - \frac{1}{(1+r)^T}\right]$.

[5]On your financial calculator, you would enter the following inputs: n (number of periods) = 60; FV (face or future value) = 1000; PMT (payment each period) = 40; i (per period interest rate) = 4%; then you would compute the price of the bond (COMP PV or CPT PV). You should find that the price is \$1,000. Actually, most calculators will display the result as *negative* \$1,000. This is because most (but not all) calculators treat the initial purchase price of the bond as a cash *outflow.* We will discuss calculators and spreadsheets more fully in a few pages.

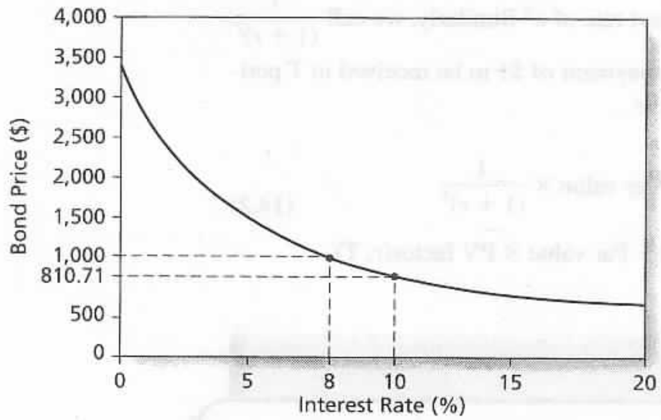

Figure 14.3 The inverse relationship between bond prices and yields. Price of an 8% coupon bond with 30-year maturity making semiannual payments

At a higher interest rate, the present value of the payments to be received by the bondholder is lower. Therefore, bond prices fall as market interest rates rise. This illustrates a crucial general rule in bond valuation.

Figure 14.3 shows the price of the 30-year, 8% coupon bond for a range of interest rates, including 8%, at which the bond sells at par, and 10%, at which it sells for $810.71. The negative slope illustrates the inverse relationship between prices and yields. Note also from the figure (and from Table 14.2) that the shape of the curve implies that an increase in the interest rate results in a price decline that is smaller than the price gain resulting from a decrease of equal magnitude in the interest rate. This property of bond prices is called *convexity* because of the convex shape of the bond price curve. This curvature reflects the fact that progressive increases in the interest rate result in progressively smaller reductions in the bond price.[6] Therefore, the price curve becomes flatter at higher interest rates. We return to convexity in Chapter 16.

CONCEPT *Check* 2 ✓

Calculate the price of the 30-year, 8% coupon bond for a market interest rate of 3% per half-year. Compare the capital gains for the interest rate decline to the losses incurred when the rate increases to 5%.

Corporate bonds typically are issued at par value. This means that the underwriters of the bond issue (the firms that market the bonds to the public for the issuing corporation) must choose a coupon rate that very closely approximates market yields. In a primary issue of bonds, the underwriters attempt to sell the newly issued bonds directly to their customers. If the coupon rate is inadequate, investors will not pay par value for the bonds.

Table 14.2

Bond prices at different interest rates (8% coupon bond, coupons paid semiannually)

	Bond Price at Given Market Interest Rate				
Time to Maturity	2%	4%	6%	8%	10%
1 year	1,059.11	1,038.83	1,029.13	1,000.00	981.41
10 years	1,541.37	1,327.03	1,148.77	1,000.00	875.35
20 years	1,985.04	1,547.11	1,231.15	1,000.00	828.41
30 years	2,348.65	1,695.22	1,276.76	1,000.00	810.71

[6] The progressively smaller impact of interest increases results from the fact that at higher rates the bond is worth less. Therefore, an additional increase in rates operates on a smaller initial base, resulting in a smaller price reduction.

After the bonds are issued, bondholders may buy or sell bonds in secondary markets. In these markets, bond prices fluctuate inversely with the market interest rate.

The inverse relationship between price and yield is a central feature of fixed-income securities. Interest rate fluctuations represent the main source of risk in the fixed-income market, and we devote considerable attention in Chapter 16 to assessing the sensitivity of bond prices to market yields. For now, however, it is sufficient to highlight one key factor that determines that sensitivity, namely, the maturity of the bond.

As a general rule, keeping all other factors the same, the longer the maturity of the bond, the greater the sensitivity of price to fluctuations in the interest rate. For example, consider Table 14.2, which presents the price of an 8% coupon bond at different market yields and times to maturity. For any departure of the interest rate from 8% (the rate at which the bond sells at par value), the change in the bond price is greater for longer times to maturity.

This makes sense. If you buy the bond at par with an 8% coupon rate, and market rates subsequently rise, then you suffer a loss: You have tied up your money earning 8% when alternative investments offer higher returns. This is reflected in a capital loss on the bond—a fall in its market price. The longer the period for which your money is tied up, the greater the loss, and correspondingly the greater the drop in the bond price. In Table 14.2, the row for 1-year maturity bonds shows little price sensitivity—that is, with only 1 year's earnings at stake, changes in interest rates are not too threatening. But for 30-year maturity bonds, interest rate swings have a large impact on bond prices. The force of discounting is greatest for the longest-term bonds.

This is why short-term Treasury securities such as T-bills are considered to be the safest. They are free not only of default risk but also largely of price risk attributable to interest rate volatility.

Bond Pricing between Coupon Dates

Equation 14.2 for bond prices assumes that the next coupon payment is in precisely one payment period, either a year for an annual payment bond or 6 months for a semiannual payment bond. But you probably want to be able to price bonds all 365 days of the year, not just on the one or two dates each year that it makes a coupon payment!

In principle, the fact that the bond is between coupon dates does not affect the pricing problem. The procedure is always the same: compute the present value of each remaining payment and sum up. But if you are between coupon dates, there will be fractional periods remaining until each payment, and this does complicate the arithmetic computations.

Fortunately, bond pricing functions are included in most spreadsheet programs such as Excel. The spreadsheet allows you to enter today's date as well as the maturity date of the bond, and so can provide prices for bonds at any date. The nearby box shows you how.

As we pointed out earlier, bond prices are typically quoted net of accrued interest. These prices, which appear in the financial press, are called *flat prices*. The actual *invoice price* that a buyer pays for the bond includes accrued interest. Thus,

$$\text{Invoice price} = \text{Flat price} + \text{Accrued interest}$$

When a bond pays its coupon, flat price equals invoice price, because at that moment accrued interest reverts to zero. However, this will be the exceptional case, not the rule.

Excel pricing functions provide the flat price of the bond. To find the invoice price, we need to add accrued interest. Fortunately, Excel also provides functions that count the days since the last coupon payment date and thus can be used to compute accrued interest. The eXcel APPLICATIONS

BOND PRICING

Excel and most other spreadsheet programs provide built-in functions to compute bond prices and yields. They typically ask you to input both the date you buy the bond (called the *settlement date*) and the maturity date of the bond. The Excel function for bond price is

= PRICE(settlement date, maturity date, annual coupon rate, yield to maturity, redemption value as percent of par value, number of coupon payments per year)

For the 2.375% coupon October 2014 maturity bond highlighted in Figure 14.1, we would enter the values in the following spreadsheet. Alternatively, we could simply enter the following function in Excel:

= PRICE(DATE(2009,10,31), DATE(2014,10,31), .02375, .0232, 100, 2)

The DATE function in Excel, which we use for both the settlement and maturity date, uses the format DATE(year,month,day). The first date is October 31, 2009, when the bond is purchased, and the second is October 31, 2014, when it matures. Most bonds pay coupons on the 15th or the last business day of the month.

Notice that the coupon rate and yield to maturity are expressed as decimals, not percentages. In most cases, redemption value is 100 (i.e., 100% of par value), and the resulting price similarly is expressed as a percent of par value. Occasionally, however, you may encounter bonds that pay off at a premium or discount to par value. One example would be callable bonds, discussed shortly.

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The value of the bond returned by the pricing function is 100.258 (cell B12), which matches the price reported in Table 14.1 to the nearest 32nd of a point. This bond has just paid a coupon. In other words, the settlement date is precisely at the beginning of the coupon period, so no adjustment for accrued interest is necessary.

To illustrate the procedure for bonds between coupon payments, consider the 3.5% coupon February 2018 bond, also appearing in Figure 14.1. Using the entries in column D of the spreadsheet, we find in cell D12 that the (flat) price of the bond is 101.946, which matches the price given in the figure except for a few cents' rounding error.

What about the bond's invoice price? Rows 13 through 16 make the necessary adjustments. The function described in cell C13 counts the days since the last coupon. This day count is based on the bond's settlement date, maturity date, coupon period (1 = annual; 2 = semiannual), and day count convention (choice 1 uses actual days). The function described in cell C14 counts the total days in each coupon payment period. Therefore, the entries for accrued interest in row 15 are the semiannual coupon multiplied by the fraction of a coupon period that has elapsed since the last payment. Finally, the invoice prices in row 16 are the sum of flat price plus accrued interest.

As a final example, suppose you wish to find the price of the bond in Example 14.2. It is a 30-year maturity bond with a coupon rate of 8% (paid semiannually). The market interest rate given in the latter part of the example is 10%. However, you are not given a specific settlement or maturity date. You can still use the PRICE function to value the bond. Simply choose an *arbitrary* settlement date (January 1, 2000, is convenient) and let the maturity date be 30 years hence. The appropriate inputs appear in column F of the spreadsheet, with the resulting price, 81.071% of face value, appearing in cell F16.

	A	B	C	D	E	F	G
1		2.375% coupon bond,		3.5% coupon bond,		8% coupon bond,	
2		maturing Oct 31, 2014	Formula in column B	maturing Feb 15, 2018		30-year maturity	
3							
4	Settlement date	10/31/2009	= DATE (2009, 10, 31)	10/31/2009		1/1/2000	
5	Maturity date	10/31/2014	= DATE (2014, 10, 31)	2/15/2018		1/1/2030	
6	Annual coupon rate	0.02375		0.035		0.08	
7	Yield to maturity	0.0232		0.0323		0.1	
8	Redemption value (% of face value)	100		100		100	
9	Coupon payments per year	2		2		2	
10							
11							
12	**Flat price (% of par)**	**100.258**	**=PRICE(B4,B5,B6,B7,B8,B9)**	**101.946**		**81.071**	
13	Days since last coupon	0	=COUPDAYBS(B4,B5,2,1)	77		0	
14	Days in coupon period	181	=COUPDAYS(B4,B5,2,1)	184		182	
15	Accrued interest	0	=(B13/B14)*B6*100/2	0.732		0	
16	**Invoice price**	**100.258**	**=B12+B15**	**102.679**		**81.071**	

nearby box also illustrates how to use these functions. The box provides examples using bonds that have just paid a coupon and so have zero accrued interest, as well as a bond that is between coupon dates.

14.3 Bond Yields

We have noted that the current yield of a bond measures only the cash income provided by the bond as a percentage of bond price and ignores any prospective capital gains or losses. We would like a measure of rate of return that accounts for both current income and the price increase or decrease over the bond's life. The yield to maturity is the standard measure of the total rate of return. However, it is far from perfect, and we will explore several variations of this measure.

Yield to Maturity

In practice, an investor considering the purchase of a bond is not quoted a promised rate of return. Instead, the investor must use the bond price, maturity date, and coupon payments to infer the return offered by the bond over its life. The **yield to maturity** (YTM) is defined as the interest rate that makes the present value of a bond's payments equal to its price. This interest rate is often interpreted as a measure of the average rate of return that will be earned on a bond if it is bought now and held until maturity. To calculate the yield to maturity, we solve the bond price equation for the interest rate given the bond's price.

Example 14.3 Yield to Maturity

Suppose an 8% coupon, 30-year bond is selling at \$1,276.76. What average rate of return would be earned by an investor purchasing the bond at this price? We find the interest rate at which the present value of the remaining 60 semiannual payments equals the bond price. This is the rate consistent with the observed price of the bond. Therefore, we solve for r in the following equation:

$$\$1{,}276.76 = \sum_{t=1}^{60} \frac{\$40}{(1+r)^t} + \frac{\$1{,}000}{(1+r)^{60}}$$

or, equivalently,

$$1{,}276.76 = 40 \times \text{Annuity factor}(r, 60) + 1{,}000 \times \text{PV factor}(r, 60)$$

These equations have only one unknown variable, the interest rate, r. You can use a financial calculator or spreadsheet to confirm that the solution is $r = .03$, or 3%, per half-year.[7] This is the bond's yield to maturity.

The financial press reports yields on an annualized basis, and annualizes the bond's semiannual yield using simple interest techniques, resulting in an annual percentage rate, or APR. Yields annualized using simple interest are also called "bond equivalent yields." Therefore, the semiannual yield would be doubled and reported in the newspaper as a bond equivalent yield of 6%. The *effective* annual yield of the bond, however, accounts for compound interest. If one earns 3% interest every 6 months, then after 1 year, each dollar invested grows with interest to $\$1 \times (1.03)^2 = \$1.0609$, and the effective annual interest rate on the bond is 6.09%.

[7] On your financial calculator, you would enter the following inputs: $n = 60$ periods; PV = −1,276.76; FV = 1000; PMT = 40; then you would compute the interest rate (COMP i or CPT i). Notice that we enter the present value, or PV, of the bond as *minus* \$1,276.76. Again, this is because most calculators treat the initial purchase price of the bond as a cash outflow. Spreadsheet 14.1 shows how to find yield to maturity using Excel. Without a financial calculator or spreadsheet, you still could solve the equation, but you would need to use a trial-and-error approach.

Excel also provides a function for yield to maturity that is especially useful in-between coupon dates. It is

= (YIELD settlement date, maturity date, annual coupon rate, bond price, redemption value as percent of par value, number of coupon payments per year)

The bond price used in the function should be the reported flat price, without accrued interest. For example, to find the yield to maturity of the bond in Example 14.3, we would use column B of Spreadsheet 14.1. If the coupons were paid only annually, we would change the entry for payments per year to 1 (see cell D8), and the yield would fall slightly to 5.99%.

The bond's yield to maturity is the internal rate of return on an investment in the bond. The yield to maturity can be interpreted as the compound rate of return over the life of the bond under the assumption that all bond coupons can be reinvested at that yield.[8] Yield to maturity is widely accepted as a proxy for average return.

Yield to maturity differs from the **current yield** of a bond, which is the bond's annual coupon payment divided by the bond price. For example, for the 8%, 30-year bond currently selling at $1,276.76, the current yield would be $80/$1,276.76 = .0627, or 6.27%, per year. In contrast, recall that the effective annual yield to maturity is 6.09%. For this bond, which is selling at a premium over par value ($1,276 rather than $1,000), the coupon rate (8%) exceeds the current yield (6.27%), which exceeds the yield to maturity (6.09%). The coupon rate exceeds current yield because the coupon rate divides the coupon payments by par value ($1,000) rather than by the bond price ($1,276). In turn, the current yield exceeds yield to maturity because the yield to maturity accounts for the built-in capital loss on the bond; the bond bought today for $1,276 will eventually fall in value to $1,000 at maturity.

Example 14.3 illustrates a general rule: For **premium bonds** (bonds selling above par value), coupon rate is greater than current yield, which in turn is greater than yield

	A	B	C	D	E
1		Semiannual coupons		Annual coupons	
2					
3	Settlement date	1/1/2000		1/1/2000	
4	Maturity date	1/1/2030		1/1/2030	
5	Annual coupon rate	0.08		0.08	
6	Bond price (flat)	127.676		127.676	
7	Redemption value (% of face value)	100		100	
8	Coupon payments per year	2		1	
9					
10	**Yield to maturity (decimal)**	**0.0600**		**0.0599**	
11					
12	The formula entered here is: =YIELD(B3,B4,B5,B6,B7,B8)				

Spreadsheet 14.1

Finding yield to maturity in Excel

eXcel
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[8]If the reinvestment rate does not equal the bond's yield to maturity, the compound rate of return will differ from YTM. This is demonstrated in Examples 14.5 and 14.6.

to maturity. For **discount bonds** (bonds selling below par value), these relationships are reversed (see Concept Check 3).

It is common to hear people talking loosely about the yield on a bond. In these cases, they almost always are referring to the yield to maturity.

CONCEPT Check 3 ✓ What will be the relationship among coupon rate, current yield, and yield to maturity for bonds selling at discounts from par? Illustrate using the 8% (semiannual payment) coupon bond, assuming it is selling at a yield to maturity of 10%.

Yield to Call

Yield to maturity is calculated on the assumption that the bond will be held until maturity. What if the bond is callable, however, and may be retired prior to the maturity date? How should we measure average rate of return for bonds subject to a call provision?

Figure 14.4 illustrates the risk of call to the bondholder. The colored line is the value at various market interest rates of a "straight" (i.e., noncallable) bond with par value $1,000, an 8% coupon rate, and a 30-year time to maturity. If interest rates fall, the bond price, which equals the present value of the promised payments, can rise substantially.

Now consider a bond that has the same coupon rate and maturity date but is callable at 110% of par value, or $1,100. When interest rates fall, the present value of the bond's *scheduled* payments rises, but the call provision allows the issuer to repurchase the bond at the call price. If the call price is less than the present value of the scheduled payments, the issuer may call the bond back from the bondholder.

The dark line in Figure 14.4 is the value of the callable bond. At high interest rates, the risk of call is negligible because the present value of scheduled payments is less than the call price; therefore the values of the straight and callable bonds converge. At lower rates, however, the values of the bonds begin to diverge, with the difference reflecting the value of the firm's option to reclaim the callable bond at the call price. At very low rates, the present value of scheduled payments exceeds the call price, so the bond is called. Its value at this point is simply the call price, $1,100.

This analysis suggests that bond market analysts might be more interested in a bond's yield to call rather than yield to maturity, especially if the bond is likely to be called. The yield to call is calculated just like the yield to maturity except that the time until call replaces time until maturity, and the call price replaces the par value. This computation is sometimes called "yield to first call," as it assumes the issuer will call the bond as soon as it may do so.

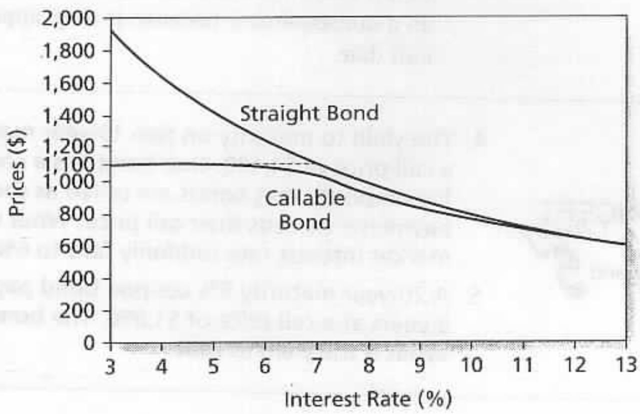

Figure 14.4 Bond prices: Callable and straight debt. Coupon = 8%; maturity = 30 years; semiannual payments.

Example 14.4 Yield to Call

Suppose the 8% coupon, 30-year maturity bond sells for $1,150 and is callable in 10 years at a call price of $1,100. Its yield to maturity and yield to call would be calculated using the following inputs:

	Yield to Call	Yield to Maturity
Coupon payment	$40	$40
Number of semiannual periods	20 periods	60 periods
Final payment	$1,100	$1,000
Price	$1,150	$1,150

Yield to call is then 6.64%. [To confirm this on a calculator, input $n = 20$; PV = (−)1,150; FV = 1100; PMT = 40; compute i as 3.32%, or 6.64% bond equivalent yield.] Yield to maturity is 6.82%. [To confirm, input $n = 60$; PV = (−)1,150; FV = 1000; PMT = 40; compute i as 3.41% or 6.82% bond equivalent yield. In Excel, you can calculate yield to call as = YIELD(DATE(2000,01,01), DATE(2010,01,01), .08, 115, 110, 2). Notice that redemption value is input as 110, i.e., 110% of par value.]

We have noted that most callable bonds are issued with an initial period of call protection. In addition, an implicit form of call protection operates for bonds selling at deep discounts from their call prices. Even if interest rates fall a bit, deep-discount bonds still will sell below the call price and thus will not be subject to a call.

Premium bonds that might be selling near their call prices, however, are especially apt to be called if rates fall further. If interest rates fall, a callable premium bond is likely to provide a lower return than could be earned on a discount bond whose potential price appreciation is not limited by the likelihood of a call. Investors in premium bonds often are more interested in the bond's yield to call rather than yield to maturity as a consequence, because it may appear to them that the bond will be retired at the call date.

CONCEPT Check 4 and 5

4. The yield to maturity on two 10-year maturity bonds currently is 7%. Each bond has a call price of $1,100. One bond has a coupon rate of 6%, the other 8%. Assume for simplicity that bonds are called as soon as the present value of their remaining payments exceeds their call price. What will be the capital gain on each bond if the market interest rate suddenly falls to 6%?
5. A 20-year maturity 9% coupon bond paying coupons semiannually is callable in 5 years at a call price of $1,050. The bond currently sells at a yield to maturity of 8%. What is the yield to call?

Realized Compound Return versus Yield to Maturity

We have noted that yield to maturity will equal the rate of return realized over the life of the bond if all coupons are reinvested at an interest rate equal to the bond's yield to maturity. Consider, for example, a 2-year bond selling at par value paying a 10% coupon once a year. The yield to maturity is 10%. If the $100 coupon payment is reinvested at an interest rate of 10%, the $1,000 investment in the bond will grow after 2 years to

$1,210, as illustrated in Figure 14.5, panel A. The coupon paid in the first year is reinvested and grows with interest to a second-year value of $110, which together with the second coupon payment and payment of par value in the second year results in a total value of $1,210.

To summarize, the initial value of the investment is $V_0 = \$1{,}000$. The final value in 2 years is $V_2 = \$1{,}210$. The compound rate of return, therefore, is calculated as follows:

$$V_0(1 + r)^2 = V_2$$
$$\$1{,}000(1 + r)^2 = \$1{,}210$$
$$r = .10 = 10\%$$

With a reinvestment rate equal to the 10% yield to maturity, the **realized compound return** equals yield to maturity.

But what if the reinvestment rate is not 10%? If the coupon can be invested at more than 10%, funds will grow to more than $1,210, and the realized compound return will exceed 10%. If the reinvestment rate is less than 10%, so will be the realized compound return. Consider the following example.

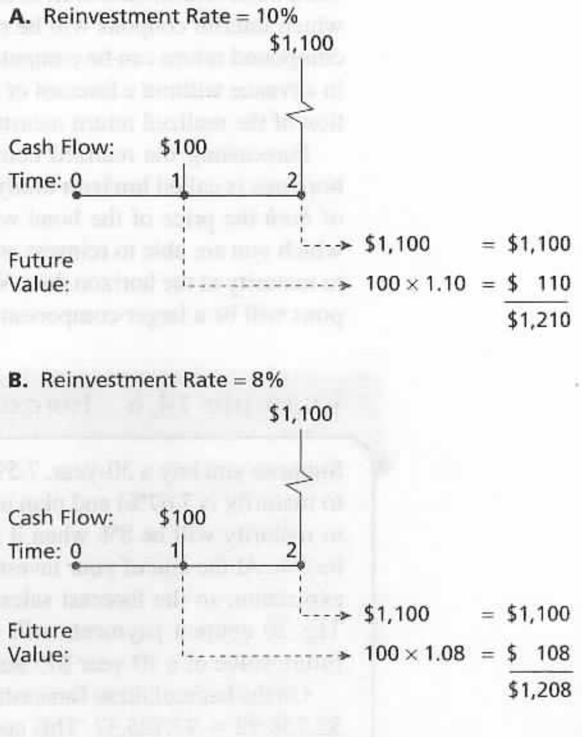

Figure 14.5 Growth of invested funds

Example 14.5 Realized Compound Return

If the interest rate earned on the first coupon is less than 10%, the final value of the investment will be less than $1,210, and the realized compound return will be less than 10%. To illustrate, suppose the interest rate at which the coupon can be invested equals 8%. The following calculations are illustrated in Figure 14.5, panel B.

Future value of first coupon payment with interest earnings = $100 × 1.08 =	$ 108
+ Cash payment in second year (final coupon plus par value)	$1,100
= Total value of investment with reinvested coupons	$1,208

The realized compound return is the compound rate of growth of invested funds, assuming that all coupon payments are reinvested. The investor purchased the bond for par at $1,000, and this investment grew to $1,208.

$$V_0(1 + r)^2 = V_2$$
$$\$1{,}000(1 + r)^2 = \$1{,}208$$
$$r = .0991 = 9.91\%$$

Example 14.5 highlights the problem with conventional yield to maturity when reinvestment rates can change over time. Conventional yield to maturity will not equal realized compound return. However, in an economy with future interest rate uncertainty, the rates at which interim coupons will be reinvested are not yet known. Therefore, although realized compound return can be computed *after* the investment period ends, it cannot be computed in advance without a forecast of future reinvestment rates. This reduces much of the attraction of the realized return measure.

Forecasting the realized compound yield over various holding periods or investment horizons is called **horizon analysis.** The forecast of total return depends on your forecasts of *both* the price of the bond when you sell it at the end of your horizon *and* the rate at which you are able to reinvest coupon income. The sales price depends in turn on the yield to maturity at the horizon date. With a longer investment horizon, however, reinvested coupons will be a larger component of your final proceeds.

Example 14.6 Horizon Analysis

Suppose you buy a 30-year, 7.5% (annual payment) coupon bond for $980 (when its yield to maturity is 7.67%) and plan to hold it for 20 years. Your forecast is that the bond's yield to maturity will be 8% when it is sold and that the reinvestment rate on the coupons will be 6%. At the end of your investment horizon, the bond will have 10 years remaining until expiration, so the forecast sales price (using a yield to maturity of 8%) will be $966.45. The 20 coupon payments will grow with compound interest to $2,758.92. (This is the future value of a 20-year $75 annuity with an interest rate of 6%.)

On the basis of these forecasts, your $980 investment will grow in 20 years to $966.45 + $2,758.92 = $3,725.37. This corresponds to an annualized compound return of 6.90%:

$$V_0(1 + r)^{20} = V_{20}$$
$$\$980(1 + r)^{20} = \$3{,}725.37$$
$$r = .0690 = 6.90\%$$

Examples 14.5 and 14.6 demonstrate that as interest rates change, bond investors are actually subject to two sources of offsetting risk. On the one hand, when rates rise, bond prices fall, which reduces the value of the portfolio. On the other hand, reinvested coupon income will compound more rapidly at those higher rates. This **reinvestment rate risk** will offset the impact of price risk. In Chapter 16, we will explore this trade-off in more detail and will discover that by carefully tailoring their bond portfolios, investors can precisely balance these two effects for any given investment horizon.

14.4 Bond Prices over Time

As we noted earlier, a bond will sell at par value when its coupon rate equals the market interest rate. In these circumstances, the investor receives fair compensation for the time value of money in the form of the recurring coupon payments. No further capital gain is necessary to provide fair compensation.

When the coupon rate is lower than the market interest rate, the coupon payments alone will not provide investors as high a return as they could earn elsewhere in the market. To receive a fair return on such an investment, investors also need to earn price appreciation on their bonds. The bonds, therefore, would have to sell below par value to provide a "built-in" capital gain on the investment.

Example 14.7 Fair Holding-Period Return

To illustrate built-in capital gains or losses, suppose a bond was issued several years ago when the interest rate was 7%. The bond's annual coupon rate was thus set at 7%. (We will suppose for simplicity that the bond pays its coupon annually.) Now, with 3 years left in the bond's life, the interest rate is 8% per year. The bond's market price is the present value of the remaining annual coupons plus payment of par value. That present value is[9]

$$\$70 \times \text{Annuity factor}(8\%, 3) + \$1{,}000 \times \text{PV factor}(8\%, 3) = \$974.23$$

which is less than par value.

In another year, after the next coupon is paid, the bond would sell at

$$\$70 \times \text{Annuity factor}(8\%, 2) + \$1{,}000 \times \text{PV factor}(8\%, 2) = \$982.17$$

thereby yielding a capital gain over the year of $7.94. If an investor had purchased the bond at $974.23, the total return over the year would equal the coupon payment plus capital gain, or $70 + $7.94 = $77.94. This represents a rate of return of $77.94/$974.23, or 8%, exactly the current rate of return available elsewhere in the market.

CONCEPT Check 6 At what price will the bond in Example 14.7 sell in yet another year, when only 1 year remains until maturity? What is the rate of return to an investor who purchases the bond at $982.17 and sells it 1 year hence?

When bond prices are set according to the present value formula, any discount from par value provides an anticipated capital gain that will augment a below-market coupon rate just enough to provide a fair total rate of return. Conversely, if the coupon rate exceeds the market interest rate, the interest income by itself is greater than that available elsewhere in the market. Investors will bid up the price of these bonds above their par values. As the bonds approach maturity, they will fall in value because fewer of these above-market coupon payments remain. The resulting capital losses offset the large coupon payments so that the bondholder again receives only a fair rate of return.

Problem 14 at the end of the chapter asks you to work through the case of the high-coupon bond. Figure 14.6 traces out the price paths of high- and low-coupon bonds (net of accrued interest) as time to maturity approaches, at least for the case in which the market interest rate is constant. The low-coupon bond enjoys capital gains, whereas the high-coupon bond suffers capital losses.[10]

We use these examples to show that each bond offers investors the same total rate of return. Although the capital gain versus income components differ, the price of each bond is set to provide competitive rates, as we should expect in well-functioning capital markets. Security returns all should be comparable on an after-tax risk-adjusted basis. If they are not, investors will try to sell low-return securities, thereby driving down their prices until

[9]Using a calculator, enter $n = 3$, $i = 8$, PMT = 70, FV = 1,000, and compute PV.

[10]If interest rates are volatile, the price path will be "jumpy," vibrating around the price path in Figure 14.6 and reflecting capital gains or losses as interest rates fluctuate. Ultimately, however, the price must reach par value at the maturity date, so the price of the premium bond will fall over time while that of the discount bond will rise.

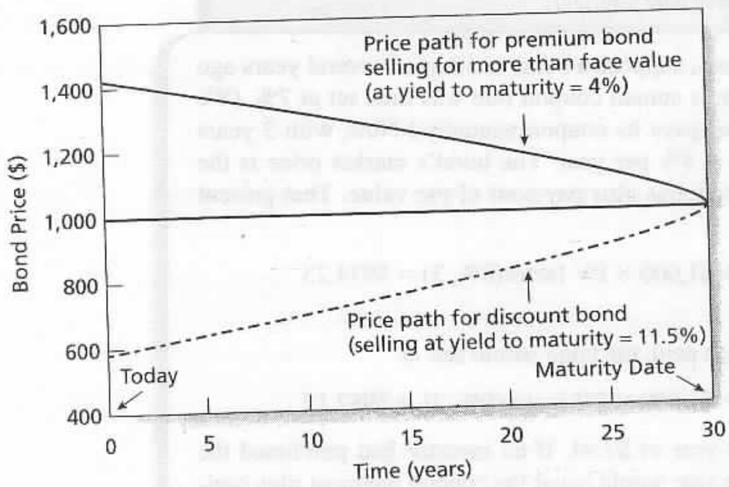

Figure 14.6 Prices over time of 30-year maturity, 6.5% coupon bonds. Bond price approaches par value as maturity approaches.

the total return at the now-lower price is competitive with other securities. Prices should continue to adjust until all securities are fairly priced in that expected returns are comparable, given appropriate risk and tax adjustments.

Yield to Maturity versus Holding-Period Return

In Example 14.7, the holding-period return and the yield to maturity were equal. The bond yield started and ended the year at 8%, and the bond's holding-period return also equaled 8%. This turns out to be a general result. When the yield to maturity is unchanged over the period, the rate of return on the bond will equal that yield. As we noted, this should not be surprising: The bond must offer a rate of return competitive with those available on other securities.

However, when yields fluctuate, so will a bond's rate of return. Unanticipated changes in market rates will result in unanticipated changes in bond returns and, after the fact, a bond's holding-period return can be better or worse than the yield at which it initially sells. An increase in the bond's yield acts to reduce its price, which reduces the holding period return. In this event, the holding period return is likely to be less than the initial yield to maturity.[11] Conversely, a decline in yield will result in a holding-period return greater than the initial yield.

Example 14.8 Yield to Maturity versus Holding-Period Return

Consider a 30-year bond paying an annual coupon of \$80 and selling at par value of \$1,000. The bond's initial yield to maturity is 8%. If the yield remains at 8% over the year, the bond price will remain at par, so the holding-period return also will be 8%. But if the yield falls below 8%, the bond price will increase. Suppose the yield falls and the price increases to \$1,050. Then the holding-period return is greater than 8%:

$$\text{Holding-period return} = \frac{\$80 + (\$1{,}050 - \$1{,}000)}{\$1{,}000} = .13, \text{ or } 13\%$$

[11]We have to be a bit careful here. When yields increase, coupon income can be reinvested at higher rates, which offsets the impact of the initial price decline. If your holding period is sufficiently long, the positive impact of the higher reinvestment rate can more than offset the initial price decline. But common performance evaluation periods for portfolio managers are no more than 1 year, and over these shorter horizons the price impact will almost always dominate the impact of the reinvestment rate. We discuss the trade-off between price risk and reinvestment rate risk more fully in Chapter 16.

CONCEPT Check ✓ 7

Show that if yield to maturity increases, then holding-period return is *less* than initial yield. For example, suppose in Example 14.8 that by the end of the first year, the bond's yield to maturity is 8.5%. Find the 1-year holding-period return and compare it to the bond's initial 8% yield to maturity.

Here is another way to think about the difference between yield to maturity and holding-period return. Yield to maturity depends only on the bond's coupon, *current* price, and par value at maturity. All of these values are observable today, so yield to maturity can be easily calculated. Yield to maturity can be interpreted as a measure of the *average* rate of return if the investment in the bond is held until the bond matures. In contrast, holding-period return is the rate of return over a particular investment period and depends on the market price of the bond at the end of that holding period; of course this price is *not* known today. Because bond prices over the holding period will respond to unanticipated changes in interest rates, holding-period return can at most be forecast.

Zero-Coupon Bonds and Treasury Strips

Original-issue discount bonds are less common than coupon bonds issued at par. These are bonds that are issued intentionally with low coupon rates that cause the bond to sell at a discount from par value. An extreme example of this type of bond is the *zero-coupon bond,* which carries no coupons and provides all its return in the form of price appreciation. Zeros provide only one cash flow to their owners, on the maturity date of the bond.

U.S. Treasury bills are examples of short-term zero-coupon instruments. If the bill has face value of \$10,000, the Treasury issues or sells it for some amount less than \$10,000, agreeing to repay \$10,000 at maturity. All of the investor's return comes in the form of price appreciation.

Longer-term zero-coupon bonds are commonly created from coupon-bearing notes and bonds. A bond dealer who purchases a Treasury coupon bond may ask the Treasury to break down the cash flows to be paid by the bond into a series of independent securities, where each security is a claim to one of the payments of the original bond. For example, a 10-year coupon bond would be "stripped" of its 20 semiannual coupons, and each coupon payment would be treated as a stand-alone zero-coupon bond. The maturities of these bonds would thus range from 6 months to 10 years. The final payment of principal would be treated as another stand-alone zero-coupon security. Each of the payments is now treated as an independent security and is assigned its own CUSIP number (by the Committee on Uniform Securities Identification Procedures), the security identifier that allows for electronic trading over the Fedwire system, a network that connects all Federal Reserve banks and their branches. The payments are still considered obligations of the U.S. Treasury. The Treasury program under which coupon stripping is performed is called STRIPS (Separate Trading of Registered Interest and Principal of Securities), and these zero-coupon securities are called Treasury *strips.*

What should happen to prices of zeros as time passes? On their maturity dates, zeros must sell for par value. Before maturity, however, they should sell at discounts from par, because of the time value of money. As time passes, price should approach par value. In fact, if the interest rate is constant, a zero's price will increase at exactly the rate of interest.

To illustrate, consider a zero with 30 years until maturity, and suppose the market interest rate is 10% per year. The price of the bond today is $\$1{,}000/(1.10)^{30} = \$57.31$. Next year, with only 29 years until maturity, if the yield is still 10%, the price will be

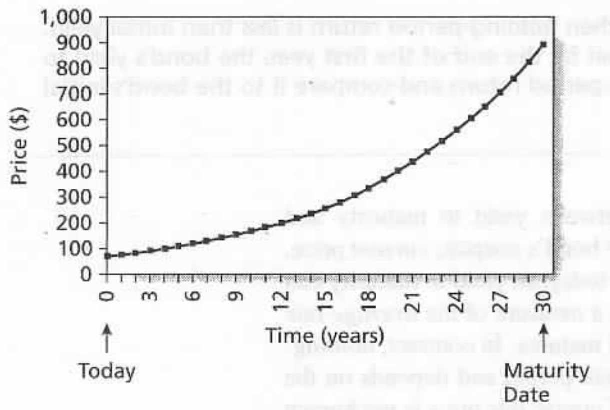

Figure 14.7 The price of a 30-year zero-coupon bond over time at a yield to maturity of 10%. Price equals $1,000/(1.10)^T$, where T is time until maturity.

$\$1,000/(1.10)^{29} = \$63.04$, a 10% increase over its previous-year value. Because the par value of the bond is now discounted for 1 year fewer, its price has increased by the 1-year discount factor.

Figure 14.7 presents the price path of a 30-year zero-coupon bond for an annual market interest rate of 10%. The bond prices rise exponentially, not linearly, until its maturity.

After-Tax Returns

The tax authorities recognize that the "built-in" price appreciation on original-issue discount (OID) bonds such as zero-coupon bonds represents an implicit interest payment to the holder of the security. The IRS, therefore, calculates a price appreciation schedule to impute taxable interest income for the built-in appreciation during a tax year, even if the asset is not sold or does not mature until a future year. Any additional gains or losses that arise from changes in market interest rates are treated as capital gains or losses if the OID bond is sold during the tax year.

Example 14.9 Taxation of Original-Issue Discount Bonds

If the interest rate originally is 10%, the 30-year zero would be issued at a price of $\$1,000/(1.10)^{30} = \$57.31$. The following year, the IRS calculates what the bond price would be if the yield were still 10%. This is $\$1,000/(1.10)^{29} = \$63.04$. Therefore, the IRS imputes interest income of $\$63.04 - \$57.31 = \$5.73$. This amount is subject to tax. Notice that the *imputed* interest income is based on a "constant yield method" that ignores any changes in market interest rates.

If interest rates actually fall, let's say to 9.9%, the bond price will be $\$1,000/(1.099)^{29} = \$64.72$. If the bond is sold, then the difference between \$64.72 and \$63.04 is treated as capital gains income and taxed at the capital gains tax rate. If the bond is not sold, then the price difference is an unrealized capital gain and does not result in taxes in that year. In either case, the investor must pay taxes on the \$5.73 of imputed interest at the rate on ordinary income.

The procedure illustrated in Example 14.9 applies as well to the taxation of other original-issue discount bonds, even if they are not zero-coupon bonds. Consider, as an example, a 30-year maturity bond that is issued with a coupon rate of 4% and a yield to maturity of 8%. For simplicity, we will assume that the bond pays coupons once annually. Because of the low coupon rate, the bond will be issued at a price far below par value, specifically at a price of \$549.69. If the bond's yield to maturity is still 8%, then its price in 1 year will rise to \$553.66. (Confirm this for yourself.) This would provide a pretax holding-period return (HPR) of exactly 8%:

$$\text{HPR} = \frac{\$40 + (\$553.66 - \$549.69)}{\$549.69} = .08$$

The increase in the bond price based on a constant yield, however, is treated as interest income, so the investor is required to pay taxes on the explicit coupon income, \$40, as well as the imputed interest income of \$553.66 − \$549.69 = \$3.97. If the bond's yield actually changes during the year, the difference between the bond's price and the constant-yield value of \$553.66 would be treated as capital gains income if the bond is sold.

CONCEPT *Check* 8 ✓

Suppose that the yield to maturity of the 4% coupon, 30-year maturity bond falls to 7% by the end of the first year and that the investor sells the bond after the first year. If the investor's federal plus state tax rate on interest income is 38% and the combined tax rate on capital gains is 20%, what is the investor's after-tax rate of return?

14.5 Default Risk and Bond Pricing

Although bonds generally *promise* a fixed flow of income, that income stream is not riskless unless the investor can be sure the issuer will not default on the obligation. While U.S. government bonds may be treated as free of default risk, this is not true of corporate bonds. Therefore, the actual payments on these bonds are uncertain, for they depend to some degree on the ultimate financial status of the firm.

Bond default risk, usually called **credit risk,** is measured by Moody's Investor Services, Standard & Poor's Corporation, and Fitch Investors Service, all of which provide financial information on firms as well as quality ratings of large corporate and municipal bond issues. International sovereign bonds, which also entail default risk, especially in emerging markets, also are commonly rated for default risk. Each rating firm assigns letter grades to the bonds of corporations and municipalities to reflect their assessment of the safety of the bond issue. The top rating is AAA or Aaa, a designation awarded to only about a dozen firms. Moody's modifies each rating class with a 1, 2, or 3 suffix (e.g., Aaa1, Aaa2, Aaa3) to provide a finer gradation of ratings. The other agencies use a + or − modification.

Those rated BBB or above (S&P, Fitch) or Baa and above (Moody's) are considered **investment-grade bonds,** whereas lower-rated bonds are classified as **speculative-grade** or **junk bonds.** Defaults on low-grade issues are not uncommon. For example, almost half of the bonds that were rated CCC by Standard & Poor's at issue have defaulted within 10 years. Highly rated bonds rarely default, but even these bonds are not free of credit risk. For example, in May 2001 WorldCom sold \$11.8 billion of bonds with an investment-grade rating. Only a year later, the firm filed for bankruptcy and its bondholders lost more than 80% of their investment. Certain regulated institutional investors such as insurance companies have not always been allowed to invest in speculative-grade bonds.

Figure 14.8 provides the definitions of each bond rating classification.

Junk Bonds

Junk bonds, also known as *high-yield bonds,* are nothing more than speculative-grade (low-rated or unrated) bonds. Before 1977, almost all junk bonds were "fallen angels," that is, bonds issued by firms that originally had investment-grade ratings but that had since been downgraded. In 1977, however, firms began to issue "original-issue junk."

Much of the credit for this innovation is given to Drexel Burnham Lambert, and especially its trader Michael Milken. Drexel had long enjoyed a niche as a junk bond trader and had established a network of potential investors in junk bonds. Firms not able to muster an

Bond Ratings

	Very High Quality	High Quality	Speculative	Very Poor
Standard & Poor's	AAA AA	A BBB	BB B	CCC D
Moody's	Aaa Aa	A Baa	Ba B	Caa C

At times both Moody's and Standard & Poor's have used adjustments to these ratings: S&P uses plus and minus signs: A+ is the strongest A rating and A− the weakest. Moody's uses a 1, 2, or 3 designation, with 1 indicating the strongest.

Moody's	S&P	
Aaa	AAA	Debt rated Aaa and AAA has the highest rating. Capacity to pay interest and principal is extremely strong.
Aa	AA	Debt rated Aa and AA has a very strong capacity to pay interest and repay principal. Together with the highest rating, this group comprises the high-grade bond class.
A	A	Debt rated A has a strong capacity to pay interest and repay principal, although it is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than debt in higher-rated categories.
Baa	BBB	Debt rated Baa and BBB is regarded as having an adequate capacity to pay interest and repay principal. Whereas it normally exhibits adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for debt in this category than in higher-rated categories. These bonds are medium-grade obligations.
Ba B Caa Ca	BB B CCC CC	Debt rated in these categories is regarded, on balance, as predominantly speculative with respect to capacity to pay interest and repay principal in accordance with the terms of the obligation. BB and Ba indicate the lowest degree of speculation, and CC and Ca the highest degree of speculation. Although such debt will likely have some quality and protective characteristics, these are outweighed by large uncertainties or major risk exposures to adverse conditions. Some issues may be in default.
C	C	This rating is reserved for income bonds on which no interest is being paid.
D	D	Debt rated D is in default, and payment of interest and/or repayment of principal is in arrears.

Figure 14.8 Definitions of each bond rating class

Source: Stephen A. Ross and Randolph W. Westerfield, *Corporate Finance*, Copyright 1988 (St. Louis: Times Mirror/Mosby College Publishing, reproduced with permission from the McGraw-Hill Companies, Inc.). Data from various editions of *Standard & Poor's Bond Guide* and *Moody's Bond Guide*.

investment-grade rating were happy to have Drexel (and other investment bankers) market their bonds directly to the public, as this opened up a new source of financing. Junk issues were a lower-cost financing alternative than borrowing from banks.

High-yield bonds gained considerable notoriety in the 1980s when they were used as financing vehicles in leveraged buyouts and hostile takeover attempts. Shortly thereafter, however, the junk bond market suffered. The legal difficulties of Drexel and Michael Milken in connection with Wall Street's insider trading scandals of the late 1980s tainted the junk bond market.

At the height of Drexel's difficulties, the high-yield bond market nearly dried up. Since then, the market has rebounded dramatically. However, it is worth noting that the average credit quality of newly issued high-yield debt issued today is higher than the average quality in the boom years of the 1980s. Of course, in periods of financial stress, junk bonds are more vulnerable than investment-grade bonds. During the credit crisis of 2008, prices on these bonds fell dramatically, and their yields to maturity rose equally dramatically. The spread between yields on junk bonds and Treasuries widened from around 3% in early 2007 to an astonishing 18% by the beginning of 2009.

Determinants of Bond Safety

Bond rating agencies base their quality ratings largely on an analysis of the level and trend of some of the issuer's financial ratios. The key ratios used to evaluate safety are

1. *Coverage ratios*—Ratios of company earnings to fixed costs. For example, the *times-interest-earned ratio* is the ratio of earnings before interest payments and taxes to interest obligations. The *fixed-charge coverage ratio* includes lease payments and sinking fund payments with interest obligations to arrive at the ratio of earnings to all fixed cash obligations (sinking funds are described below). Low or falling coverage ratios signal possible cash flow difficulties.
2. *Leverage ratio, Debt-to-equity ratio*—A too-high leverage ratio indicates excessive indebtedness, signaling the possibility the firm will be unable to earn enough to satisfy the obligations on its bonds.
3. *Liquidity ratios*—The two most common liquidity ratios are the *current ratio* (current assets/current liabilities) and the *quick ratio* (current assets excluding inventories/current liabilities). These ratios measure the firm's ability to pay bills coming due with its most liquid assets.
4. *Profitability ratios*—Measures of rates of return on assets or equity. Profitability ratios are indicators of a firm's overall financial health. The *return on assets* (earnings before interest and taxes divided by total assets) or *return on equity* (net income/equity) are the most popular of these measures. Firms with higher returns on assets or equity should be better able to raise money in security markets because they offer prospects for better returns on the firm's investments.
5. *Cash flow-to-debt ratio*—This is the ratio of total cash flow to outstanding debt.

Standard & Poor's periodically computes median values of selected ratios for firms in several rating classes, which we present in Table 14.3. Of course, ratios must be evaluated in the context of industry standards, and analysts differ in the weights they place on particular ratios. Nevertheless, Table 14.3 demonstrates the tendency of ratios to improve along with the firm's rating class. And default rates vary dramatically with bond rating. Historically, only about 1% of bonds originally rated AA or better at issuance had defaulted after 15 years. That ratio is around 7.5% for BBB-rated bonds, and 40% for B-rated bonds. Credit risk clearly varies dramatically across rating classes.

Many studies have tested whether financial ratios can in fact be used to predict default risk. One of the best-known series of tests was conducted by Edward Altman, who used discriminant analysis to predict bankruptcy. With this technique a firm is assigned a score based on its financial characteristics. If its score exceeds a cut-off value, the firm is deemed creditworthy. A score below the cut-off value indicates significant bankruptcy risk in the near future.

To illustrate the technique, suppose that we were to collect data on the return on equity (ROE) and coverage ratios of a sample of firms, and then keep records of any corporate

	3-year (2002 to 2004) medians						
	AAA	AA	A	BBB	BB	B	CCC
EBIT interest coverage multiple	23.8	19.5	8.0	4.7	2.5	1.2	0.4
EBITDA interest coverage multiple	25.5	24.6	10.2	6.5	3.5	1.9	0.9
Funds from operations/total debt (%)	203.3	79.9	48.0	35.9	22.4	11.5	5.0
Free operating cash flow/total debt (%)	127.6	44.5	25.0	17.3	8.3	2.8	(2.1)
Total debt/EBITDA multiple	0.4	0.9	1.6	2.2	3.5	5.3	7.9
Return on capital (%)	27.6	27.0	17.5	13.4	11.3	8.7	3.2
Total debt/total debt + equity (%)	12.4	28.3	37.5	42.5	53.7	75.9	113.5

Note: EBITDA is earnings before interest, taxes, depreciation, and amortization
Source: *Corporate Rating Criteria*, Standard & Poor's, 2006.

Table 14.3

Financial ratios by rating class, long-term debt

bankruptcies. In Figure 14.9 we plot the ROE and coverage ratios for each firm using *X* for firms that eventually went bankrupt and *O* for those that remained solvent. Clearly, the *X* and *O* firms show different patterns of data, with the solvent firms typically showing higher values for the two ratios.

The discriminant analysis determines the equation of the line that best separates the *X* and *O* observations. Suppose that the equation of the line is $.75 = .9 \times \text{ROE} + .4 \times \text{Coverage}$. Then, based on its own financial ratios, each firm is assigned a "*Z*-score" equal to $.9 \times \text{ROE} + .4 \times \text{Coverage}$. If its *Z*-score exceeds .75, the firm plots above the line and is considered a safe bet; *Z*-scores below .75 foretell financial difficulty.

Altman found the following equation to best separate failing and nonfailing firms:

$$Z = 3.1\frac{\text{EBIT}}{\text{Total assets}} + 1.0\frac{\text{Sales}}{\text{Assets}} + .42\frac{\text{Shareholders' equity}}{\text{Total liabilities}}$$
$$+ .85\frac{\text{Retained earnings}}{\text{Total assets}} + .72\frac{\text{Working capital}}{\text{Total assets}}$$

where EBIT = earnings before interest and taxes.[12] *Z*-scores below 1.23 indicate vulnerability to bankruptcy, scores between 1.2 and 2.90 are a gray area, and scores above 2.90 are considered safe.

CONCEPT Check 9

Suppose we add a new variable equal to current liabilities/current assets to Altman's equation. Would you expect this variable to receive a positive or negative coefficient?

Bond Indentures

A bond is issued with an *indenture*, which is the contract between the issuer and the bondholder. Part of the indenture is a set of restrictions that protect the rights of the bondholders. Such restrictions include provisions relating to collateral, sinking funds, dividend policy, and further borrowing. The issuing firm agrees to these *protective covenants* in order to market its bonds to investors concerned about the safety of the bond issue.

[12] Altman's original work was published in Edward I. Altman, "Financial Ratios, Discriminant Analysis, and the Prediction of Corporate Bankruptcy," *Journal of Finance* 23 (September 1968). This equation is from his updated study, *Corporate Financial Distress and Bankruptcy*, 2nd ed. (New York: Wiley, 1993), p. 29.

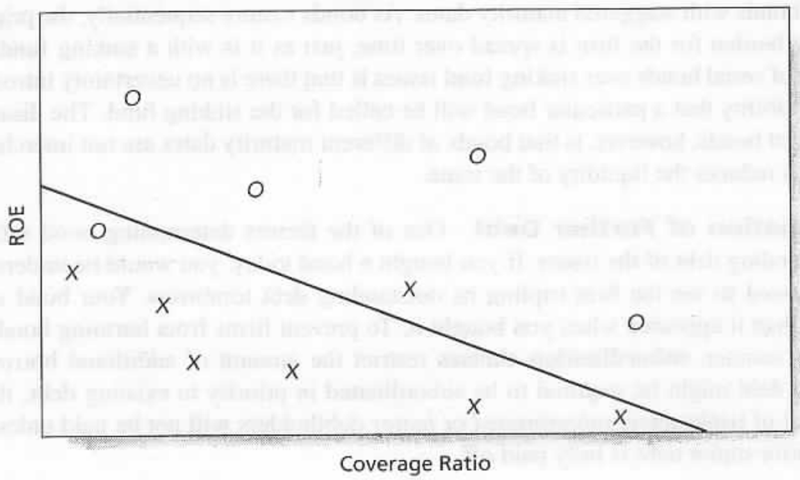

Figure 14.9 Discriminant analysis

Sinking Funds Bonds call for the payment of par value at the end of the bond's life. This payment constitutes a large cash commitment for the issuer. To help ensure the commitment does not create a cash flow crisis, the firm agrees to establish a **sinking fund** to spread the payment burden over several years. The fund may operate in one of two ways:

1. The firm may repurchase a fraction of the outstanding bonds in the open market each year.
2. The firm may purchase a fraction of the outstanding bonds at a special call price associated with the sinking fund provision. The firm has an option to purchase the bonds at either the market price or the sinking fund price, whichever is lower. To allocate the burden of the sinking fund call fairly among bondholders, the bonds chosen for the call are selected at random based on serial number.[13]

The sinking fund call differs from a conventional bond call in two important ways. First, the firm can repurchase only a limited fraction of the bond issue at the sinking fund call price. At best, some indentures allow firms to use a *doubling option*, which allows repurchase of double the required number of bonds at the sinking fund call price. Second, while callable bonds generally have call prices above par value, the sinking fund call price usually is set at the bond's par value.

Although sinking funds ostensibly protect bondholders by making principal repayment more likely, they can hurt the investor. The firm will choose to buy back discount bonds (selling below par) at market price, while exercising its option to buy back premium bonds (selling above par) at par. Therefore, if interest rates fall and bond prices rise, firms will benefit from the sinking fund provision that enables them to repurchase their bonds at below-market prices. In these circumstances, the firm's gain is the bondholder's loss.

[13] Although it is less common, the sinking fund provision also may call for periodic payments to a trustee, with the payments invested so that the accumulated sum can be used for retirement of the entire issue at maturity.

One bond issue that does not require a sinking fund is a *serial bond* issue, in which the firm sells bonds with staggered maturity dates. As bonds mature sequentially, the principal repayment burden for the firm is spread over time, just as it is with a sinking fund. One advantage of serial bonds over sinking fund issues is that there is no uncertainty introduced by the possibility that a particular bond will be called for the sinking fund. The disadvantage of serial bonds, however, is that bonds of different maturity dates are not interchangeable, which reduces the liquidity of the issue.

Subordination of Further Debt One of the factors determining bond safety is total outstanding debt of the issuer. If you bought a bond today, you would be understandably distressed to see the firm tripling its outstanding debt tomorrow. Your bond would be riskier than it appeared when you bought it. To prevent firms from harming bondholders in this manner, **subordination clauses** restrict the amount of additional borrowing. Additional debt might be required to be subordinated in priority to existing debt; that is, in the event of bankruptcy, *subordinated* or *junior* debtholders will not be paid unless and until the prior senior debt is fully paid off.

& Mobil Corp. debenture 8s, due 2032:
Rating — Aa2

AUTH----$250,000,000.
OUTSTG----Dec. 31, 1993, $250,000,000.
DATED----Oct. 30, 1991.
INTEREST----F&A 12.
TRUSTEE----Chemical Bank.
DENOMINATION----Fully registered, $1,000 and integral multiplies thereof. Transferable and exchangeable without service charge.
CALLABLE----As a whole or in part, at any time, on or after Aug. 12, 2002, at the option of Co. on at least 30 but not more than the 60 days' notice to each Aug. 11 as follows:

2003..........105.007	2004..........104.756	2005..........104.506
2006..........104.256	2007..........104.005	2008..........103.755
2009..........103.505	2010..........103.254	2011..........103.004
2012..........102.754	2013..........102.503	2014..........102.253
2015..........102.003	2016..........101.752	2017..........101.502
2018..........101.252	2019..........101.001	2020..........100.751
2021..........100.501	2022..........100.250	

and thereafter at 100 plus accrued interest.
SECURITY----Not secured. Ranks equally with all other unsecured and unsubordinated indebtedness of Co. Co. nor any Affiliate will not incur any indebtedness; provided that Co. will not create as security for any indebtedness for borrowed money, any mortgage, pledge, security interest or lien on any stock or indebtedness is directly owned by Co. without effectively providing that the debt securities shall be secured equally and ratably with such indebtedness. so long as such indebtedness shall be so secured.
INDENTURE MODIFICATION----Indenture may be modified, except as provided with, consent of 66 2/3% of debs. outstg.
RIGHTS ON DEFAULT----Trustee, or 25% of debs. outstg., may declare principal due and payable (30 days' grace for payment of interest).

LISTED----On New York Stock Exchange.
PURPOSE----Proceeds used for general corporate purposes.
OFFERED----($250,000,000) at 99.51 plus accrued interest (proceeds to Co., 99.11) on Aug. 5, 1992 thru Merrill Lynch & Co., Donaldson, Lufkin & Jenerette Securities Corp., PaineWebber Inc., Prudential Securities Inc., Smith Barney, Harris Upham & Co. Inc. and associates.

Figure 14.10 Callable bond issued by Mobil

Source: *Mergent's Industrial Manual*, Mergent's Investor Services, 1994. Reprinted with permission.

Dividend Restrictions Covenants also limit the dividends firms may pay. These limitations protect the bondholders because they force the firm to retain assets rather than paying them out to stockholders. A typical restriction disallows payments of dividends if cumulative dividends paid since the firm's inception exceed cumulative retained earnings plus proceeds from sales of stock.

Collateral Some bonds are issued with specific collateral behind them. **Collateral** is a particular asset that the bondholders receive if the firm defaults on the bond. If the collateral is property, the bond is called a *mortgage bond.* If the collateral takes the form of other securities held by the firm, the bond is a *collateral trust bond.* In the case of equipment, the bond is known as an *equipment obligation bond.* This last form of collateral is used most commonly by firms such as railroads, where the equipment is fairly standard and can be easily sold to another firm should the firm default.

Collateralized bonds generally are considered safer than general **debenture** bonds, which are *unsecured,* meaning they do not provide for specific collateral. Credit risk of unsecured bonds depends on the general earning power of the firm. If the firm defaults, debenture owners become general creditors of the firm. Because they are safer, collateralized bonds generally offer lower yields than general debentures.

Figure 14.10 shows the terms of a bond issued by Mobil as described in *Moody's Industrial Manual.* The bond is registered and listed on the NYSE. It was issued in 1991 but was not callable until 2002. Although the call price started at 105.007% of par value, it declines gradually until reaching par after 2020. Most of the terms of the bond are typical and illustrate many of the indenture provisions we have mentioned. However, in recent years there has been a marked trend away from the use of call provisions.

Yield to Maturity and Default Risk

Because corporate bonds are subject to default risk, we must distinguish between the bond's promised yield to maturity and its expected yield. The promised or stated yield will be realized only if the firm meets the obligations of the bond issue. Therefore, the stated yield is the *maximum possible* yield to maturity of the bond. The expected yield to maturity must take into account the possibility of a default.

For example, in mid-October 2009, the bank holding company CIT Group faced a wave of defaults on loans it had extended to many small businesses, and it was quickly approaching its own bankruptcy. Its 6.5% coupon bonds due in 2014 were rated CC and were selling at about 62% of par value, resulting in a yield to maturity of about 18%. Investors did not really believe the expected rate of return on these bonds was 18%. They recognized that bondholders were very unlikely to receive all the payments promised in the bond contract and that the yield based on *expected* cash flows was far less than the yield based on *promised* cash flows.

Example 14.10 Expected vs. Promised Yield to Maturity

Suppose a firm issued a 9% coupon bond 20 years ago. The bond now has 10 years left until its maturity date but the firm is having financial difficulties. Investors believe that the firm will be able to make good on the remaining interest payments, but that at the maturity date, the firm will be forced into bankruptcy, and bondholders will receive only 70% of par value. The bond is selling at $750.

Yield to maturity (YTM) would then be calculated using the following inputs:

	Expected YTM	**Stated YTM**
Coupon payment	$45	$45
Number of semiannual periods	20 periods	20 periods
Final payment	$700	$1,000
Price	$750	$750

The yield to maturity based on promised payments is 13.7%. Based on the expected payment of $700 at maturity, however, the yield to maturity would be only 11.6%. The stated yield to maturity is greater than the yield investors actually expect to receive.

Example 14.10 suggests that when a bond becomes more subject to default risk, its price will fall, and therefore its promised yield to maturity will rise. Similarly, the default premium, the spread between the stated yield to maturity and that on otherwise-comparable Treasury bonds, will rise. However, its expected yield to maturity, which ultimately is tied to the systematic risk of the bond, will be far less affected. Let's continue Example 14.10.

Example 14.11 Default Risk and the Default Premium

Suppose that the condition of the firm in Example 14.10 deteriorates further, and investors now believe that the bond will pay off only 55% of face value at maturity. Investors now demand an expected yield to maturity of 12% (i.e., 6% semiannually), which is .4% higher than in Example 14.10. But the price of the bond will fall from $750 to $688 [$n = 20$; $i = 6$;

FV = 550; PMT = $45]. At this price, the stated yield to maturity based on promised cash flows is 15.2%. While the expected yield to maturity has increased by .4%, the drop in price has caused the promised yield to maturity to rise by 1.5%.

CONCEPT Check 10

What is the expected yield to maturity in Example 14.11 if the firm is in even worse condition? Investors expect a final payment of only $500, and the bond price has fallen to $650.

To compensate for the possibility of default, corporate bonds must offer a **default premium.** The default premium is the difference between the promised yield on a corporate bond and the yield of an otherwise-identical government bond that is riskless in terms of default. If the firm remains solvent and actually pays the investor all of the promised cash flows, the investor will realize a higher yield to maturity than would be realized from the government bond. If, however, the firm goes bankrupt, the corporate bond is likely to provide a lower return than the government bond. The corporate bond has the potential for both better and worse performance than the default-free Treasury bond. In other words, it is riskier.

The pattern of default premiums offered on risky bonds is sometimes called the *risk structure of interest rates.* The greater the default risk, the higher the default premium. Figure 14.11 shows spreads between yields to maturity of bonds of different risk classes. You can see here clear evidence of credit-risk premiums on promised yields. Note, for example, the incredible run-up of credit spreads during the financial crisis of 2008.

Credit Default Swaps

A **credit default swap (CDS)** is in effect an insurance policy on the default risk of a corporate bond or loan. To illustrate, the annual premium in September 2009 on a 5-year Citigroup CDS was about 1.5%, meaning that the CDS buyer would pay the seller an annual premium of $1.50 for each $100 of bond principal. The seller collects these annual payments for the term of the contract but must compensate the buyer for loss of bond value in the event of a default.[14] That compensation can take two forms. The CDS holder may deliver a defaulted bond to the CDS issuer in return for the bond's par value. This is called *physical settlement.* Instead, the issuer may pay the swap holder the difference between the par value of the bond and its market price (even in a default, the bond

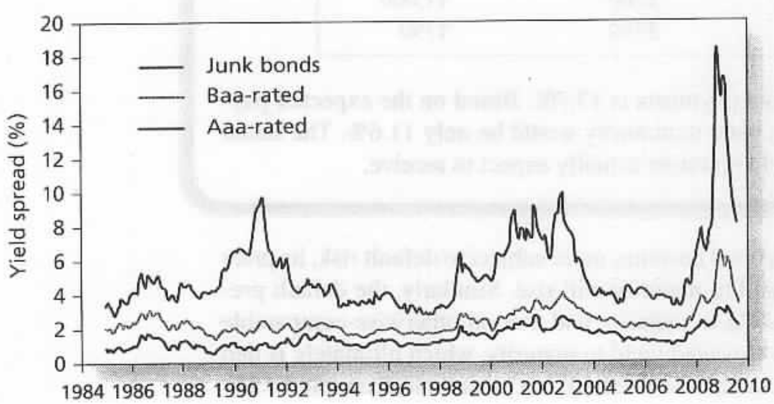

Figure 14.11 Yield spreads between corporate and 10-year Treasury bonds

[14] Actually, credit default swaps may pay off even short of an actual default. The contract specifies the particular "credit events" that will trigger a payment. For example, restructuring (rewriting the terms of a firm's outstanding debt as an alternative to formal bankruptcy proceedings) may be defined as a triggering credit event.

will still sell at a positive price since creditors recovery some value in a bankruptcy). This is called *cash settlement.*

Credit default swaps were designed to allow lenders to buy protection against default risk. The natural buyers of CDSs would then be large bondholders or banks that wished to enhance the creditworthiness of their outstanding loans. Even if the borrowing firm had shaky credit standing, the "insured" debt would be as safe as the issuer of the CDS. An investor holding a bond with a BB rating could in principle raise the effective quality of the debt to AAA by buying a CDS on the issuer.

This insight suggests how CDS contracts should be priced. If a BB-rated bond bundled with insurance via a CDS is effectively equivalent to a AAA-rated bond, then the premium on the swap ought to approximate the yield spread between AAA-rated and BB-rated bonds.[15] The risk structure of interest rates and CDS prices ought to be tightly aligned.

Figure 14.12 shows the sharp run-up in the prices of 5-year CDSs on several financial firms in the months preceding the Lehman Brothers bankruptcy in September 2008. As perceived credit risk of these firms increased, so did the price of insuring their debt.

While CDSs were conceived as a form of bond insurance, it wasn't long before investors realized that they could be used to speculate on the financial health of particular companies. As Figure 14.12 makes clear, someone in August 2008 wishing to bet against the financial sector might have purchased CDS contracts on those firms and would have profited as CDS prices spiked in September.

In principle, with traders establishing CDS contracts purely to speculate on other firms, there can be more contracts outstanding than there are physical bonds to insure! As Lehman Brothers entered bankruptcy, about $400 billion of Lehman CDS contracts were outstanding, despite the fact that its total debt was only around $155 billion. However, while this apparent imbalance was widely noted at the time, it greatly overstated the true mismatch. That is because many traders had offset CDS positions established at one date with opposite positions established at a later date. The widely cited $400 billion figure was the gross value of outstanding contracts, and did not net out these offsetting positions. In the end, it seems that only about $7 billion needed to change hands to settle the CDS contracts.

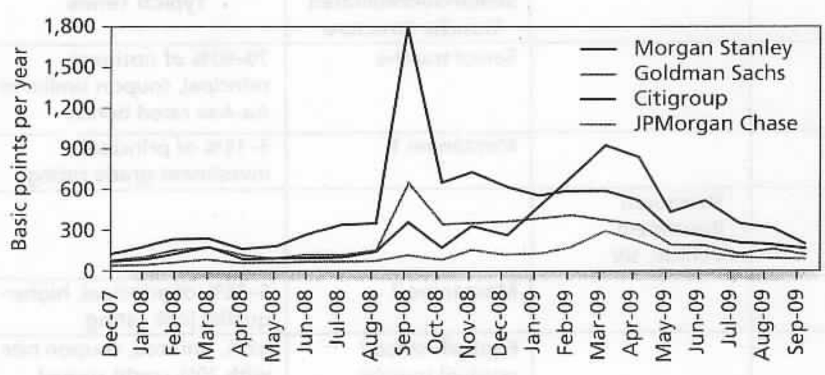

Figure 14.12 Prices of Credit Default Swaps

[15]We say approximately because there are some differences between highly rated bonds and bonds synthetically enhanced with credit default swaps. For example, the term of the swap may not match the maturity of the bond. Tax treatment of coupon payments versus swap payments may differ, as may the liquidity of the bonds. Finally, some CDSs may entail one-time up-front payments as well as annual premiums.

Nevertheless, this episode highlighted the utter lack of transparency about firms' CDS obligations. Such uncertainty about firms' exposures to the credit risk of others gave rise to doubts about their own financial stability. This lack of transparency was a contributing factor in the credit meltdown of 2008.

Credit Risk and Collateralized Debt Obligations

Collateralized debt obligations, or **CDOs**, emerged in the last decade as a major mechanism to reallocate credit risk in the fixed-income markets. To create a CDO, a financial institution, commonly a bank, first would establish a legally distinct entity to buy and later resell a portfolio of bonds or other loans. A common vehicle for this purpose was the so-called Structured Investment Vehicle (SIV).[16] An SIV raises funds, often by issuing short-term commercial paper, and uses the proceeds to buy corporate bonds or other forms of debt such as mortgage loans or credit card debt. These loans are first pooled together and then split into a series of classes known as *tranches.* (*Tranche* is the French word for "slice.")

Each tranche is given a different level of seniority in terms of its claims on the underlying loan pool, and each can be sold as a stand-alone security. As the loans in the underlying pool make their interest payments, the proceeds are distributed to pay interest to each tranche in order of seniority. This priority structure implies that each tranche has a different exposure to credit risk.

Figure 14.13 illustrates a typical setup. The senior tranche is on top. Its investors may account for perhaps 80% of the principal of the entire pool. But it has first claim on *all* the debt service. Using our numbers, even if 20% of the debt pool defaults, the senior tranche can be paid in full. Once the highest seniority tranche is paid off, the next-lower class (e.g., the mezzanine 1 tranche in Figure 14.13) receives the proceeds from the pool of loans until its claims also are satisfied. Using junior tranches to insulate senior tranches from credit risk in this manner, one can create Aaa-rated bonds even from a junk-bond portfolio.

		Senior-Subordinated Tranche Structure	Typical Terms
		Senior tranche	70–90% of notional principal, coupon similar to Aa-Aaa rated bonds
		Mezzanine 1	5–15% of principal, investment-grade rating
Bank	Structured Investment Vehicle, SIV		
		Mezzanine 2	5–15% of principal, higher-quality junk rating
		Equity/first loss/ residual tranche	<2%, unrated, coupon rate with 20% credit spread

Figure 14.13 Collateralized debt obligations

[16] The legal separation of the bank from the SIV allows the ownership of the loans to be conducted off the bank's balance sheet, and thus avoids capital requirements the bank would otherwise encounter.

Investor Losses from Lehman Minibonds secured by CDOs

Mounting public anger in Asia over soured investments in complex financial products tied to Lehman Brothers Holdings Inc. is fueling a public backlash and calls for tighter regulation.

In Hong Kong, more than 1,000 investors marched on the city's legislature, saying they were conned into buying now-defunct Lehman Brothers derivatives called "minibonds" from local banks that pitched them as safe investments. Investors were left holding 12.6 billion Hong Kong dollars (US$1.62 billion) in Lehman minibonds, according to Hong Kong's Securities and Futures Commission.

Taiwan's Financial Supervisory Commission estimated Lehman's structured notes were sold to some 51,000 retail investors by 20 different banks in that country, adding up to more than US$1 billion in notes to individual investors alone. In recent days, pressure has increased there for local banks to compensate investors as lawmakers discuss new rules to protect investors.

In Singapore, regulators have appointed third parties to review individual demands for restitution, pledging "a quick and fair resolution" for complaints. "The current crisis has raised the need for regulators to re-examine aspects of their regulatory and supervisory approach," the Monetary Authority of Singapore said in a statement posted on its Web site last week.

Details differ depending on the product, but the minibonds in general were touted as investments of three years or longer with annual fixed returns of roughly 5%. They were often pitched as tied to the debt of companies well-known in Asia, such as oil producer China National Offshore Oil Corp., or Cnooc, and HSBC Holdings PLC. Sometimes gifts of video cameras or flat-panel TVs were offered to potential investors. The marketing materials also usually noted minibond investors risked losing their principal.

The minibonds at the center of the clashes in Asia were backed by Lehman Brothers, according to the fine print. The minibonds were secured by collateralized debt obligations, a complex debt product, tied to the big-name companies but issued by the New York investment bank. Lehman stopped paying interest on some of the notes after filing for Chapter 11 bankruptcy protection in the U.S. last month, leaving investors without their payments.

Source: Jonathan Cheng, "International Finance: Lehman Anger Rises," *The Wall Street Journal,* October 9, 2008. Reprinted with permission from Dow Jones & Company, Inc., © 2008.

Of course, shielding senior tranches from default risk means that the risk is concentrated on the lower tranches. The bottom tranche—called alternatively the equity, first-loss, or residual tranche—has last call on payments from the pool of loans, or, put differently, is at the head of the line in terms of absorbing default or delinquency risk.

Not surprisingly, investors in tranches with the greatest exposure to credit risk demand the highest coupon rates. Therefore, while the lower mezzanine and equity tranches bear the most risk, they will provide the highest returns if credit experience turns out favorably.

Mortgage-backed CDOs were an investment disaster in 2007 and 2008. These were CDOs formed by pooling subprime mortgage loans made to individuals whose credit standing did not allow them to qualify for conventional mortgages. When home prices stalled in 2007 and interest rates on these typically adjustable-rate loans reset to market levels, mortgage delinquencies and home foreclosures soared, and investors in these securities lost billions of dollars. Even highly rated tranches suffered extreme losses as default rates turned out to be far higher than anticipated.

Not surprisingly, the rating agencies that had certified these tranches as investment-grade came under considerable fire. Questions were raised concerning conflicts of interest: Because the rating agencies are paid by bond issuers, the agencies were accused of responding to pressure to ease their standards.

Many non-mortgage-backed CDOs and related derivative securities were also an investment disaster in 2007 and 2008. For example, many Asian investors suffered losses from their investments in Lehman Brothers backed minibonds that were secured by CDOs (see nearby box).

Summary

1. Fixed-income securities are distinguished by their promise to pay a fixed or specified stream of income to their holders. The coupon bond is a typical fixed-income security.
2. Treasury notes and bonds have original maturities greater than 1 year. They are issued at or near par value, with their prices quoted net of accrued interest.
3. Callable bonds should offer higher promised yields to maturity to compensate investors for the fact that they will not realize full capital gains should the interest rate fall and the bonds be called away from them at the stipulated call price. Bonds often are issued with a period of call protection. In addition, discount bonds selling significantly below their call price offer implicit call protection.
4. Put bonds give the bondholder rather than the issuer the option to terminate or extend the life of the bond.
5. Convertible bonds may be exchanged, at the bondholder's discretion, for a specified number of shares of stock. Convertible bondholders "pay" for this option by accepting a lower coupon rate on the security.
6. Floating-rate bonds pay a coupon rate at a fixed premium over a reference short-term interest rate. Risk is limited because the rate is tied to current market conditions.
7. The yield to maturity is the single interest rate that equates the present value of a security's cash flows to its price. Bond prices and yields are inversely related. For premium bonds, the coupon rate is greater than the current yield, which is greater than the yield to maturity. The order of these inequalities is reversed for discount bonds.
8. The yield to maturity is often interpreted as an estimate of the average rate of return to an investor who purchases a bond and holds it until maturity. This interpretation is subject to error, however. Related measures are yield to call, realized compound yield, and expected (versus promised) yield to maturity.
9. Prices of zero-coupon bonds rise exponentially over time, providing a rate of appreciation equal to the interest rate. The IRS treats this built-in price appreciation as imputed taxable interest income to the investor.
10. When bonds are subject to potential default, the stated yield to maturity is the maximum possible yield to maturity that can be realized by the bondholder. In the event of default, however, that promised yield will not be realized. To compensate bond investors for default risk, bonds must offer default premiums, that is, promised yields in excess of those offered by default-free government securities. If the firm remains healthy, its bonds will provide higher returns than government bonds. Otherwise the returns may be lower.
11. Bond safety is often measured using financial ratio analysis. Bond indentures are another safeguard to protect the claims of bondholders. Common indentures specify sinking fund requirements, collateralization of the loan, dividend restrictions, and subordination of future debt.
12. Credit default swaps provide insurance against the default of a bond or loan. The swap buyer pays an annual premium to the swap seller, but collects a payment equal to lost value if the loan later goes into default.
13. Collateralized debt obligations are used to reallocate the credit risk of a pool of loans. The pool is sliced into tranches, with each tranche assigned a different level of seniority in terms of its claims on the cash flows from the underlying loans. High seniority tranches are usually quite safe, with credit risk concentrated on the lower level tranches. Each tranche can be sold as a stand-alone security.

Related Web sites for this chapter are available at **www.mhedication.asia/olc/bodie**

Key Terms

debt securities
bond
par value
face value
coupon rate
bond indenture
zero-coupon bonds
convertible bonds
put bond
floating-rate bonds
yield to maturity
current yield

premium bonds
discount bonds
realized compound return
horizon analysis
reinvestment rate risk
credit risk
investment-grade bonds
speculative-grade or junk bonds
sinking fund
subordination clauses
collateral
debenture
default premium
credit default swap (CDS)
collateralized debt obligations (CDOs)

Problem Sets

Basic

1. Define the following types of bonds:
   a. Catastrophe bond.
   b. Eurobond.
   c. Zero-coupon bond.
   d. Samurai bond.
   e. Junk bond.
   f. Convertible bond.
   g. Serial bond.
   h. Equipment obligation bond.
   i. Original issue discount bond.
   j. Indexed bond.
   k. Callable bond.
   l. Puttable bond.
2. Two bonds have identical times to maturity and coupon rates. One is callable at 105, the other at 110. Which should have the higher yield to maturity? Why?
3. The stated yield to maturity and realized compound yield to maturity of a (default-free) zero-coupon bond will always be equal. Why?

Intermediate

4. Why do bond prices go down when interest rates go up? Don't lenders like high interest rates?
5. A bond with an annual coupon rate of 4.8% sells for $970. What is the bond's current yield?
6. Which security has a higher *effective* annual interest rate?
   a. A 3-month T-bill selling at $97,645 with par value $100,000.
   b. A coupon bond selling at par and paying a 10% coupon semiannually.
7. Treasury bonds paying an 8% coupon rate with *semiannual* payments currently sell at par value. What coupon rate would they have to pay in order to sell at par if they paid their coupons *annually?* (Hint: What is the effective annual yield on the bond?)
8. Consider a bond with a 10% coupon and with yield to maturity = 8%. If the bond's yield to maturity remains constant, then in 1 year, will the bond price be higher, lower, or unchanged? Why?
9. Consider an 8% coupon bond selling for $953.10 with 3 years until maturity making *annual* coupon payments. The interest rates in the next 3 years will be, with certainty, $r_1 = 8\%$, $r_2 = 10\%$, and $r_3 = 12\%$. Calculate the yield to maturity and realized compound yield of the bond.
10. Assume you have a 1-year investment horizon and are trying to choose among three bonds. All have the same degree of default risk and mature in 10 years. The first is a zero-coupon bond that pays $1,000 at maturity. The second has an 8% coupon rate and pays the $80 coupon once per year. The third has a 10% coupon rate and pays the $100 coupon once per year.
    a. If all three bonds are now priced to yield 8% to maturity, what are their prices?
    b. If you expect their yields to maturity to be 8% at the beginning of next year, what will their prices be then? What is your before-tax holding-period return on each bond? If your tax

bracket is 30% on ordinary income and 20% on capital gains income, what will your after-tax rate of return be on each?

c. Recalculate your answer to (*b*) under the assumption that you expect the yields to maturity on each bond to be 7% at the beginning of next year.

11. A 20-year maturity bond with par value of $1,000 makes semiannual coupon payments at a coupon rate of 8%. Find the bond equivalent and effective annual yield to maturity of the bond if the bond price is:

a. $950.
b. $1,000.
c. $1,050.

12. Repeat Problem 11 using the same data, but assuming that the bond makes its coupon payments annually. Why are the yields you compute lower in this case?

13. Fill in the table below for the following zero-coupon bonds, all of which have par values of $1,000.

Price	Maturity (years)	Bond-Equivalent Yield to Maturity
$400	20	—
$500	20	—
$500	10	—
—	10	10%
—	10	8%
$400	—	8%

14. Consider a bond paying a coupon rate of 10% per year semiannually when the market interest rate is only 4% per half-year. The bond has 3 years until maturity.

a. Find the bond's price today and 6 months from now after the next coupon is paid.
b. What is the total (6-month) rate of return on the bond?

15. A bond with a coupon rate of 7% makes semiannual coupon payments on January 15 and July 15 of each year. *The Wall Street Journal* reports the asked price for the bond on January 30 at 100:02. What is the invoice price of the bond? The coupon period has 182 days.

16. A bond has a current yield of 9% and a yield to maturity of 10%. Is the bond selling above or below par value? Explain.

17. Is the coupon rate of the bond in Problem 16 more or less than 9%?

18. Return to Table 14.1 and calculate both the real and nominal rates of return on the TIPS bond in the second and third years.

19. A newly issued 20-year maturity, zero-coupon bond is issued with a yield to maturity of 8% and face value $1,000. Find the imputed interest income in the first, second, and last year of the bond's life.

20. A newly issued 10-year maturity, 4% coupon bond making *annual* coupon payments is sold to the public at a price of $800. What will be an investor's taxable income from the bond over the coming year? The bond will not be sold at the end of the year. The bond is treated as an original-issue discount bond.

21. A 30-year maturity, 8% coupon bond paying coupons semiannually is callable in 5 years at a call price of $1,100. The bond currently sells at a yield to maturity of 7% (3.5% per half-year).

a. What is the yield to call?
b. What is the yield to call if the call price is only $1,050?
c. What is the yield to call if the call price is $1,100, but the bond can be called in 2 years instead of 5 years?

22. A 10-year bond of a firm in severe financial distress has a coupon rate of 14% and sells for $900. The firm is currently renegotiating the debt, and it appears that the lenders will allow the firm to reduce coupon payments on the bond to one-half the originally contracted amount. The firm can handle these lower payments. What is the stated and expected yield to maturity of the bonds? The bond makes its coupon payments annually.

23. A 2-year bond with par value $1,000 making annual coupon payments of $100 is priced at $1,000. What is the yield to maturity of the bond? What will be the realized compound yield to maturity if the 1-year interest rate next year turns out to be (*a*) 8%, (*b*) 10%, (*c*) 12%?

24. Suppose that today's date is April 15. A bond with a 10% coupon paid semiannually every January 15 and July 15 is listed in *The Wall Street Journal* as selling at an asked price of 101:04. If you buy the bond from a dealer today, what price will you pay for it?

25. Assume that two firms issue bonds with the following characteristics. Both bonds are issued at par.

	ABC Bonds	XYZ Bonds
Issue size	$1.2 billion	$150 million
Maturity	10 years*	20 years
Coupon	9%	10%
Collateral	First mortgage	General debenture
Callable	Not callable	In 10 years
Call price	None	110
Sinking fund	None	Starting in 5 years

*Bond is extendible at the discretion of the bondholder for an additional 10 years.

Ignoring credit quality, identify four features of these issues that might account for the lower coupon on the ABC debt. Explain.

26. An investor believes that a bond may temporarily increase in credit risk. Which of the following would be the most liquid method of exploiting this?

a. The purchase of a credit default swap.
b. The sale of a credit default swap.
c. The short sale of the bond.

27. Which of the following *most accurately* describes the behavior of credit default swaps?

a. When credit risk increases, swap premiums increase.
b. When credit and interest rate risk increases, swap premiums increase.
c. When credit risk increases, swap premiums increase, but when interest rate risk increases, swap premiums decrease.

28. What would be the likely effect on the yield to maturity of a bond resulting from:

a. An increase in the issuing firm's times-interest-earned ratio.
b. An increase in the issuing firm's debt-to-equity ratio.
c. An increase in the issuing firm's quick ratio.

29. A large corporation issued both fixed and floating-rate notes 5 years ago, with terms given in the following table:

	9% Coupon Notes	Floating-Rate Note
Issue size	$250 million	$280 million
Original maturity	20 years	10 years
Current price (% of par)	93	98
Current coupon	9%	8%
Coupon adjusts	Fixed coupon	Every year
Coupon reset rule	—	1-year T-bill rate + 2%
Callable	10 years after issue	10 years after issue
Call price	106	102.50
Sinking fund	None	None
Yield to maturity	9.9%	—
Price range since issued	$85–$112	$97–$102

a. Why is the price range greater for the 9% coupon bond than the floating-rate note?
b. What factors could explain why the floating-rate note is not always sold at par value?
c. Why is the call price for the floating-rate note not of great importance to investors?
d. Is the probability of a call for the fixed-rate note high or low?
e. If the firm were to issue a fixed-rate note with a 15-year maturity, what coupon rate would it need to offer to issue the bond at par value?
f. Why is an entry for yield to maturity for the floating-rate note not appropriate?

30. Masters Corp. issues two bonds with 20-year maturities. Both bonds are callable at $1,050. The first bond is issued at a deep discount with a coupon rate of 4% and a price of $580 to yield 8.4%. The second bond is issued at par value with a coupon rate of 8¾%.
a. What is the yield to maturity of the par bond? Why is it higher than the yield of the discount bond?
b. If you expect rates to fall substantially in the next 2 years, which bond would you prefer to hold?
c. In what sense does the discount bond offer "implicit call protection"?

Challenge

31. A newly issued bond pays its coupons once annually. Its coupon rate is 5%, its maturity is 20 years, and its yield to maturity is 8%.
a. Find the holding-period return for a 1-year investment period if the bond is selling at a yield to maturity of 7% by the end of the year.
b. If you sell the bond after 1 year, what taxes will you owe if the tax rate on interest income is 40% and the tax rate on capital gains income is 30%? The bond is subject to original-issue discount tax treatment.
c. What is the after-tax holding-period return on the bond?
d. Find the realized compound yield *before taxes* for a 2-year holding period, assuming that (1) you sell the bond after 2 years, (2) the bond yield is 7% at the end of the second year, and (3) the coupon can be reinvested for 1 year at a 3% interest rate.
e. Use the tax rates in (*b*) above to compute the *after-tax* 2-year realized compound yield. Remember to take account of OID tax rules.

CFA® PROBLEMS

1. Leaf Products may issue a 10-year maturity fixed-income security, which might include a sinking fund provision and either refunding or call protection.
a. Describe a sinking fund provision.
b. Explain the impact of a sinking fund provision on:
i. The expected average life of the proposed security.
ii. Total principal and interest payments over the life of the proposed security.
c. From the investor's point of view, explain the rationale for demanding a sinking fund provision.

2. Bonds of Zello Corporation with a par value of $1,000 sell for $960, mature in 5 years, and have a 7% annual coupon rate paid semiannually.
a. Calculate the:
i. Current yield.
ii. Yield to maturity (to the nearest whole percent, i.e., 3%, 4%, 5%, etc.).
iii. Realized compound yield for an investor with a 3-year holding period and a reinvestment rate of 6% over the period. At the end of 3 years the 7% coupon bonds with 2 years remaining will sell to yield 7%.
b. Cite one major shortcoming for each of the following fixed-income yield measures:
i. Current yield.
ii. Yield to maturity.
iii. Realized compound yield.

3. On May 30, 2008, Janice Kerr is considering one of the newly issued 10-year AAA corporate bonds shown in the following exhibit.

Description	Coupon	Price	Callable	Call Price
Sentinal, due May 30, 2018	6.00%	100	Noncallable	NA
Colina, due May 30, 2018	6.20%	100	Currently callable	102

a. Suppose that market interest rates decline by 100 basis points (i.e., 1%). Contrast the effect of this decline on the price of each bond.

b. Should Kerr prefer the Colina over the Sentinal bond when rates are expected to rise or to fall?

c. What would be the effect, if any, of an increase in the *volatility* of interest rates on the prices of each bond?

4. A convertible bond has the following features:

Coupon	5.25%
Maturity	June 15, 2027
Market price of bond	\$77.50
Market price of underlying common stock	\$28.00
Annual dividend	\$1.20
Conversion ratio	20.83 shares

Calculate the conversion premium for this bond.

5. *a.* Explain the impact on the offering yield of adding a call feature to a proposed bond issue.

b. Explain the impact on the bond's expected life of adding a call feature to a proposed bond issue.

c. Describe one advantage and one disadvantage of including callable bonds in a portfolio.

6. *a.* An investment in a coupon bond will provide the investor with a return equal to the bond's yield to maturity at the time of purchase if:

i. The bond is not called for redemption at a price that exceeds its par value.
ii. All sinking fund payments are made in a prompt and timely fashion over the life of the issue.
iii. The reinvestment rate is the same as the bond's yield to maturity and the bond is held until maturity.
iv. All of the above.

b. A bond with a call feature:

i. Is attractive because the immediate receipt of principal plus premium produces a high return.
ii. Is more apt to be called when interest rates are high because the interest savings will be greater.
iii. Will usually have a higher yield to maturity than a similar noncallable bond.
iv. None of the above.

c. In which *one* of the following cases is the bond selling at a discount?

i. Coupon rate is greater than current yield, which is greater than yield to maturity.
ii. Coupon rate, current yield, and yield to maturity are all the same.
iii. Coupon rate is less than current yield, which is less than yield to maturity.
iv. Coupon rate is less than current yield, which is greater than yield to maturity.

d. Consider a 5-year bond with a 10% coupon that has a present yield to maturity of 8%. If interest rates remain constant, 1 year from now the price of this bond will be:

i. Higher.
ii. Lower.
iii. The same.
iv. Par.

E-Investments Exercises

Credit Spreads

At **www.bondsonline.com** review the *Industrial Spreads* for various ratings (click the links on the left-side menus to follow the links to *Today's Markets, U.S. Corporate Bond Spreads*). These are spreads above U.S. Treasuries of comparable maturities. What factors tend to explain the yield differences? How might these yield spreads differ during an economic boom versus a recession?

From the home page, select *Today's Markets* from the left-side menu and then select the link for *Composite Bond Yields.* How do the Yield Curves for Treasury, Agency, Corporate, and Municipal bonds compare to each other?

Solutions to CONCEPT *Check*

1. The callable bond will sell at the *lower* price. Investors will not be willing to pay as much if they know that the firm retains a valuable option to reclaim the bond for the call price if interest rates fall.

2. At a semiannual interest rate of 3%, the bond is worth $40 × Annuity factor (3%, 60) + $1,000 × PV factor(3%, 60) = $1,276.76, which results in a capital gain of $276.76. This exceeds the capital loss of $189.29 (i.e., $1,000 − $810.71) when the semiannual interest rate increased to 5%.

3. Yield to maturity exceeds current yield, which exceeds coupon rate. Take as an example the 8% coupon bond with a yield to maturity of 10% per year (5% per half year). Its price is $810.71, and therefore its current yield is 80/810.71 = .0987, or 9.87%, which is higher than the coupon rate but lower than the yield to maturity.

4. The bond with the 6% coupon rate currently sells for 30 × Annuity factor (3.5%, 20) + 1,000 × PV factor(3.5%, 20) = $928.94. If the interest rate immediately drops to 6% (3% per half-year), the bond price will rise to $1,000, for a capital gain of $71.06, or 7.65%. The 8% coupon bond currently sells for $1,071.06. If the interest rate falls to 6%, the present value of the *scheduled* payments increases to $1,148.77. However, the bond will be called at $1,100, for a capital gain of only $28.94, or 2.70%.

5. The current price of the bond can be derived from its yield to maturity. Using your calculator, set: $n = 40$ (semiannual periods); payment = $45 per period; future value = $1,000; interest rate = 4% per semiannual period. Calculate present value as $1,098.96. Now we can calculate yield to call. The time to call is 5 years, or 10 semiannual periods. The price at which the bond will be called is $1,050. To find yield to call, we set: $n = 10$ (semiannual periods); payment = $45 per period; future value = $1,050; present value = $1,098.96. Calculate yield to call as 3.72%.

6. Price = $70 × Annuity factor(8%, 1) + $1,000 × PV factor(8%, 1) = $990.74

$$\text{Rate of return to investor} = \frac{\$70 + (\$990.74 - \$982.17)}{\$982.17} = .080 = 8\%$$

7. By year-end, remaining maturity is 29 years. If the yield to maturity were still 8%, the bond would still sell at par and the holding-period return would be 8%. At a higher yield, price and return will be lower. Suppose, for example, that the yield to maturity rises to 8.5%. With annual payments of $80 and a face value of $1,000, the price of the bond will be

\$946.70 [$n = 29$; $i = 8.5\%$; PMT = \$80; FV = \$1,000]. The bond initially sold at \$1,000 when issued at the start of the year. The holding-period return is

$$\text{HPR} = \frac{80 + (946.70 - 1{,}000)}{1{,}000} = .0267 = 2.67\%$$

which is less than the initial yield to maturity of 8%.

8. At the lower yield, the bond price will be \$631.67 [$n = 29$, $i = 7\%$, FV = \$1,000, PMT = \$40]. Therefore, total after-tax income is

Coupon	\$40 × (1 −.38)	= \$24.80
Imputed interest	(\$553.66 − \$549.69) × (1 − .38)	= 2.46
Capital gains	(\$631.67 − \$553.66) × (1 − .20)	= 62.41
Total income after taxes		\$89.67

Rate of return = 89.67/549.69 = .163 = 16.3%.

9. It should receive a negative coefficient. A high ratio of liabilities to assets is a poor omen for a firm that should lower its credit rating.

10. The coupon payment is \$45. There are 20 semiannual periods. The final payment is assumed to be \$500. The present value of expected cash flows is \$650. The expected yield to maturity is 6.317% semiannual or annualized, 12.63%, bond equivalent yield.