Credit Risk and the Value of Corporate Debt

We first looked at how to value bonds way back in Chapter 3. We explained in that chapter what bond dealers mean when they refer to spot rates of interest and yields to maturity. We discussed why long-term and short-term bonds may offer different rates of interest and why prices of long-term bonds are affected more by a change in rates. We looked at the difference between nominal and real (inflation-adjusted) interest rates, and we saw how interest rates respond to changes in the prospects for inflation.

All the lessons of Chapter 3 hold good for both government and corporate bonds, but there is also a fundamental distinction between government and corporate issues. When the U.S. Treasury borrows money, you can be confident that the debt will be repaid in full and on time. This is not true of corporate borrowing. Look, for example, at Figure 23.1. You can see that in 2008 companies defaulted on a record $430 billion of debt. Bondholders are aware of the danger that they will not get their money back and so demand a higher rate of interest.

The extra yield on corporate bonds is the annual payment that investors demand for taking on the possibility of default. We begin our review of corporate bonds by looking at how this yield spread varies with the likelihood of default. Then in Section 23-2 we look more carefully at the company's decision to default. We show that default is an *option;* if the going becomes too tough, the company has the option to stop payments on its bonds and hand over the business to the debtholders. We know what determines the value of options; therefore, we know the basic variables that must enter into the valuation of corporate bonds.

Our next step is to look at bond ratings and some of the techniques that are used by banks and bond investors to estimate the probability that the borrower will not be able to repay its debts. As a company's prospects deteriorate, bondholders worry increasingly about this risk, and their worries are reflected in lower bond prices. Therefore, in the final section we describe some of the ways that financial managers measure the risk of loss from investment in corporate bonds.

23-1 Yields on Corporate Debt

Six Flags is known for the roller-coaster rides at its theme parks, but the company itself has also experienced a white-knuckle ride of its own. By early 2009 the price of its 9.625% bonds of 2014 had fallen to 19.5% of face value and offered a yield to maturity of 64%. A naïve investor who compared this yield with the 2% yield on Treasury bonds might have concluded that the Six Flags debt was a wonderful investment. But the owner would earn a return of 64% on the debt only if the company repaid the bonds in full. That was looking increasingly doubtful. Over the previous decade the company had recorded a series of losses, and it entered 2009 with over $2 billion of debt and negative book equity. Because there was a considerable risk that the company would default on its bonds, the *expected* return was much less than 64%.

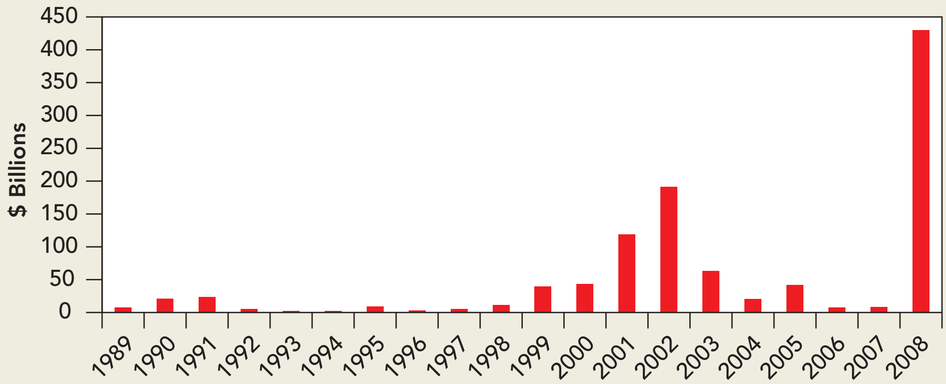


FIGURE 23.1

Global face value of defaulting debt, 1989–2008, in billions of dollars.

Source: Standard & Poor's, *Default, Transition and Recovery: 2008 Annual Global Corporate Default Study and Rating Transitions,* April 2, 2009.

Corporate bonds, such as the Six Flags bond, offer a higher *promised* yield than government bonds, but do they necessarily offer a higher *expected* yield? We can answer this question with a simple numerical example. Suppose that the interest rate on one-year *risk-free* bonds is 5%. Backwoods Chemical Company has issued 5% notes with a face value of $1,000, maturing in one year. What will the Backwoods notes sell for?

If the notes are risk-free, the answer is easy—just discount principal ($1,000) and interest ($50) at 5%:

$$\text{PV of notes} = \frac{\$1{,}000 + 50}{1.05} = \$1{,}000$$

Suppose, however, that there is a 20% chance that Backwoods will default and that, if default does occur, holders of its notes receive half the face value of the notes, or $500. In this case, the possible payoffs to the noteholders are:

	Payoff	Probability
No default	$1,050	.8
Default	500	.2

The expected payment is .8($1,050) + .2($500) = $940.

We can value the Backwoods notes like any other risky asset, by discounting their expected payoff ($940) at the appropriate opportunity cost of capital. We might discount at the risk-free interest rate (5%) if Backwoods's possible default is totally unrelated to other events in the economy. In this case default risk is wholly diversifiable, and the beta of the notes is zero. The notes would sell for:

$$\text{PV of notes} = \frac{\$940}{1.05} = \$895$$

An investor who purchased the notes for $895 would receive a *promised* yield of 17.3%:

$$\text{Promised yield} = \frac{\$1050}{\$895} - 1 = .173$$

That is, an investor who purchased the notes for \$895 would earn a return of 17.3% if Backwoods does not default. Bond traders therefore might say that the Backwoods notes "yield 17.3%." But the smart investor would realize that the notes' *expected* yield is only 5%, the same as on risk-free bonds.

This of course assumes that the risk of default with these notes is wholly diversifiable, so that they have no market risk. In general, risky bonds do have market risk (that is, positive betas) because default is more likely to occur in recessions when all businesses are doing poorly. Suppose that investors demand a 3% risk premium and an 8% expected rate of return. Then the Backwoods notes will sell for $940/1.08 = \$870$ and offer a promised yield of $(1{,}050/870) - 1 = .207$, or 20.7%.

What Determines the Yield Spread?

Figure 23.2 shows how the yield spread on U.S. corporate bonds varies with the bond's risk. Bonds rated Aaa by Moody's are the highest-grade bonds and are issued only by blue-chip companies. The promised yield on these bonds has on average been 1% higher than the yield on Treasuries. Baa bonds are rated three notches lower; the yield spread on these bonds has averaged over 2%. At the bottom of the heap are high-yield or "junk" bonds. There is considerable variation in the yield spreads on junk bonds; a typical spread might be about 5% over Treasuries, but, as we saw in the case of the Six Flags bond, spreads can go skyward as companies approach distress.

Remember these are promised yields and companies don't always keep their promises. Many high-yielding bonds have defaulted, while some of the more successful issuers have called their debt, thus depriving their holders of the prospect of a continuing stream of high coupon payments. So while the *promised yield* on junk bonds has averaged 5% more than yields on Treasuries, the annual *return* since 1980 has been less than 2% higher.

Figure 23.2 also shows that yield spreads can vary quite sharply from one year to the next. For example, they were unusually high in 1990–1991, 2000–2002, and 2008. Why is this? The main reason is that these were periods when profits were poor and defaults more likely. (Figure 23.1 shows how default rates jumped in these years.) However, the fluctuations in spreads appear to be too large to be due simply to changing probabilities of default. It seems that there are occasions when investors are particularly reluctant to bear the risk of low-grade bonds and so scurry to the safe haven of government debt.[1]

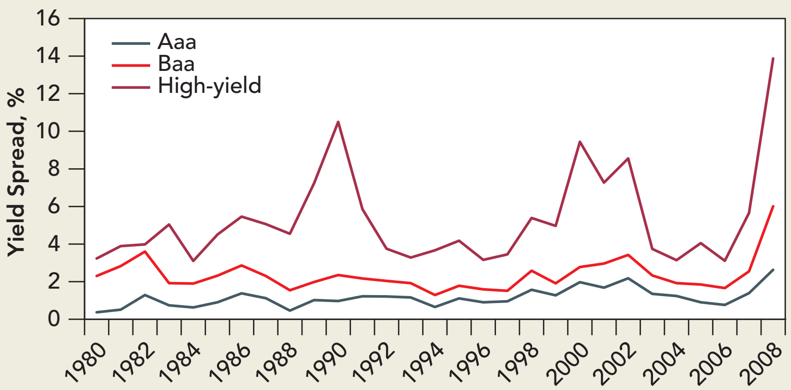


FIGURE 23.2

End-year yield spreads between corporate and 10-year Treasury bonds, 1980–2008.

Source: The Federal Reserve, www.federalreserve.gov, and Datastream.

[1] For evidence on the effect of changing risk aversion on bond spreads, see A. Berndt, R. Douglas, D. Duffie, M. Ferguson, and D. Schranzk, "Measuring Default Risk Premia from Default Swap Rates and EDFs," unpublished paper, Graduate School of Business, Stanford University, November 2005.

To understand more precisely what the yield spread measures, compare these two strategies:

Strategy 1: Invest $1,000 in a floating-rate default-free bond yielding 9%.[2]

Strategy 2: Invest $1,000 in a comparable floating-rate corporate bond yielding 10%. At the same time take out an insurance policy to protect yourself against the possibility of default. You pay an insurance premium of 1% a year, but in the event of default you are compensated for any loss in the bond's value.

Both strategies provide exactly the same payoff. In the case of Strategy 2 you gain a 1% higher yield but this is exactly offset by the 1% annual premium on the insurance policy. Why does the insurance premium have to be equal to the spread? Because, if it weren't, one strategy would dominate the other and there would be an arbitrage opportunity. The law of one price tells us that two equivalent risk-free investments must cost the same.

Our example tells us how to interpret the spread on corporate bonds. It is equal to the annual premium that would be needed to insure the bond against default.[3]

By the way, you *can* insure corporate bonds; you do so with an arrangement called a *credit default swap* (CDS). If you buy a default swap, you commit to pay a regular insurance premium (or *spread*).[4] In return, if the company subsequently defaults on its debt, the seller of the swap pays you the difference between the face value of the debt and its market value. For example, when General Motors defaulted in 2009, its unsecured bonds were auctioned for 12.5% of face value. Thus sellers of default swaps had to pay out 87.5 cents on each dollar of GM debt that they had insured.

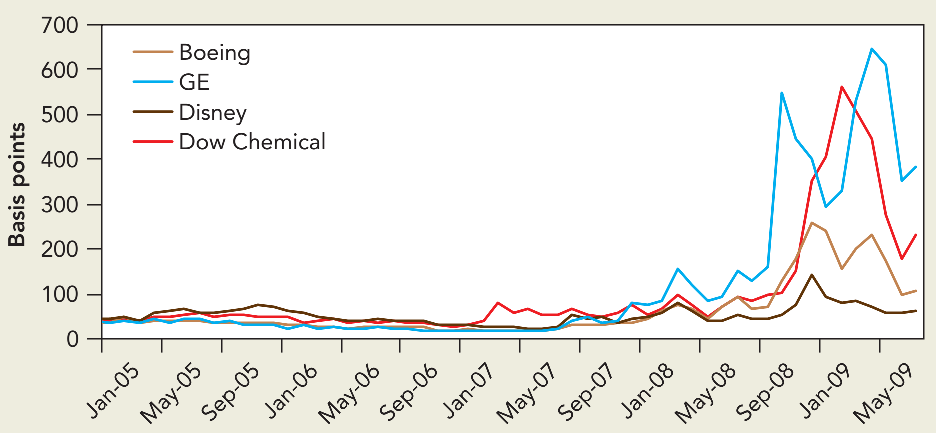
CDSs have proved very popular, particularly with banks that need to reduce the risk of their loan books. From almost nothing in 2000, the notional value of default swaps and related products had mushroomed to $55 trillion in 2008.[5]

Figure 23.3 shows the annual cost of insuring the 10-year bonds of a sample of well-known firms. Notice the sharp increase in the cost of the default swaps in the second half of 2008. By the end of September it cost $5.50 a year to insure $100 of General Electric debt.

FIGURE 23.3

Credit default swaps insure the holders of corporate bonds against default. This figure shows the cost of default swaps on the 10-year senior debt of four companies.

Source: Datastream



[2] The interest payment on floating-rate bonds goes up and down as the general level of interest rates changes. Thus a floating-rate default-free bond will sell at close to face value on each coupon date. Many governments issue "floaters." The U.S. Treasury does not do so, though some U.S. government agencies do.

[3] For illustration, we have used the example of a floating-rate bond to demonstrate the equivalence between the yield spread and the cost of default insurance. But the spread on a fixed-rate corporate bond should be effectively identical to that on a floater.

[4] In the case of low-grade bonds, when the regular spread does not sufficiently protect the seller against the possibility of an early default, the buyer of the default swap may also be asked to pay an up-front fee.

[5] Related credit derivatives include credit-linked notes, total return swaps, and credit options. For a useful survey of the credit-derivative market, see J. P. Morgan, "The J. P. Morgan Guide to Credit Derivatives," at **www.investinginbonds.com/assets/files/intro_to_credit_derivatives.pdf**.

Many of these default swaps were sold by *monoline insurers,* which specialize in providing services to the capital markets. The monolines had traditionally concentrated on insuring relatively safe municipal debt but had been increasingly prepared to underwrite corporate debt, as well as many securities that were backed by subprime mortgages. By 2008 insurance companies had sold protection on $2.4 trillion of bonds. As the outlook for many of these bonds deteriorated, investors began to question whether the insurance companies had sufficient capital to make good on their guarantees.

One of the largest providers of credit protection was AIG Financial Products, part of the giant insurance group, AIG, with a portfolio of over $440 billion of credit guarantees. AIG's clients never dreamt that the company would be unable to pay up: not only was AIG triple-A rated, but it had promised to post generous collateral if the value of the insured securities dropped or if its own credit rating fell. So confident was AIG of its strategy that the head of its financial products group claimed that it was hard "to even see a scenario within any kind of realm of reason that would see us losing one dollar in any of these transactions." But in September 2008 this unthinkable scenario occurred, when the credit rating agencies downgraded AIG's debt, and the company found itself obliged to provide $32 billion of additional collateral within the next 15 days. Had AIG defaulted, everyone who had bought a CDS contract from the company would have suffered large losses on these contracts. To save AIG from imminent collapse, the Federal Reserve stepped in with an $85 billion rescue package.

23-2 The Option to Default

The difference between a corporate bond and a comparable Treasury bond is that the company has the option to default whereas the government supposedly doesn't.[6] That is a valuable option. If you don't believe us think about whether (other things equal) you would prefer to be a shareholder in a company with limited liability or in a company with unlimited liability. Of course, you would prefer to have the option to walk away from your company's debts. Unfortunately, every silver lining has its cloud, and the drawback to having a default option is that corporate bondholders expect to be compensated for giving it to you. That is why corporate bonds sell at lower prices and offer higher yields than government bonds.

We can illustrate the nature of the default option by returning to the plight of Circular File Company, which we discussed in Chapter 18. Circular File borrowed $50 per share, but then the firm fell on hard times and the market value of its assets fell to $30. Circular's bond and stock prices fell to $25 and $5, respectively. Thus Circular's *market-value* balance sheet is:

Circular File Company (Market Values)

Asset value	$30	$25	Bonds
		5	Stock
	$30	$30	Firm value

If Circular's debt were due and payable now, the firm could not repay the $50 it originally borrowed. It would default, leaving bondholders with assets worth $30 and shareholders with nothing. The reason that Circular stock has a market value of $5 is that the debt is *not* due now, but rather a year from now. A stroke of good fortune could increase

[6] But governments cannot print the currencies of other countries. Therefore, they may be forced into default on their foreign currency debt. For example, in 2008 Ecuador defaulted on $3.9 billion of foreign currency debt. Very occasionally governments have even defaulted on their own currency's debt. For example, in 1998 the Russian government defaulted on $36 billion of ruble debt.

firm value enough to pay off the bondholders in full, with something left over for the stockholders.

When Circular File borrowed, it acquired an option to default. In other words, it is not compelled to repay the debt at maturity. If the value of its assets is less than the $50 that it owes, it will choose to default on the debt and the bondholders will get to keep the assets. To put it another way, when Circular borrowed, the bondholders effectively acquired the company's assets and the shareholders gained an option to buy them back by paying off the debt. In effect, the stockholders purchased a call option on the assets of the firm. Thus the balance sheet of Circular File can be expressed as follows:

Circular File Company (Market Values)

Asset value	$30	$25	Bond value = asset value − value of call
		5	Stock value = value of call
	$30	$30	Firm value = asset value

Figure 23.4 shows the possible payoffs to Circular File's shareholders when the bonds mature at the end of the year. If the future value of the assets is less than $50, Circular will default and the stock will be worthless. If the value of the assets exceeds $50, the stockholders will receive asset value *less* the $50 paid over to the bondholders. Does Figure 23.4 look familiar to you? It should if you have read Chapter 20 on options. The payoffs in Figure 23.4 are identical to those of a call option on the firm's assets with an exercise price of $50.

In Chapter 20 we also set out the basic relationship between calls and puts:

$$\text{Value of call} + \text{present value of exercise price} = \text{value of put} + \text{value of share}$$

To apply this to Circular File, we need to interpret "value of share" as "asset value," because the common stock is a call option on the firm's assets. Also "present value of exercise price" is the present value of receiving the promised payment of $50 to bondholders *for sure* next year. Thus,

$$\begin{aligned}&\text{Value of call} + \text{present value of promised payment to bondholders}\\&= \text{value of put} + \text{asset value}\end{aligned}$$

Now we can solve for the value of Circular's bonds. This is equal to the firm's asset value less the value of the shareholders' call option on these assets:

$$\begin{aligned}\text{Bond value} &= \text{asset value} - \text{value of call}\\&= \text{present value of promised payment to bondholders} - \text{value of put}\end{aligned}$$

Circular's bondholders have in effect bought a safe bond, but at the same time given the shareholders a put option to sell them the firm's assets for the amount of the debt.

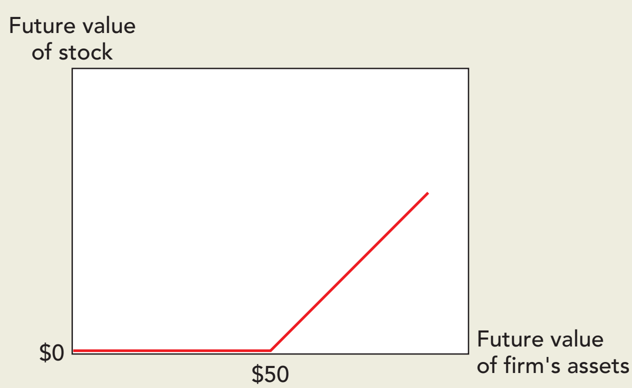


FIGURE 23.4

The value of Circular's common stock is the value of a call option on the firm's assets with an exercise price of $50.

Now you can see why bond traders, investors, and financial managers refer to *default puts*. When a firm defaults, its stockholders are in effect exercising their default put. The put's value is the value of limited liability—the value of the stockholders' right to walk away from their firm's debts in exchange for handing over the firm's assets to its creditors. In the case of Circular File this option to default is extremely valuable because default is likely to occur. At the other extreme, the value of IBM's option to default is trivial compared with the value of IBM's assets. Default on IBM bonds is possible but extremely unlikely. Option traders would say that for Circular File the put option is "deep in the money" because today's asset value ($30) is well below the exercise price ($50). For IBM the put option is far "out of the money" because the value of IBM's assets substantially exceeds the amount of IBM's debt.

Valuing corporate bonds should be a two-step process:

$$\text{Bond value} = \begin{matrix}\text{bond value assuming}\\ \text{no chance of default}\end{matrix} - \begin{matrix}\text{value of put}\\ \text{option on assets}\end{matrix}$$

The first step is easy: Calculate the bond's value assuming no default risk. (Discount promised interest and principal payments at the rates offered by Treasury issues.) Second, calculate the value of a put written on the firm's assets, where the maturity of the put equals the maturity of the bond and the exercise price of the put equals the promised payment to bondholders.

Owning a corporate bond is also equivalent to owning the firm's assets but giving a call option on these assets to the firm's stockholders:

$$\text{Bond value} = \text{asset value} - \text{value of call option on assets}$$

Thus you can also calculate a bond's value, given the value of the firm's assets, by valuing a call option on these assets and subtracting the value of this call from that of the assets. (Remember: The call value is just the value of the firm's common stock.) Therefore, if you can value puts and calls on the firm's assets, you can value its debt.[7]

How the Default Option Affects a Bond's Risk and Yield

If the firm's debt is risk-free, the equityholders bear all the risk of the underlying assets. But when the firm has limited liability, the debtholders share this risk with the equityholders. We have seen that the equity of a firm with limited liability is equivalent to a call option on the firm's assets. So, if we can calculate the risk of this call, we can find how the firm's risk is shared between the equityholders and the debtholders.[8]

Think back to Chapter 21 where you learned how to calculate the risk of a call option. This involved two steps:

Step 1: Find the combination of the underlying asset and risk-free borrowing that provides the same payoffs as the call option (in the present case, the call option is the leveraged equity).

Step 2: Calculate the beta of this replicating portfolio.

Figure 23.5 takes a hypothetical company whose underlying assets have a beta of 1.0 and shows how the beta of these assets is shared between the equityholders and the debtholders. If the company had unlimited liability, the equityholders would bear all the risk of the assets and the debt would be risk-free. But with *limited* liability, the debtholders bear part

[7] However, option-valuation procedures cannot value the *assets* of the firm. Puts and calls must be valued as a proportion of asset value. For example, note that the Black–Scholes formula (Section 21-3) requires stock price to compute the value of a call option.

[8] The classic paper on the valuation of the option to default is R. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* 29 (May 1974), pp. 449–470.

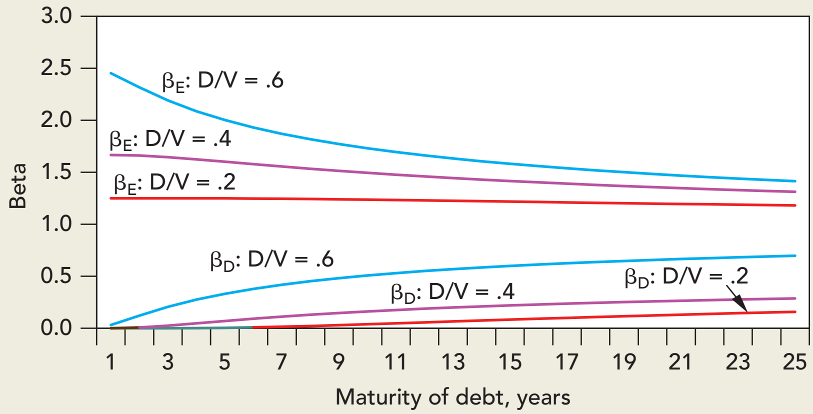


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FIGURE 23.5

How the betas of the debt and equity vary with the degree of leverage and the maturity of the debt. These curves are calculated using option pricing theory under the following simplified assumptions: (1) the risk-free interest rate is constant for all maturities; (2) the standard deviation of the returns on the company's assets is 25% per annum; (3) the asset beta is 1.0; (4) debt is in the form of zero-coupon bonds; and (5) leverage is the ratio *D/V,* where *D* is the face value of the debt discounted at the risk-free interest rate and *V* is the market value of the assets.

of the risk. The higher the leverage and the longer the maturity of the debt, the greater the proportion of the risk that is assumed by the debtholders. For example, suppose that our hypothetical company is financed 60% by 25-year debt. With *unlimited* liability the debt would have a beta of zero and the equity would have a beta of 2.5.[9] But, when the risk of the assets is shared, the debt has a beta of .7 and the equity a beta of 1.4.

Figure 23.6 stays with the same hypothetical company and shows how the promised yield on its debt varies with leverage and bond maturity. For example, you can see that if a company has a 20% debt ratio and all its debt matures in 25 years, then it should pay about .50 percentage point above the government rate to compensate for default risk. Notice that just as risk increases with maturity, so generally does the promised yield. This makes sense, for the longer you have to wait for repayment, the greater the chance that things will go wrong.[10]

Notice that in constructing Figure 23.6 we made several artificial assumptions. One assumption is that the company does not pay dividends or repurchase stock. If it does regularly pay out part of its assets to stockholders, there will be fewer assets to protect the bondholder in the event of trouble. In this case, the market will justifiably require a higher yield on the company's bonds.

There are other complications that make the valuation of corporate debt a good bit more difficult than it sounds. For example, Figure 23.6 assumes that the company makes only a single issue of zero-coupon debt. But suppose instead that it issues a 10-year bond

[9] Remember that the beta of the assets is a weighted average of the beta of the debt and that of the equity:

$$\beta_{\text{assets}} = (D/V)\beta_{\text{debt}} + (E/V)\beta_{\text{equity}}$$

If $\beta_{\text{assets}} = 1.0$ and $\beta_{\text{debt}} = 0$, then with 60% leverage:

$$1.0 = (.6 \times 0) + (.4 \times \beta_{\text{equity}})$$
$$\beta_{\text{equity}} = 2.5$$

[10] The *price* of the bond always declines with maturity and leverage. (Remember the value of a put option increases with maturity and with the exercise price.) However, with very long maturities and high leverage the bond's *yield per annum* will start to decline.

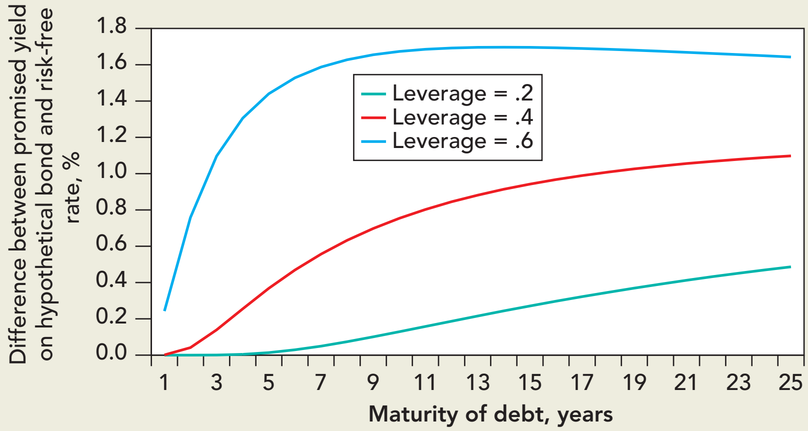

FIGURE 23.6

How the interest rate on risky corporate debt changes with leverage and maturity.

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that pays interest annually. We can still think of the company's stock as a call option that can be exercised by making the promised payments. But in this case there are 10 payments rather than just one. To value the stock, we would need to value 10 sequential call options. The first option can be exercised by making the first interest payment when it comes due. By exercising, the stockholders obtain a second call option, which can be exercised by making the second interest payment. The reward to exercising is that the stockholders get a third call option, and so on. Finally, in year 10 the stockholders can exercise the tenth option. By paying off both the principal and the last year's interest, the stockholders regain unencumbered ownership of the company's assets.

Of course, if the firm does not make any of these payments when due, bondholders take over and stockholders are left with nothing. In other words, by not exercising one call option, stockholders give up all subsequent call options.

Valuing the equity when the 10-year bond is issued is equivalent to valuing the first of the 10 call options. But you cannot value the first option without valuing the nine that follow.[11] Even this example understates the practical difficulties, because large firms may have dozens of outstanding debt issues with different interest rates and maturities, and before the current debt matures they may make further issues. Consequently, when bond traders evaluate a corporate bond, they do not immediately reach for their option calculator. They are more likely to start by identifying bonds with a similar risk of default and look at the yield spreads offered by these bonds.

In practice, interest rate differentials tend to be much greater than those shown in Figure 23.6. The highest-grade corporate bonds typically offer promised yields about 1 percentage point higher than U.S. Treasury bonds. It is very difficult to justify differentials of this magnitude simply in terms of default risk.[12] So what is going on? It could be that companies are paying too much for their debt, but it seems likely that the high yields on corporate bonds stem in part from some other drawback. One possibility is that investors demand the additional yield to compensate for the lack of liquidity in corporate debt markets.[13] There is little doubt that investors prefer bonds that are easily bought and sold. We

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[11] The other approach to valuing the company's debt (subtracting the value of a put option from risk-free bond value) is no easier. The analyst would be confronted by not one simple put option but a package of 10 sequential puts.

[12] See, for example, J. Huang and M. Huang, "How Much of the Corporate-Treasury Yield Spread Is Due to Credit Risk? Results from a New Calibration Approach," working paper, Pennsylvania State University, May 2003.

[13] For evidence that the more liquid corporate bonds have lower yields than less liquid bonds, see E. J. Elton, M. J. Gruber, D. Agrawal, and C. Mann, "Factors Affecting the Valuation of Corporate Bonds," *Journal of Banking and Finance* 28 (November 2006), pp. 2747–2767.

can even see small yield differences in the Treasury bond market, where the latest bonds issued (known as "on-the-run" bonds) are traded much more heavily and typically yield a little less than more seasoned issues.

Another reason that corporate bond investors in the United States may require a higher yield is that interest payments are subject to both federal and state tax. Interest on Treasury bonds is exempt from state tax. Suppose, for example, that you hold a corporate bond with a 6% coupon and pay state tax of 5%. Then you would need an additional yield of about $.05 \times 6 = .3\%$ simply to compensate for the additional tax.[14]

A Digression: Valuing Government Financial Guarantees

When Bethlehem Steel declared bankruptcy in 2003, its pension plan had liabilities of $7 billion and assets of just $3 billion. But the 97,000 workers and retirees did not face a destitute old age. Their pensions were largely guaranteed by the Pension Benefit Guaranty Corporation (PBGC).[15]

Pension promises don't always appear on the company's balance sheet, but they are a long-term liability just like the promises to bondholders. The guarantee by the PBGC changes the pension promises from a risky liability to a safe one. If the company goes belly-up and there are insufficient assets to cover the pensions, the PBGC makes up the difference.

The government recognizes that the guarantee provided by the PBGC is costly. Thus shortly after assuming the liability for the Bethlehem Steel plan, the PBGC calculated that the discounted value of payments on defaulted plans and those close to default amounted to $23 billion.

Unfortunately, these calculations ignore the risk that other firms in the future may fail and hand over their pension liability to the PBGC. To calculate the cost of the guarantee, we need to think about what the value of company pension promises would be without any guarantee:

$$\begin{aligned}\text{Value of guarantee} &= \text{value of guaranteed pensions} \\ &\quad - \text{value of pension promises without a guarantee}\end{aligned}$$

With the guarantee the pensions are as safe as a promise by the U.S. government;[16] *without* the guarantee the pensions are like an ordinary debt obligation of the firm. We already know what the difference is between the value of safe government debt and risky corporate debt. It is the value of the firm's right to hand over the assets of the firm and to walk away from its obligations. Thus the value of the pension guarantee is the value of this put option.

In a paper prepared for the Congressional Budget Office, Wendy Kiska, Deborah Lucas, and Marvin Phaup show how option pricing models can help to give a better measure of the cost to the PBGC of pension guarantees.[17] Their estimates suggest that the true cost is in excess of $87 billion, or $64 billion more than the published figure.

The PBGC is not the only government body to provide financial guarantees. For example, the Federal Deposit Insurance Corporation (FDIC) guarantees bank deposit accounts; the Federal Family Education Loan (FFEL) program guarantees loans to students; the Small Business Administration (SBA) provides partial guarantees for loans to small businesses, and so on. The government's liability under these programs is enormous. Fortunately, option pricing is leading to a better way to calculate their cost.

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[14] See E. J. Elton, M. J. Gruber, D. Agrawal, and C. Mann, "Explaining the Rate Spread on Corporate Bonds," *Journal of Finance* 56 (February 2001), pp. 247–277. Since state taxes are deductible when calculating federal taxes, our calculation slightly overstates the effect of state tax.

[15] An even more costly failure occurred when United Airlines declared bankruptcy, leaving the PBGC with a liability of $6.6 billion.

[16] The pension guarantee is not ironclad. If the PBGC cannot meet its obligations, the government is not committed to providing the extra cash. But few doubt that it would do so.

[17] Congressional Budget Office, "The Risk Exposure of the Pension Benefit Guaranty Corporation," Washington, DC, September 2005.

23-3 Bond Ratings and the Probability of Default

Banks and other financial institutions not only want to know the value of the loans that they have made. They also need to know the risk that they are incurring. Some rely on the judgments of specialized bond rating services. Others have developed their own models for measuring the probability that the borrower will default. We describe bond ratings first, and then discuss two models for predicting default.

The relative quality of most traded bonds can be judged by bond ratings. There are three principal rating services—Moody's, Standard & Poor's, and Fitch.[18] Table 23.1 summarizes these ratings. For example, the highest-quality bonds are rated triple-A (Aaa) by Moody's, then come double-A (Aa) bonds, and so on. Bonds rated Baa or above are known as *investment-grade* bonds.[19] Commercial banks, many pension funds, and other financial institutions are not allowed to invest in bonds unless they are investment-grade.[20]

Bonds rated below Baa are termed **high-yield,** or **junk, bonds.** Most junk bonds used to be *fallen angels*, that is, bonds of companies that had fallen on hard times. But during the 1980s new issues of junk bonds multiplied tenfold as more and more companies issued large quantities of low-grade debt to finance takeovers. The result was that for the first time corporate midgets were able to take control of corporate giants.

Issuers of these junk bonds often had debt ratios of 90% to 95%. Many worried that this threatened the health of corporate America and, as default rates rose in the early 1990s, the market for new issues of junk bonds dried up. Later in the decade, with increasing economic prosperity, the annual default rate fell to below 2% and junk bonds returned to fashion. Once more the boom years did not last. In 2001, 11% of U.S. junk bond issues defaulted, and companies for a second time found it difficult for a while to market their junk bonds.

Bond ratings are judgments about firms' financial and business prospects. There is no fixed formula by which ratings are calculated. Nevertheless, investment bankers, bond portfolio managers, and others who follow the bond market closely can get a fairly good

Moody's	Standard & Poor's and Fitch
Investment-grade bonds:	
Aaa	AAA
Aa	AA
A	A
Baa	BBB
Junk bonds:	
Ba	BB
B	B
Caa	CCC
Ca	CC
C	C

TABLE 23.1 Key to bond ratings. The highest-quality bonds are rated triple-A. Investment-grade bonds have to be the equivalent of Baa or higher. Bonds that don't make this cut are called " high-yield" or "junk" bonds.

[18] The SEC has been concerned about the power wielded by the three bond-rating agencies. It has therefore approved five new services: Dominion Bond (2003), A.M. Best (2005), Egan-Jones Rating (2007), Japan Credit Rating Agency (2007), and Ratings and Investment Information (2007).

[19] Rating services also provide a finer breakdown. Thus a bond might be rated A-1, A-2, or A-3 (the lowest A rating). In addition, the rating service may announce that it has put an issue on its watch list for a possible upgrade or downgrade.

[20] Investment-grade bonds can usually be entered at face value on the books of banks and life insurance companies.

Ratio	AAA	AA	A	BBB	BB	B	CCC
EBIT/interest*	23.8	19.5	8.0	4.7	2.5	1.2	0.4
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†

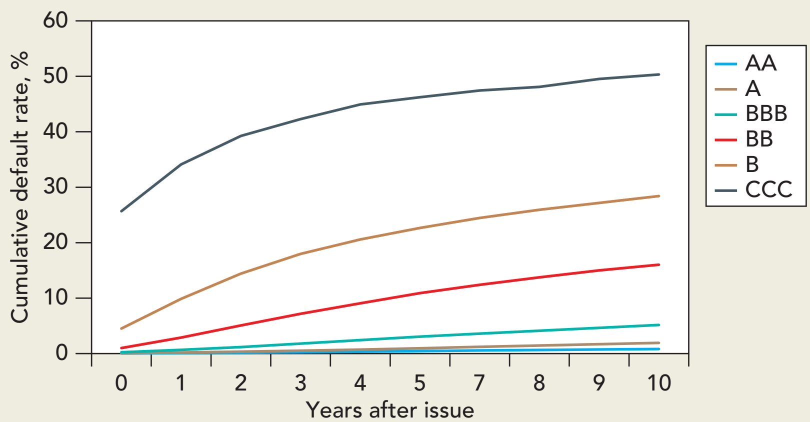
TABLE 23.2 How financial ratios differ according to a firm's bond rating. Three-year (2002–2004) median ratios for industrial firms by bond rating.

* EBIT = earnings before interest and taxes.
† A debt ratio greater than 100% means that book equity is negative.
Source: Standard & Poor's, *Corporate Bond Rating Criteria*, 2006, www.standardandpoors.com.

FIGURE 23.7

Default rates of corporate bonds 1981–2008, by Standard & Poor's rating at time of issue.

Source: Standard & Poor's, *"Default, Transition, and Recovery: 2008 Global Annual Corporate Default Study and Rating Transitions,"* February 2009. www.standardandpoors.com.



idea of how a bond will be rated by looking at a few key numbers such as the firm's debt ratio, the ratio of earnings to interest, and the return on assets. Table 23.2 shows how these ratios vary with the firm's bond rating.

Figure 23.7 shows that bond ratings do reflect the probability of default. Since 1981 only 3 in 10,000 bonds that were initially rated triple-A by Standard & Poor's have defaulted in the year after issue and only 55 in 10,000 have defaulted within 10 years of issue. (The AAA default rate is not plotted in Figure 23.7. It would be invisible.) At the other extreme, half of CCC bonds have defaulted by year 10. Of course, bonds do not usually fall suddenly from grace. As time passes and the company becomes progressively more shaky, the agencies revise downward the bond's rating to reflect the increasing probability of default.

Rating agencies don't always get it right. When Enron went belly-up in 2001, investors protested that only two months earlier the company's debt had an investment-grade rating. And when agencies *do* downgrade a company's debt, they are often accused of precipitate action that increases the cost of borrowing.

23-4 Predicting the Probability of Default

Credit Scoring

If you apply for a credit card or a bank loan, you will probably be asked to complete a questionnaire that provides details about your job, home, and financial health. This information is then used to calculate an overall credit score.[21] If you do not make the grade on

[21] The most commonly used consumer credit score is the FICO score developed by Fair Isaac & Co., which uses data provided by any one of three credit bureaus—Experian, TransUnion, or Equifax.

the score, you are likely to be refused credit or subjected to a more detailed analysis. In a similar way, mechanical credit scoring systems are used by banks to assess the risk of their corporate loans and by firms when they extend credit to customers.

Suppose that you are given the task of developing a credit scoring system that will help to decide whether to extend credit to businesses. You start by comparing the financial statements of companies that went bankrupt over a 40-year period with those of surviving firms. Figure 23.8 shows what you find. Panel (*a*) illustrates that, as early as four years before

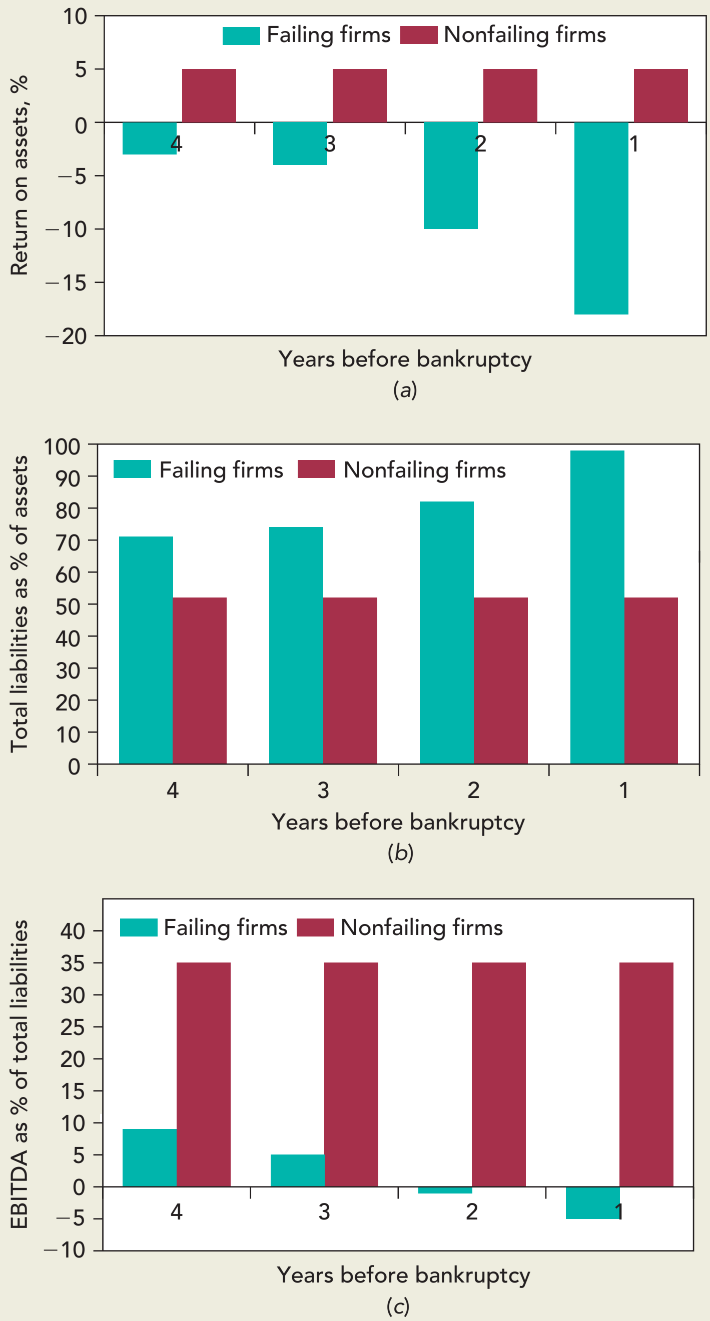


FIGURE 23.8

Financial ratios of 544 failing and nonfailing firms.

Source: W. H. Beaver, M. F. McNichols, and J-W. Rhie, "Have Financial Statements Become Less Informative? Evidence from the Ability of Financial Ratios to Predict Bankruptcy," *Review of Accounting Studies* 10 (2005), pp. 93–122. © 2005 Springer Verlag.

they went bankrupt, failing firms were earning a much lower return on assets (ROA) than firms that survived. Panel (*b*) shows that on average they also had a high ratio of liabilities to assets, and Panel (*c*) shows that EBITDA (earnings before interest, taxes, and depreciation) was low relative to the firms' total liabilities. Thus bankrupt firms were less profitable (low ROA), were more highly leveraged (high ratio of liabilities to assets), and generated relatively little cash (low ratio of EBITDA to liabilities). In each case these indicators of the firms' financial health steadily deteriorated as bankruptcy approached.

William Beaver, Maureen McNichols, and Jung-Wu Rhie, who studied these firms, concluded that the chance of failing during the next year relative to the chance of not failing was best estimated by the following equation:[22]

$$\begin{aligned}&\text{Log(relative chance of failure)}\\&\quad = -6.445 - 1.192\text{ROA} + 2.307\,\text{liabilities/assets} - .346\,\text{EBITDA/liabilities}\end{aligned}$$

As we write this in early 2009, Eastman Kodak is struggling with declining sales and huge debts. Its bonds are rated B. But what are the odds that Kodak will fail over the coming year? Let's use the above equation to check. Based on the latest annual statements, Kodak's return on assets was −4.5%, its total liabilities were 89.5% of its assets, and its EBITDA was −2.5% of liabilities. Plugging these figures into the equation gives Kodak's relative odds of failing as:

$$\begin{aligned}&\text{Log(relative chance of failure)}\\&\quad = -6.445 - 1.192(-.045) + 2.307(.895) - .346(-.025) = -4.32\\&\text{Relative chance of failure} = e^{(-4.32)} = .013, \text{ or } 1.3\%\end{aligned}$$

A variety of techniques have been used to develop credit scoring systems. The model that we described just above uses the technique of *hazard analysis.* An early, and still widely used model, the famous *Z*-score model developed by Edward Altman, uses *multiple discriminant analysis* to separate the creditworthy sheep from the impecunious goats.[23]

Credit scoring systems should carry a health warning. When you construct a risk index, it is tempting to experiment with many different combinations of variables until you find the equation that would have worked best in the past. Unfortunately, if you "mine" the data in this way, you are likely to find that the system works less well in the future than it did previously. If you are misled by the past successes into placing too much faith in your model, you may refuse credit to a number of potentially good customers. The profits that you lose by turning away these customers could more than offset the gains that you make by avoiding a few bad eggs. As a result, you could be worse off than if you had pretended that you could not tell one would-be borrower from another and extended credit to all of them.

Does this mean that firms should not use credit scoring systems? Not a bit. It merely implies that it is not sufficient to have a good system; you also need to know how much to rely on it.

Market-Based Risk Models

Credit scoring systems rely primarily on the companies' financial statements to estimate which firms are most likely to become bankrupt and default on their debts. For small

[22] See W. H. Beaver, M. F. McNichols, and J-W. Rhie, "Have Financial Statements Become Less Informative? Evidence from the Ability of Financial Ratios to Predict Bankruptcy," *Review of Accounting Studies* 10 (2005), pp. 93–122.

[23] For a description of the *Z*-score model, see E. I. Altman, *Corporate Financial Distress and Bankruptcy,* 3rd ed. (New York: John Wiley, 2005).

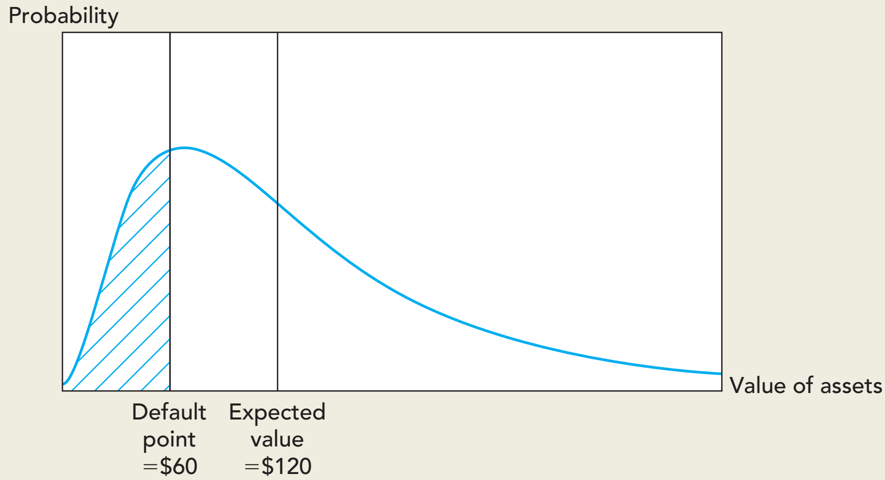


FIGURE 23.9

Phlogiston Chemical has issued five-year debt with a face value of $60. The shaded area shows that there is a 20% probability that the value of the company's assets in year 5 will be less than $60, in which case the company will choose to default.

businesses there may be little alternative to the use of accounting data, but for large, publicly traded firms it is also possible to take advantage of the information in security prices. These techniques build on the idea that stockholders will exercise their option to default if the market value of the assets falls below the payments that must be made on the debt.

Suppose that the assets of Phlogiston Chemical have a current market value of $100 and its debt has a face value of $60 (i.e., 60% leverage), all of which is due to be repaid at the end of five years. Figure 23.9 shows the range of possible values of Phlogiston's assets when the loan becomes due. The expected value of the assets is $120, but this value is by no means certain. There is a probability of 20% that the asset value could fall below $60, in which case the company will default on its debt. This probability is shown by the shaded area in Figure 23.9.

To calculate the probability that Phlogiston will default, we need to know the expected growth in the market value of its assets, the face value and maturity of the debt, and the variability of future asset values. Real-world cases are likely to be more complex than our Phlogiston example. For example, firms may have several classes of debt maturing on different dates. If so, it may pay the stockholders to put up more money to pay off the short-term debt and thus keep alive the chance that the firm's fortunes will recover before the rest of the debt becomes due.

However, banks and consulting firms are now finding that they can use these ideas to measure the risk of actual loans. For example, in Section 23-1 we encountered the troubled theme-park operator, Six Flags. In June 2009, Six Flags finally succumbed and filed for bankruptcy.

The black line in Figure 23.10 shows the market value that investors placed on Six Flags's assets, and the red line shows the asset value at which the company would choose to default on its debts. You can see how the value of the company's assets crept closer and closer to the default point before finally hitting it.

Of course, nobody had a crystal ball that foretold the eventual outcome, but Moody's KMV, which specializes in credit models, regularly estimates the probability that companies will default on their debts during the next year. Figure 23.11 shows how KMV progressively increased its estimate of the chances that the value of Six Flags's assets would hit the

FIGURE 23.10

The market value of the assets of Six Flags crept closer and closer to the point at which the firm would choose to default.

Source: Moody's KMV.

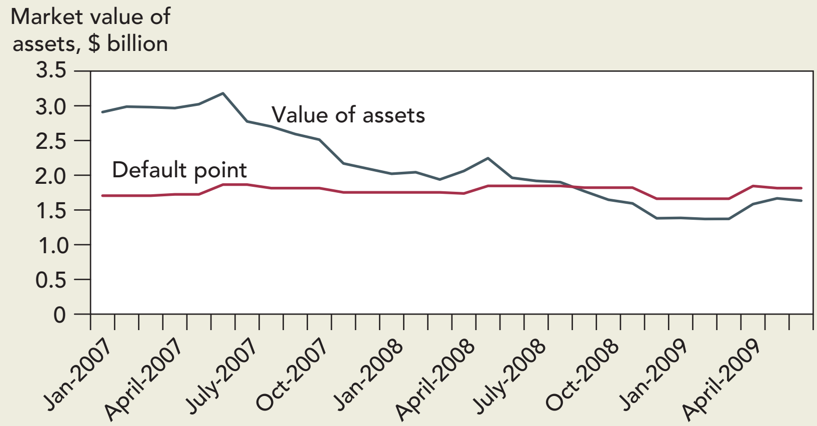
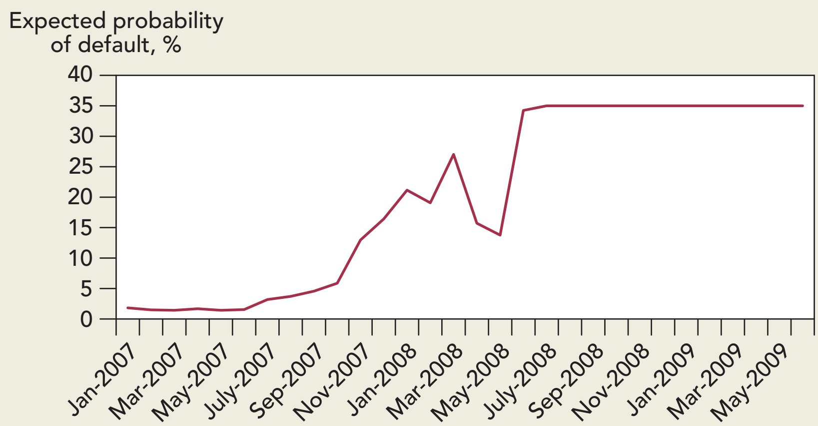


FIGURE 23.11

Estimates by Moody's KMV of the probability that Six Flags would default on its debt within a year.

Note: The probabilities reported by Moody's KMV are limited to a range from .01% to 35%.



default point. As the value of the company's assets started to collapse, KMV's assessment of the probability of default progressively increased. By July 2008 it had reached the maximum figure of 35%.[24]

23-5 Value at Risk

It is March 2009 and you own Starbucks 6.25% bonds maturing in 2017. The bonds are rated BBB by Standard & Poor's and are currently priced at 94.25% to offer a *promised* yield to maturity of 7.2%. If you plan to hold the bonds for the next 12 months, how much risk are you taking?

You may be tempted to look back at past default rates for BBB-rated bonds and conclude that there is only a negligible chance that the bonds will default during the next year and therefore your investment is almost as safe as U.S. Treasuries. But of course this ignores

[24] The probabilities provided by Moody's KMV are kept within the range of .01% to 35%.

	Rating at Year-end								
Rating at Start of Year	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC to C**	**Default**	**Not Rated**
AAA	88.39	7.63	0.53	0.06	0.08	0.03	0.06	0	3.23
AA	0.58	87.02	7.79	0.54	0.06	0.09	0.03	0.03	3.86
A	0.04	2.04	87.19	5.35	0.4	0.16	0.03	0.08	4.72
BBB	0.01	0.15	3.87	84.28	4	0.69	0.16	0.24	6.6
BB	0.02	0.05	0.19	5.3	75.74	7.22	0.8	0.99	9.68
B	0	0.05	0.15	0.26	5.68	73.02	4.34	4.51	12
CCC to C	0	0	0.23	0.34	0.97	11.84	46.96	25.67	14

TABLE 23.3 Global Average One-Year Transition Rates, 1981–2008, showing the percentage of bonds changing from one rating to another.

Source: Standard & Poor's, "Default, Transition, and Recovery: 2008 Annual Global Default Study and Rating Transitions," February 2009.

the possibility that, although default is unlikely in the short term, Starbucks's prospects may not be as good at the end of the year as they are now. If so, the bonds could be downrated and their value would fall.

Banks and consulting firms have developed a variety of ways to measure the risk of a deterioration in credit quality. For example, one of the most popular, the *CreditMetrics* system, looks at the possible impact of changes in the bond rating.[25] Table 23.3 shows how frequently bonds were rerated in the years 1981–2008. Since your Starbucks bonds are BBB-rated, we will focus on the fourth row of the table. You can see that in the past 84.28% of BBB bonds were still rated triple-B after one year and a few were even upgraded to A or better. However, the bad news is that after one year over 5% of BBB-rated bonds had moved into the junk bond category of BB or below.

If Starbucks debt were to be downgraded to BB, investors would undoubtedly demand a higher yield. For example, in 2009 the yield on BB bonds was about 1.1% higher than that on triple-Bs. If the yield on your Starbucks bonds rose by this amount, the price would fall by about 6%. In other words, there is more than a 5% chance that the value of your investment will fall by 6% or more over the coming year. Bankers refer to this as the **value at risk** (or **VAR**) on the Starbucks bonds.

There are a number of ways to improve this back-of-the-envelope estimate of the value at risk. For example, we assumed that the yield spreads on corporate bonds are constant. But, if investors become more reluctant to take on credit risk, you could lose much more than 6% on your investment. Notice also that when we calculated the risk from investing in Starbucks debt, we looked only at how the price of the bonds would be affected by a change in credit rating. If we wanted a comprehensive measure of value at risk, we would need to recognize that risk-free interest rates, too, may change over the year.

Banks and bond investors are not just interested in the risk of individual loans; they would also like to know the risk of their entire portfolio. Therefore, specialists in credit risk need to worry about the correlation between the outcomes. A portfolio of loans, all of which are to factory outlets in suburban Hicksville, is likely to be more risky than a portfolio with a variety of different borrowers.

[25] *CreditMetrics* was originally developed by J.P. Morgan. For a description of *CreditMetrics*, see the manuals provided by **www.riskmetrics.com**.

SUMMARY

Corporations have limited liability. If companies are unable to pay their debts, they can file for bankruptcy. Lenders are aware that they may receive less than they are owed, and that the *expected* yield on a corporate bond is less than the *promised yield.*

Because of the possibility of default, the promised yield on a corporate bond is higher than on a government bond. You can think of this extra yield as the amount that you would need to pay to insure the bond against default. There is an active market for insurance policies that protect the debtholder against default. These policies are called credit default swaps. There are no free lunches in financial markets. So the extra yield you get for buying a corporate bond is eaten up by the cost of insuring against default.

The company's option to default is equivalent to a put option. If the value of the firm's assets is less than the amount of the debt, it will pay for the company to default and to allow the lenders to take over the assets in settlement of the debt. This insight tells us what we need to think about when valuing corporate debt—the current value of the firm relative to the point at which it would default, the volatility of the assets, the maturity of the debt payments, and the risk-free interest rate. Unfortunately, most companies have several loans outstanding with payments due at different times. This considerably complicates the task of valuing the put option.

Because of these complications, bond investors do not regularly use option models to value the default option that is attached to a corporate bond. More commonly, they rely on their experience to judge whether the spread between the yield on a corporate bond and the yield on a comparable government issue compensates for the possibility of default. Spreads can change rapidly as investors reassess the chances of default or become more or less risk-averse.

When investors want a measure of the risk of a company's bonds, they usually look at the rating that has been assigned by Moody's, Standard & Poor's, or Fitch. They know that bonds with a triple-A rating are much less likely to default than bonds with a junk rating.

Banks, rating services, and consulting firms have also developed a number of models for estimating the likelihood of default. Credit scoring systems take accounting ratios or other indicators of corporate health and weight them to produce a single measure of default. Moody's KMV takes a different tack and seeks to measure the probability that the market value of the firm's assets will fall to the point at which the firm will choose to default rather than try to keep up with its debt payments.

Don't assume that there is no risk just because there is no immediate prospect of default. If the quality of the bonds deteriorates, investors will demand a higher yield and the bond price will fall. One way to calculate the value at risk is to look at the probability of possible ratings changes and to estimate the likely effect of these changes for the bond's price.

FURTHER READING

The Web sites of the main credit rating agencies and of Moody's KMV contain a variety of useful reports on credit risk. (*See in particular* **www.moodys.com**, **www.standardandpoors.com**, **www.fitch.com**, and **www.moodyskmv.com**.)

Altman provides a review of credit scoring models in:

E. I. Altman, *Corporate Financial Distress and Bankruptcy,* 3rd ed. (New York: John Wiley, 2005).

There are a number of books that discuss corporate bonds and credit risk. Look, for example, at:

A. Saunders and L. Allen, *Credit Risk Measurement,* 2nd ed. (New York: John Wiley, 2002).

J. B. Caouette, E. I. Altman, P. Narayanan, and R. Nimmo, *Managing Credit Risk* (New York: John Wiley, 2008).

D. Duffie and K. J. Singleton, *Credit Risk: Pricing, Measurement and Management* (Princeton, NJ: Princeton University Press, 2003).

Select problems are available in McGraw-Hill Connect. Please see the preface for more information.

BASIC

PROBLEM SETS

1. You own a 5% bond maturing in two years and priced at 87%. Suppose that there is a 10% chance that at maturity the bond will default and you will receive only 40% of the promised payment. What is the bond's promised yield to maturity? What is its expected yield?
2. Other things equal, would you expect the difference between the price of a Treasury bond and a corporate bond to increase or decrease with
   a. The company's business risk?
   b. The degree of leverage?
3. The difference between the value of a government bond and a simple corporate bond is equal to the value of an option. What is this option and what is its exercise price?
4. The following table shows some financial data for two companies:

	A	B
Total assets	$1,552.1	$1,565.7
EBITDA	−60	70
Net income + interest	−80	24
Total liabilities	814.0	1,537.1

   Use the formula shown in Section 23-4 to calculate which has the higher probability of default.
5. What variables are required to use a market-based approach to calculate the probability that a company will default on its debt?
6. You have a B-rated bond. On past evidence, what is the probability that it will continue to be rated B in one year's time? What is the probability that it will have a lower rating?
7. You have an A-rated bond. Is a rise in rating more likely than a fall? Would your answer be the same if the bond were B-rated?
8. Why is it more difficult to estimate the value at risk for a portfolio of loans rather than for a single loan?

INTERMEDIATE

9. Company A has issued a single zero-coupon bond maturing in 10 years. Company B has issued a coupon bond maturing in 10 years. Explain why it is more complicated to value B's debt than A's.
10. Company X has borrowed $150 maturing this year and $50 maturing in 10 years. Company Y has borrowed $200 maturing in five years. In both cases asset value is $140. Sketch a scenario in which X does not default but Y does.
11. Discuss the problems with developing a numerical credit scoring system for evaluating personal loans. You can only test your system using data for applicants who have in the past been granted credit. Is this a potential problem?
12. What problems are you likely to encounter when using a market-based approach for estimating the probability that a company will default?
13. How much would it cost you to insure the bonds of Backwoods Chemical against default? (See Section 23-1.)

CHALLENGE

14. Look back to the first Backwoods Chemical example at the start of Section 23-1. Suppose that the firm's book balance sheet is:

Backwoods Chemical Company (Book Values)

Net working capital	$ 400	$1,000	Debt
Net fixed assets	1,600	1,000	Equity (net worth)
Total assets	$2,000	$2,000	Total value

The debt has a one-year maturity and a promised interest payment of 9%. Thus, the promised payment to Backwoods's creditors is $1,090. The market value of the assets is $1,200 and the standard deviation of asset value is 45% per year. The risk-free interest rate is 9%. Calculate the value of Backwoods debt and equity.

eXcel
Visit us at www.mhhe.com/bma

15. Use the Black–Scholes model and redraw Figures 23.5 and 23.6 assuming that the standard deviation of the return on the firm's assets is 40% a year. Do the calculations for 60% leverage only. (*Hint:* It is simplest to assume that the risk-free interest rate is zero.) What does this tell you about the effect of changing risk on the spread between high-grade and low-grade corporate bonds? (You may find it helpful to use the Black–Scholes program on the "live" spreadsheet for Chapter 21 at **www.mhhe.com/bma**.)

REAL-TIME DATA ANALYSIS

STANDARD & POOR'S

Use data from the Standard & Poor's Market Insight Database at www.mhhe.com/edumarketinsight to answer the following question.

1. Select three industrial companies that have been experiencing difficult times.

a. For each of them draw a figure similar to Figure 23.8. Are the companies' troubles reflected in their financial ratios?

b. Calculate a default probability for each using the formula shown in Section 23-4.

c. Now look at the company's bond rating. Do the two measures provide consistent messages?

2. Log in to the Moody's KMV Web site at **www.moodyskmv.com**. This site contains a number of case studies showing how the probability of default (termed the *expected default frequency* or *EDF*) changes as default comes closer. Compare the information provided by the EDFs with that provided by the credit ratings.