36. Treasury Bonds [LO2] The following Treasury bond quote appeared in *The Wall Street Journal* on May 11, 2004:

5/15/2009	9.125	100.09375	100.12500	0	−2.15

Why would anyone buy this Treasury bond with a negative yield to maturity? How is this possible?

37. Real Cash Flows [LO4] When Marilyn Monroe died, ex-husband Joe DiMaggio vowed to place fresh flowers on her grave every Sunday as long as he lived. The week after she died in 1962, a bunch of fresh flowers that the former baseball player thought appropriate for the star cost about $7. Based on actuarial tables, "Joltin' Joe" could expect to live for 30 years after the actress died. Assume that the EAR is 6.4 percent. Also, assume that the price of the flowers will increase at 3.7 percent per year, when expressed as an EAR. Assuming that each year has exactly 52 weeks, what is the present value of this commitment? Joe began purchasing flowers the week after Marilyn died.

38. Real Cash Flows [LO4] You are planning to save for retirement over the next 30 years. To save for retirement, you will invest $800 per month in a stock account in real dollars and $400 per month in a bond account in real dollars. The effective annual return of the stock account is expected to be 11 percent, and the bond account will earn 7 percent. When you retire, you will combine your money into an account with an effective return of 9 percent. The returns are stated in nominal terms. The inflation rate over this period is expected to be 4 percent. How much can you withdraw each month from your account in real terms assuming a 25-year withdrawal period? What is the nominal dollar amount of your last withdrawal?

EXCEL MASTER IT! PROBLEM

Companies often buy bonds to meet a future liability or cash outlay. Such an investment is called a dedicated portfolio because the proceeds of the portfolio are dedicated to the future liability. In such a case, the portfolio is subject to reinvestment risk. Reinvestment risk occurs because the company will be reinvesting the coupon payments it receives. If the YTM on similar bonds falls, these coupon payments will be reinvested at a lower interest rate, which will result in a portfolio value that is lower than desired at maturity. Of course, if interest rates increase, the portfolio value at maturity will be higher than needed.

Suppose Ice Cubes, Inc., has the following liability due in five years. The company is going to buy five-year bonds today to meet the future obligation. The liability and current YTM are below.

Amount of liability:	$100,000,000
Current YTM:	8%

a. At the current YTM, what is the face value of the bonds the company has to purchase today to meet its future obligation? Assume that the bonds in the relevant range will have the same coupon rate as the current YTM and these bonds make semiannual coupon payments.

b. Assume that the interest rates remain constant for the next five years. Thus, when the company reinvests the coupon payments, it will reinvest at the current YTM. What is the value of the portfolio in five years?

c. Assume that immediately after the company purchases the bonds, interest rates either rise or fall by 1 percent. What is the value of the portfolio in five years under these circumstances?

One way to eliminate reinvestment risk is called *immunization*. Rather than buying bonds with the same maturity as the liability, the company instead buys bonds with the same duration as the liability. If you think about the dedicated portfolio, if the interest rate falls, the future value of the reinvested coupon payments decreases. However, as interest rates fall, the price of the bond increases. These effects offset each other in an immunized portfolio.

Another advantage of using duration to immunize a portfolio is that the duration of a portfolio is the weighted average of the duration of the assets in the portfolio. In other words, to find the duration of a portfolio, you take the weight of each asset multiplied by its duration and then sum the results.

d. What is the duration of the liability for Ice Cubes, Inc.?

e. Suppose the two bonds shown below are the only bonds available to immunize the liability. What face amount of each bond will the company need to purchase to immunize the portfolio?

	Bond A	Bond B
Settlement:	1/1/2000	1/1/2000
Maturity:	1/1/2003	1/1/2008
Coupon rate:	7.00%	8.00%
YTM:	7.50%	9.00%
Coupons per year:	2	2

MINICASE

Financing S&S Air's Expansion Plans with a Bond Issue

Mark Sexton and Todd Story, the owners of S&S Air, have decided to expand their operations. They instructed their newly hired financial analyst, Chris Guthrie, to enlist an underwriter to help sell $35 million in new 10-year bonds to finance construction. Chris has entered into discussions with Renata Harper, an underwriter from the firm of Raines and Warren, about which bond features S&S Air should consider and what coupon rate the issue will likely have.

Although Chris is aware of the bond features, he is uncertain about the costs and benefits of some features, so he isn't sure how each feature would affect the coupon rate of the bond issue. You are Renata's assistant, and she has asked you to prepare a memo to Chris describing the effect of each of the following bond features on the coupon rate of the bond. She would also like you to list any advantages or disadvantages of each feature.

QUESTIONS

1. The security of the bond—that is, whether the bond has collateral.
2. The seniority of the bond.
3. The presence of a sinking fund.
4. A call provision with specified call dates and call prices.
5. A deferred call accompanying the call provision.
6. A make-whole call provision.
7. Any positive covenants. Also, discuss several possible positive covenants S&S Air might consider.
8. Any negative covenants. Also, discuss several possible negative covenants S&S Air might consider.
9. A conversion feature (note that S&S Air is not a publicly traded company).
10. A floating-rate coupon.

Stock Valuation

Chapter 8

WHEN THE STOCK MARKET CLOSED on December 29, 2017, the common stock of video game retailer GameStop was going for $17.95 per share. On that same day, stock in industrial giant General Electric closed at $17.45, while stock in data center and technology company Switch, Inc., closed at $18.19. Because the stock prices of these three companies were so similar, you might expect that they would be offering similar dividends to their stockholders, but you would be wrong. In fact, GameStop's annual dividend was $1.52 per share, General Electric's was $.48 per share, and Switch was paying no dividend at all!

As we will see in this chapter, the dividends currently being paid are one of the primary factors we look at when attempting to value common stocks. However, it is obvious from looking at Micron Technology that current dividends are not the end of the story. This chapter explores dividends, stock values, and the connection between the two.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Explain how stock prices depend on future dividends and dividend growth.

LO2 Show how to value stocks using multiples.

LO3 Lay out the different ways corporate directors are elected to office.

LO4 Define how the stock markets work.

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In our previous chapter, we introduced you to bonds and bond valuation. In this chapter, we turn to the other major source of financing for corporations: Common and preferred stock. We first describe the cash flows associated with a share of stock and then go on to develop a famous result, the dividend growth model. From there, we move on to examine various important features of common and preferred stock, focusing on shareholder rights. We close the chapter with a discussion of how shares of stock are traded and how stock prices and other important information are reported in the financial press.

8.1 Common Stock Valuation

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A share of common stock is more difficult to value in practice than a bond for at least three reasons. First, with common stock, not even the promised cash flows are known in advance. Second, the life of the investment is essentially forever because common stock has no maturity. Third, there is no way to easily observe the rate of return that the market requires. Nonetheless, as we will see, there are cases in which we can come up with the present value of the future cash flows for a share of stock and thus determine its value.

CASH FLOWS

Imagine that you are considering buying a share of stock today. You plan to sell the stock in one year. You somehow know that the stock will be worth $70 at that time. You predict that the stock will also pay a $10 per share dividend at the end of the year. If you require a 25 percent return on your investment, what is the most you would pay for the stock? In other words, what is the present value of the $10 dividend along with the $70 ending value at 25 percent?

If you buy the stock today and sell it at the end of the year, you will have a total of $80 in cash. At 25 percent:

$$\text{Present value} = (\$10 + 70)/1.25 = \$64$$

Therefore, $64 is the value you would assign to the stock today.

More generally, let P_0 be the current price of the stock, and assign P_1 to be the price in one period. If D_1 is the cash dividend paid at the end of the period, then:

$$\boldsymbol{P_0 = (D_1 + P_1)/(1 + R)}$$ 8.1

where R is the required return in the market on this investment.

Notice that we really haven't said much so far. If we wanted to determine the value of a share of stock today (P_0), we would first have to come up with the value in one year (P_1). This is even harder to do, so we've only made the problem more complicated.

What is the price in one period, P_1? We don't know in general. Instead, suppose we somehow knew the price in two periods, P_2. Given a predicted dividend in two periods, D_2, the stock price in one period would be:

$$P_1 = (D_2 + P_2)/(1 + R)$$

If we were to substitute this expression for P_1 into our expression for P_0, we would have:

$$P_0 = \frac{D_1 + P_1}{1 + R} = \frac{D_1 + \dfrac{D_2 + P_2}{1 + R}}{1 + R}$$

$$= \frac{D_1}{(1 + R)^1} + \frac{D_2}{(1 + R)^2} + \frac{P_2}{(1 + R)^2}$$

Now we need to get a price in two periods. We don't know this either, so we can procrastinate again and write:

$$P_2 = (D_3 + P_3)/(1 + R)$$

If we substitute this back in for P_2, we have:

$$P_0 = \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{P_2}{(1+R)^2}$$

$$= \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{\dfrac{D_3 + P_3}{1+R}}{(1+R)^2}$$

$$= \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \frac{P_3}{(1+R)^3}$$

You should start to notice that we can push the problem of coming up with the stock price off into the future forever. Note that no matter what the stock price is, the present value is essentially zero if we push the sale of the stock far enough away.[1] What we are eventually left with is the result that the current price of the stock can be written as the present value of the dividends beginning in one period and extending out forever:

$$P_0 = \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \frac{D_4}{(1+R)^4} + \frac{D_5}{(1+R)^5} + \cdots$$

We have illustrated here that the price of the stock today is equal to the present value of all of the future dividends. How many future dividends are there? In principle, there can be an infinite number. This means that we still can't compute a value for the stock because we would have to forecast an infinite number of dividends and then discount them all. In the next section, we consider some special cases in which we can get around this problem.

[1]The only assumption we make about the stock price is that it is a finite number no matter how far away we push it. It can be extremely large, just not infinitely so. Because no one has ever observed an infinite stock price, this assumption is plausible.

Growth Stocks — EXAMPLE 8.1

You might be wondering about shares of stock in companies such as Alphabet that currently pay no dividends. Small, growing companies frequently plow back everything and pay no dividends. Are such shares worth nothing? It depends. When we say that the value of the stock is equal to the present value of the future dividends, we don't rule out the possibility that some number of those dividends are zero. They just can't *all* be zero.

Imagine a company that has a provision in its corporate charter that prohibits the paying of dividends now or ever. The corporation never borrows any money, never pays out any money to stockholders in any form whatsoever, and never sells any assets. Such a corporation couldn't really exist because the IRS wouldn't like it, and the stockholders could always vote to amend the charter if they wanted to. If it did exist, however, what would the stock be worth?

The stock would be worth absolutely nothing. Such a company would be a financial "black hole." Money goes in, but nothing valuable ever comes out. Because nobody would ever get any return on this investment, the investment would have no value. This example is a little absurd, but it illustrates that when we speak of companies that don't pay dividends, what we really mean is that they are not *currently* paying dividends.

SOME SPECIAL CASES

In a few useful special circumstances, we can come up with a value for the stock. What we have to do is make some simplifying assumptions about the pattern of future dividends. The three cases we consider are the following: (1) The dividend has a zero growth rate, (2) the dividend grows at a constant rate, and (3) the dividend grows at a constant rate after some length of time. We consider each of these separately.

Zero Growth The case of zero growth is one we've already seen. A share of common stock in a company with a constant dividend is much like a share of preferred stock. From Chapter 6 (see Example 6.7), we know that the dividend on a share of preferred stock has zero growth and is constant through time. For a zero-growth share of common stock, this implies that:

$$D_1 = D_2 = D_3 = D = \text{constant}$$

So, the value of the stock is:

$$P_0 = \frac{D}{(1+R)^1} + \frac{D}{(1+R)^2} + \frac{D}{(1+R)^3} + \frac{D}{(1+R)^4} + \frac{D}{(1+R)^5} + \cdots$$

Because the dividend is always the same, the stock can be viewed as an ordinary perpetuity with a cash flow equal to D every period. The per-share value is given by:

$$\boldsymbol{P_0 = D/R} \qquad \textbf{8.2}$$

where R is the required return.

For example, suppose the Paradise Prototyping Company has a policy of paying a $10 per share dividend every year. If this policy is to be continued indefinitely, what is the value of a share of stock if the required return is 20 percent? The stock in this case amounts to an ordinary perpetuity, so the stock is worth $10/.20 = $50 per share.

Constant Growth Suppose we know that the dividend for some company always grows at a steady rate. Call this growth rate g. If we let D_0 be the dividend just paid, then the next dividend, D_1, is:

$$D_1 = D_0 \times (1 + g)$$

The dividend in two periods is:

$$\begin{aligned} D_2 &= D_1 \times (1 + g) \\ &= [D_0 \times (1 + g)] \times (1 + g) \\ &= D_0 \times (1 + g)^2 \end{aligned}$$

We could repeat this process to come up with the dividend at any point in the future. In general, from our discussion of compound growth in Chapter 6, we know that the dividend t periods into the future, D_t, is given by:

$$D_t = D_0 \times (1 + g)^t$$

As we have previously seen, an asset with cash flows that grow at a constant rate forever is called a *growing perpetuity*.

The assumption of steady dividend growth might strike you as peculiar. Why would the dividend grow at a constant rate? The reason is that, for many companies, steady growth in dividends is an explicit goal. For example, in 2016, Procter & Gamble, the Cincinnati-based maker of personal care and household products, increased its dividend by 1 percent to $2.68 per share; this increase was notable because it was the 60th in a row. The subject of dividend growth falls under the general heading of dividend policy, so we will defer further discussion of it to a later chapter.

Dividend Growth — EXAMPLE 8.2

The Hedless Corporation has just paid a dividend of $3 per share. The dividend of this company grows at a steady rate of 8 percent per year. Based on this information, what will the dividend be in five years?

Here we have a $3 current amount that grows at 8 percent per year for five years. The future amount is thus:

$$\$3 \times 1.08^5 = \$3 \times 1.4693 = \$4.41$$

The dividend will increase by $1.41 over the coming five years.

If the dividend grows at a steady rate, then we have replaced the problem of forecasting an infinite number of future dividends with the problem of coming up with a single growth rate, a considerable simplification. In this case, if we take D_0 to be the dividend just paid and g to be the constant growth rate, the value of a share of stock can be written as:

$$\begin{aligned} P_0 &= \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \cdots \\ &= \frac{D_0(1+g)^1}{(1+R)^1} + \frac{D_0(1+g)^2}{(1+R)^2} + \frac{D_0(1+g)^3}{(1+R)^3} + \cdots \end{aligned}$$

As long as the growth rate, g, is less than the discount rate, r, the present value of this series of cash flows can be written as:

$$\boldsymbol{P_0 = \frac{D_0 \times (1+g)}{R-g} = \frac{D_1}{R-g}} \qquad \textbf{8.3}$$

This elegant result goes by a lot of different names. We will call it the **dividend growth model**. By any name, it is easy to use. To illustrate, suppose D_0 is $2.30, R is 13 percent, and g is 5 percent. The price per share in this case is:

dividend growth model
A model that determines the current price of a stock as its dividend next period divided by the discount rate less the dividend growth rate.

$$\begin{aligned} P_0 &= D_0 \times (1+g)/(R-g) \\ &= \$2.30 \times 1.05/(.13 - .05) \\ &= \$2.415/.08 \\ &= \$30.19 \end{aligned}$$

We can actually use the dividend growth model to get the stock price at any point in time, not just today. In general, the price of the stock as of Time t is:

$$\boldsymbol{P_t = \frac{D_t \times (1+g)}{R-g} = \frac{D_{t+1}}{R-g}} \qquad \textbf{8.4}$$

In our example, suppose we are interested in the price of the stock in five years, P_5. We first need the dividend at Time 5, D_5. Because the dividend just paid is $2.30 and the growth rate is 5 percent per year, D_5 is:

$$D_5 = \$2.30 \times 1.05^5 = \$2.30 \times 1.2763 = \$2.935$$

From the dividend growth model, we get the price of the stock in five years:

$$P_5 = \frac{D_5 \times (1+g)}{R-g} = \frac{\$2.935 \times 1.05}{.13 - .05} = \frac{\$3.0822}{.08} = \$38.53$$

EXAMPLE 8.3 Gordon Growth Company

The next dividend for the Gordon Growth Company will be $4 per share. Investors require a 16 percent return on companies such as Gordon. Gordon's dividend increases by 6 percent every year. Based on the dividend growth model, what is the value of Gordon's stock today? What is the value in four years?

The only tricky thing here is that the next dividend, D_1, is given as $4, so we won't multiply this by $(1 + g)$. With this in mind, the price per share is given by:

$$\begin{aligned} P_0 &= D_1/(R - g) \\ &= \$4/(.16 - .06) \\ &= \$4/.10 \\ &= \$40 \end{aligned}$$

Because we already have the dividend in one year, we know that the dividend in four years is equal to $D_1 \times (1 + g)^3 = \$4 \times 1.06^3 = \$4.764$. So, the price in four years is:

$$\begin{aligned} P_4 &= D_4 \times (1 + g)/(R - g) \\ &= \$4.764 \times 1.06/(.16 - .06) \\ &= \$5.05/.10 \\ &= \$50.50 \end{aligned}$$

Notice in this example that P_4 is equal to $P_0 \times (1 + g)^4$.

$$P_4 = \$50.50 = \$40 \times 1.06^4 = P_0 \times (1 + g)^4$$

To see why this is so, notice first that:

$$P_4 = D_5/(R - g)$$

However, D_5 is just equal to $D_1 \times (1 + g)^4$, so we can write P_4 as:

$$\begin{aligned} P_4 &= D_1 \times (1 + g)^4/(R - g) \\ &= [D_1/(R - g)] \times (1 + g)^4 \\ &= P_0 \times (1 + g)^4 \end{aligned}$$

This last example illustrates that the dividend growth model makes the implicit assumption that the stock price will grow at the same constant rate as the dividend. This really isn't too surprising. What it tells us is that if the cash flows on an investment grow at a constant rate through time, so does the value of that investment.

You might wonder what would happen with the dividend growth model if the growth rate, g, were greater than the discount rate, R. It looks like we would get a negative stock price because $R - g$ would be less than zero. This is not what would happen.

Instead, if the constant growth rate exceeds the discount rate, then the stock price is infinitely large. Why? If the growth rate is bigger than the discount rate, the present value of the dividends keeps getting bigger. Essentially the same is true if the growth rate and the discount rate are equal. In both cases, the simplification that allows us to replace the infinite stream of dividends with the dividend growth model is "illegal," so the answers we get from the dividend growth model are nonsense unless the growth rate is less than the discount rate.

Finally, the expression we came up with for the constant growth case will work for any growing perpetuity, not just dividends on common stock. As we saw in Chapter 6, if C_1 is the next cash flow on a growing perpetuity, then the present value of the cash flows is given by:

$$\text{Present value} = C_1/(R - g) = C_0(1 + g)/(R - g)$$

Notice that this expression looks like the result for an ordinary perpetuity except that we have $R - g$ on the bottom instead of just R.

Nonconstant Growth The next case we consider is nonconstant growth. The main reason to consider this case is to allow for "supernormal" growth rates over some finite length of time. As we discussed earlier, the growth rate cannot exceed the required return indefinitely, but it certainly could do so for some number of years. To avoid the problem of having to forecast and discount an infinite number of dividends, we will require that the dividends start growing at a constant rate sometime in the future.

For a simple example of nonconstant growth, consider the case of a company that is currently not paying dividends. You predict that, in five years, the company will pay a dividend for the first time. The dividend will be \$.50 per share. You expect that this dividend will then grow at a rate of 10 percent per year indefinitely. The required return on companies such as this one is 20 percent. What is the price of the stock today?

To see what the stock is worth today, we first find out what it will be worth once dividends are paid. We can then calculate the present value of that future price to get today's price. The first dividend will be paid in five years, and the dividend will grow steadily from then on. Using the dividend growth model, we can say that the price in four years will be:

$$\begin{aligned} P_4 &= D_4 \times (1 + g)/(R - g) \\ &= D_5/(R - g) \\ &= \$.50/(.20 - .10) \\ &= \$5 \end{aligned}$$

If the stock will be worth \$5 in four years, then we can get the current value by discounting this price back four years at 20 percent:

$$P_0 = \$5/1.20^4 = \$5/2.0736 = \$2.41$$

The stock is worth \$2.41 today.

The problem of nonconstant growth is only slightly more complicated if the dividends are not zero for the first several years. For example, suppose you have come up with the following dividend forecasts for the next three years:

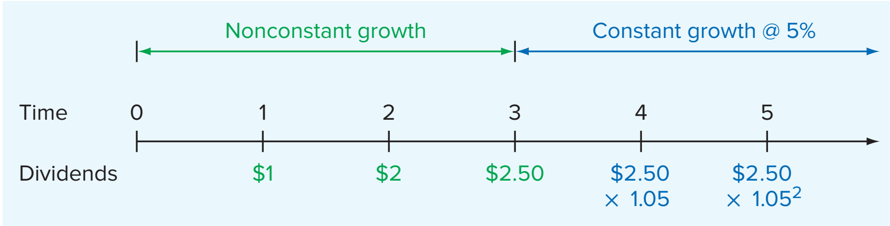
Year	Expected Dividend
1	\$1.00
2	\$2.00
3	\$2.50

After the third year, the dividend will grow at a constant rate of 5 percent per year. The required return is 10 percent. What is the value of the stock today?

In dealing with nonconstant growth, a time line can be helpful. Figure 8.1 illustrates a time line for this problem. The important thing to notice is when constant growth starts. As we've shown, for this problem, constant growth starts at Time 3. This means we can use our constant growth model to determine the stock price at Time 3, P_3. By far the most common mistake in this situation is to incorrectly identify the start of the constant growth phase and, as a result, calculate the future stock price at the wrong time.

As always, the value of the stock is the present value of all the future dividends. To calculate this present value, we first have to compute the present value of the stock price three years down the road, just as we did before. We then have to add in the present

FIGURE 8.1
Nonconstant Growth



value of the dividends that will be paid between now and then. So, the price in three years is:

$$\begin{aligned} P_3 &= D_3 \times (1 + g)/(R - g) \\ &= \$2.50 \times 1.05/(.10 - .05) \\ &= \$52.50 \end{aligned}$$

We can now calculate the total value of the stock as the present value of the first three dividends plus the present value of the price at Time 3, P_3:

$$\begin{aligned} P_0 &= \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \frac{P_3}{(1+R)^3} \\ &= \frac{\$1}{1.10} + \frac{2}{1.10^2} + \frac{2.50}{1.10^3} + \frac{52.50}{1.10^3} \\ &= \$.91 + 1.65 + 1.88 + 39.44 \\ &= \$43.88 \end{aligned}$$

The value of the stock today is thus $43.88.

EXAMPLE 8.4 Supernormal Growth

Chain Reaction, Inc., has been growing at a phenomenal rate of 30 percent per year because of its rapid expansion and explosive sales. You believe this growth rate will last for three more years and will then drop to 10 percent per year. If the growth rate then remains at 10 percent indefinitely, what is the total value of the stock? Total dividends just paid were $5 million, and the required return is 20 percent.

Chain Reaction's situation is an example of supernormal growth. It is unlikely that a 30 percent growth rate can be sustained for any extended time. To value the equity in this company, we first need to calculate the total dividends over the supernormal growth period:

Year	Total Dividends (in millions)
1	$5.00 × 1.3 = $ 6.500
2	6.50 × 1.3 = 8.450
3	8.45 × 1.3 = 10.985

The price at Time 3 can be calculated as:

$$P_3 = D_3 \times (1 + g)/(R - g)$$

where g is the long-run growth rate. So, we have:

$$P_3 = \$10.985 \times 1.10/(.20 - .10) = \$120.835$$

To determine the value today, we need the present value of this amount plus the present value of the total dividends:

$$\begin{aligned}P_0 &= \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \frac{P_3}{(1+R)^3}\\ &= \frac{\$6.50}{1.20} + \frac{8.45}{1.20^2} + \frac{10.985}{1.20^3} + \frac{120.835}{1.20^3}\\ &= \$5.42 + 5.87 + 6.36 + 69.93\\ &= \$87.57\end{aligned}$$

The total value of the stock today is thus \$87.57 million. If there were, for example, 20 million shares, then the stock would be worth \$87.57/20 = \$4.38 per share.

Two-Stage Growth The last case we consider is a special case of nonconstant growth: Two-stage growth. Here, the idea is that the dividend will grow at a rate of g_1 for t years and then grow at a rate of g_2 thereafter, forever. In this case, the value of the stock can be written as:

$$\boldsymbol{P_0 = \frac{D_1}{R - g_1} \times \left[1 - \left(\frac{1+g_1}{1+R}\right)^t\right] + \frac{P_t}{(1+R)^t}} \qquad \textbf{8.5}$$

Notice that the first term in our expression is the present value of a growing annuity, which we discussed in Chapter 6. In this first stage, g_1 can be greater than R. The second part is the present value of the stock price once the second stage begins at Time t.

We can calculate P_t as follows:

$$\boldsymbol{P_t = \frac{D_{t+1}}{R - g_2} = \frac{D_0 \times (1+g_1)^t \times (1+g_2)}{R - g_2}} \qquad \textbf{8.6}$$

In this calculation, we need the dividend at Time $t + 1$, D_{t+1}, to get the stock price at Time t, P_t. Notice that to get the dividend at Time $t + 1$, we grew the current dividend, D_0, at rate g_1 for t periods and then grew it one period at rate g_2. Also, in this second stage, g_2 must be less than R.

Two-Stage Growth — EXAMPLE 8.5

The Highfield Company's dividend is expected to grow at 20 percent for the next five years. After that, the growth is expected to be 4 percent forever. If the required return is 10 percent, what's the value of the stock? The dividend just paid was \$2.

There is a fair amount of computation here, but it is mostly just "plug and chug" with a calculator. We can start by calculating the stock price five years from now, P_5:

$$\begin{aligned}P_5 &= \frac{D_6}{R - g_2} = \frac{D_0 \times (1+g_1)^5 \times (1+g_2)}{R - g_2}\\ &= \frac{\$2 \times (1+.20)^5 \times (1+.04)}{.10 - .04} = \frac{\$5.18}{.06}\\ &= \$86.26\end{aligned}$$

We then plug this result into our two-stage growth formula to get the price today:

$$\begin{aligned}P_0 &= \frac{D_1}{R - g_1} \times \left[1 - \left(\frac{1+g_1}{1+R}\right)^t\right] + \frac{P_t}{(1+R)^t}\\ &= \frac{\$2 \times (1+.20)}{.10 - .20} \times \left[1 - \left(\frac{1+.20}{1+.10}\right)^5\right] + \frac{\$86.26}{(1+.10)^5}\\ &= \$66.64\end{aligned}$$

Notice that we were given $D_0 = \$2$ here, so we had to grow it by 20 percent for one period to get D_1. Notice also that g_1 is bigger than R in this problem, but that fact does not cause a problem.

COMPONENTS OF THE REQUIRED RETURN

Thus far, we have taken the required return, or discount rate, R, as given. We will have quite a bit to say about this subject in Chapters 12 and 13. For now, we want to examine the implications of the dividend growth model for this required return. Earlier, we calculated P_0 as:

$$P_0 = D_1/(R - g)$$

If we rearrange this to solve for R, we get:

$$R - g = D_1/P_0$$
$$R = D_1/P_0 + g \quad \text{8.7}$$

dividend yield
A stock's expected cash dividend divided by its current price.

capital gains yield
The dividend growth rate, or the rate at which the value of an investment grows.

This tells us that the total return, R, has two components. The first of these, D_1/P_0, is called the **dividend yield**. Because this is calculated as the expected cash dividend divided by the current price, it is conceptually similar to the current yield on a bond.

The second part of the total return is the growth rate, g. We know that the dividend growth rate is also the rate at which the stock price grows (see Example 8.3). This growth rate can be interpreted as the **capital gains yield**—that is, the rate at which the value of the investment grows.[2]

To illustrate the components of the required return, suppose we observe a stock selling for \$20 per share. The next dividend will be \$1 per share. You think that the dividend will grow by 10 percent per year more or less indefinitely. What return does this stock offer if this is correct?

The dividend growth model calculates total return as:

$$R = \text{Dividend yield} + \text{Capital gains yield}$$
$$R = \quad D_1/P_0 \quad + \quad g$$

In this case, total return works out to be:

$$\begin{aligned} R &= \$1/20 + 10\% \\ &= 5\% + 10\% \\ &= 15\% \end{aligned}$$

This stock has an expected return of 15 percent.

We can verify this answer by calculating the price in one year, P_1, using 15 percent as the required return. Based on the dividend growth model, this price is:

$$\begin{aligned} P_1 &= D_1 \times (1 + g)/(R - g) \\ &= \$1 \times 1.10/(.15 - .10) \\ &= \$1.10/.05 \\ &= \$22 \end{aligned}$$

[2]Here and elsewhere, we use the term *capital gains* a little loosely. For the record, a capital gain (or loss) is, strictly speaking, something defined by the IRS. For our purposes, it would be more accurate (but less common) to use the term *price appreciation* instead of *capital gain*.

Notice that this \$22 is \$20 × 1.1, so the stock price has grown by 10 percent, as it should. If you pay \$20 for the stock today, you will get a \$1 dividend at the end of the year, and you will have a \$22 − 20 = \$2 gain. Your dividend yield is thus \$1/20 = 5%. Your capital gains yield is \$2/20 = 10%, so your total return is 5% + 10% = 15%.

To get a feel for actual numbers in this context, consider that, according to the December 2016 Value Line *Investment Survey,* Procter & Gamble's dividends were expected to grow by 5 percent over the next 5 or so years, compared to a historical growth rate of 7.5 percent over the preceding 5 years and 9.5 percent over the preceding 10 years. In 2017, the projected dividend for the coming year was given as \$2.85. The stock price at that time was about \$85 per share. What is the return investors require on P&G? Here, the dividend yield is 3.35 percent and the capital gains yield is 5 percent, giving a total required return of 8.35 percent on P&G stock.

STOCK VALUATION USING MULTIPLES

An obvious problem with our dividend-based approach to stock valuation is that many companies don't pay dividends. What do we do in such cases? A common approach is to make use of the PE ratio, which we defined in Chapter 3 as the ratio of a stock's price per share to its earnings per share (EPS) over the previous year. The idea here is to have some sort of benchmark or reference PE ratio, which we then multiply by earnings to come up with a price:

$$\text{Price at Time } t = P_t = \text{Benchmark PE ratio} \times \text{EPS}_t \qquad \textbf{8.8}$$

The benchmark PE ratio could come from one of several possible sources. It could be based on similar companies (perhaps an industry average or median), or it could be based on a company's own historical values. For example, suppose we are trying to value Inactivision, Inc., a video game developer known for its hit *Slack Ops* series. Inactivision does not pay dividends, but after studying the industry, you feel that a PE ratio of 20 is appropriate for a company like this one. Total earnings over the four most recent quarters combined are \$2 per share, so you think the stock should sell for 20 × \$2 = \$40. You might view this stock as an attractive purchase if it is going for less than \$40, but not attractive if it sells for more than \$40.

Security analysts spend a lot of time forecasting future earnings, particularly for the coming year. A PE ratio that is based on estimated future earnings is called a *forward* PE ratio. For example, suppose you felt that Inactivision's earnings for the coming year were going to be \$2.50, reflecting the growing popularity of the company's *World of Slackcraft* massively multiplayer online role-playing game (MMORPG). In this case, if the current stock price is \$40, the forward PE ratio is \$40/\$2.50 = 16.

Finally, notice that your benchmark PE of 20 applies to earnings over the previous year. If earnings over the coming year turn out to be \$2.50, then the stock price one year from today should be 20 × \$2.50 = \$50. Forecast prices such as this one are often called *target* prices.

Often we will be interested in valuing newer companies that both don't pay dividends and are not yet profitable, meaning that earnings are negative. What do we do then? One answer is to use the price-sales ratio, which we also introduced in Chapter 3. As the name suggests, this ratio is the price per share on the stock divided by sales per share. You use this ratio just like you use the PE ratio, except you use sales per share instead of earnings per share. As with PE ratios, price-sales ratios vary depending on company age and industry. Typical values are in the .8–2.0 range, but they can be much higher for younger, faster-growing companies.

For future reference, our discussion of stock valuation techniques is summarized in Table 8.1.

TABLE 8.1

Summary of Stock Valuation

I. The General Case

In general, the price today of a share of stock, P_0, is the present value of all of its future dividends, $D_1, D_2, D_3, \ldots$:

$$P_0 = \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \frac{D_3}{(1+R)^3} + \cdots$$

where R is the required return.

II. Constant Growth Case

If the dividend grows at a steady rate, g, then the price can be written as:

$$P_0 = \frac{D_1}{R - g}$$

This result is called the *dividend growth model*.

III. Nonconstant Growth

If the dividend grows steadily after t periods, then the price can be written as:

$$P_0 = \frac{D_1}{(1+R)^1} + \frac{D_2}{(1+R)^2} + \cdots + \frac{D_t}{(1+R)^t} + \frac{P_t}{(1+R)^t}$$

where

$$P_t = \frac{D_t \times (1+g)}{(R - g)}$$

IV. Two-Stage Growth

If the dividend grows at rate g_1 for t periods and then grows at rate g_2 thereafter, then the price can be written as:

$$P_0 = \frac{D_1}{R - g_1} \times \left[1 - \left(\frac{1+g_1}{1+R}\right)^t\right] + \frac{P_t}{(1+R)^t}$$

where

$$P_t = \frac{D_{t+1}}{R - g_2} = \frac{D_0 \times (1+g_1)^t \times (1+g_2)}{R - g_2}$$

V. Valuation Using Multiples

For stocks that don't pay dividends (or have erratic dividend growth rates), we can value them using the PE ratio and/or the price-sales ratio:

P_t = Benchmark PE ratio × EPS_t

P_t = Benchmark price-sales ratio × Sales per share_t

VI. The Required Return

The required return, R, can be written as the sum of two things:

$$R = D_1/P_0 + g$$

where D_1/P_0 is the *dividend yield* and g is the *capital gains yield* (which is the same thing as the growth rate in dividends for the steady growth case).

Concept Questions

8.1a What are the relevant cash flows for valuing a share of common stock?

8.1b Does the value of a share of stock depend on how long you expect to keep it?

8.1c What is the value of a share of stock when the dividend grows at a constant rate?

Some Features of Common and Preferred Stocks

8.2

In discussing common stock features, we focus on shareholder rights and dividend payments. For preferred stock, we explain what *preferred* means, and we also debate whether preferred stock is really debt or equity.

COMMON STOCK FEATURES

The term **common stock** means different things to different people, but it is usually applied to stock that has no special preference either in receiving dividends or in bankruptcy.

common stock
Equity without priority for dividends or in bankruptcy.

Shareholder Rights

The conceptual structure of the corporation assumes that shareholders elect directors who, in turn, hire managers to carry out their directives. Shareholders, therefore, control the corporation through the right to elect the directors. Generally, only shareholders have this right.

Directors are elected each year at an annual meeting. Although there are exceptions (discussed next), the general idea is "one share, one vote" (*not* one share*holder*, one vote). Corporate democracy is thus very different from our political democracy. With corporate democracy, the "golden rule" prevails absolutely.[3]

Directors are elected at an annual shareholders' meeting by a vote of the holders of a majority of shares who are present and entitled to vote. However, the exact mechanism for electing directors differs across companies. The most important difference is whether shares must be voted cumulatively or voted straight.

To illustrate the two different voting procedures, imagine that a corporation has two shareholders: Smith with 20 shares and Jones with 80 shares. Both want to be a director. Jones does not want Smith to be a director, however. We assume there are a total of four directors to be elected.

The effect of **cumulative voting** is to permit minority participation.[4] If cumulative voting is permitted, the total number of votes that each shareholder may cast is determined first. This is usually calculated as the number of shares (owned or controlled) multiplied by the number of directors to be elected.

cumulative voting
A procedure in which a shareholder may cast all votes for one member of the board of directors.

With cumulative voting, the directors are elected all at once. In our example, this means that the top four vote getters will be the new directors. A shareholder can distribute votes however he or she wishes.

Will Smith get a seat on the board? If we ignore the possibility of a five-way tie, then the answer is yes. Smith will cast $20 \times 4 = 80$ votes, and Jones will cast $80 \times 4 = 320$ votes. If Smith gives all his votes to himself, he is assured of a directorship. The reason is that Jones can't divide 320 votes among four candidates in such a way as to give all of them more than 80 votes, so Smith will finish fourth at worst.

In general, if there are N directors up for election, then $1/(N + 1)$ percent of the stock plus one share will guarantee you a seat. In our current example, this is $1/(4 + 1) = .20$, or 20%. So the more seats that are up for election at one time, the easier (and cheaper) it is to win one.

With **straight voting**, the directors are elected one at a time. Each time, Smith can cast 20 votes and Jones can cast 80. As a consequence, Jones will elect all of the candidates. The

straight voting
A procedure in which a shareholder may cast all votes for each member of the board of directors.

[3]The golden rule: Whosoever has the gold makes the rules.

[4]By *minority participation*, we mean participation by shareholders with relatively small amounts of stock.

only way to guarantee a seat is to own 50 percent plus one share. This also guarantees that you will win every seat, so it's really all or nothing.

EXAMPLE 8.6 Buying the Election

Stock in JRJ Corporation sells for \$20 per share and features cumulative voting. There are 10,000 shares outstanding. If three directors are up for election, how much does it cost to ensure yourself a seat on the board?

The question here is how many shares of stock it will take to get a seat. The answer is 2,501, so the cost is 2,501 × \$20 = \$50,020. Why 2,501? Because there is no way the remaining 7,499 votes can be divided among three people to give all of them more than 2,501 votes. For example, suppose two people receive 2,502 votes and the first two seats. A third person can receive at most 10,000 − 2,502 − 2,502 − 2,501 = 2,495, so the third seat is yours.

Many companies have staggered elections for directors. With staggered elections, only a fraction of the directorships (often one-third) are up for election at a particular time. If only two directors are up for election at any one time, it will take $1/(2 + 1) = .3333$, or 33.33% of the stock plus one share to guarantee a seat. Staggered boards are often called *classified* boards because directors are placed into different classes with terms that expire at different times. In recent years, corporations have come under pressure to declassify their boards, meaning that all directors would stand for election every year, and many have done so.

Overall, staggering has two basic effects:

1. Staggering makes it more difficult for a minority to elect a director because there are fewer directors to be elected at one time.
2. Staggering makes takeover attempts less likely to be successful because it makes it more difficult to vote in a majority of new directors.

We should note that staggering may serve a beneficial purpose. It provides "institutional memory"—that is, continuity on the board of directors. This may be important for corporations with significant long-range plans and projects.

proxy
A grant of authority by a shareholder allowing another individual to vote his or her shares.

Proxy Voting A **proxy** is the grant of authority by a shareholder to someone else to vote his or her shares. For convenience, much of the voting in large public corporations is actually done by proxy.

As we have seen, with straight voting, each share of stock has one vote. The owner of 10,000 shares has 10,000 votes. Large companies have hundreds of thousands or even millions of shareholders. Shareholders can come to the annual meeting and vote in person, or they can transfer their right to vote to another party.

Obviously, management always tries to get as many proxies as possible transferred to it. If shareholders are not satisfied with management, an "outside" group of shareholders can try to obtain votes via proxy. They can vote by proxy in an attempt to replace management by electing enough directors. The resulting battle is called a *proxy fight*.

Classes of Stock Some firms have more than one class of common stock. Often the classes are created with unequal voting rights. The Ford Motor Company, for example, has Class B common stock, which is not publicly traded (it is held by Ford family interests and trusts). This class has 40 percent of the voting power, even though it represents less than 10 percent of the total number of shares outstanding.

There are many other cases of corporations with different classes of stock. For example, at one time, General Motors had its "GM Classic" shares (the original) and two additional classes, Class E ("GME") and Class H ("GMH"). These classes were created to help pay for two large acquisitions, Electronic Data Systems and Hughes Aircraft. Another good example is Alphabet, the web search company, which became publicly owned in 2004. Alphabet originally had two classes of common stock, A and B. The Class A shares are held by the public, and each share has one vote. The Class B shares are held by company insiders, and each Class B share has 10 votes. Then, in 2014, the company had a stock split of its Class B shares, creating Class C shares, which have no vote at all. As a result, Alphabet's founders and managers control the company. Facebook joined Alphabet when it created its own nonvoting Class C shares in 2016.

Historically, the New York Stock Exchange did not allow companies to create classes of publicly traded common stock with unequal voting rights. Exceptions (like Ford) appear to have been made. In addition, many non-NYSE companies have dual classes of common stock.

A primary reason for creating dual or multiple classes of stock has to do with control of the firm. If such stock exists, management of a firm can raise equity capital by issuing nonvoting or limited-voting stock while maintaining control.

The subject of unequal voting rights is controversial in the United States, and the idea of one share, one vote has a strong following and a long history. Interestingly, shares with unequal voting rights are quite common in the United Kingdom and elsewhere around the world.

Other Rights The value of a share of common stock in a corporation is directly related to the general rights of shareholders. In addition to the right to vote for directors, shareholders usually have the following rights:

1. The right to share proportionally in dividends paid.
2. The right to share proportionally in assets remaining after liabilities have been paid in a liquidation.
3. The right to vote on stockholder matters of great importance, such as a merger. Voting is usually done at the annual meeting or a special meeting.

In addition, stockholders sometimes have the right to share proportionally in any new stock sold. This is called the *preemptive right*.

Essentially, a preemptive right means that a company that wishes to sell stock must first offer it to the existing stockholders before offering it to the general public. The purpose is to give stockholders the opportunity to protect their proportionate ownership in the corporation.

Dividends A distinctive feature of corporations is that they have shares of stock on which they are authorized by law to pay dividends to their shareholders. **Dividends** paid to shareholders represent a return on the capital directly or indirectly contributed to the corporation by the shareholders. The payment of dividends is at the discretion of the board of directors.

dividends
Payments by a corporation to shareholders, made in either cash or stock.

Some important characteristics of dividends include the following:

1. Unless a dividend is declared by the board of directors of a corporation, it is not a liability of the corporation. A corporation cannot default on an undeclared dividend. As a consequence, corporations cannot become bankrupt because of nonpayment of dividends. The amount of the dividend and even whether it is paid are decisions based on the business judgment of the board of directors.

2. The payment of dividends by the corporation is not a business expense. Dividends are not deductible for corporate tax purposes. In short, dividends are paid out of the corporation's aftertax profits.
3. Dividends received by individual shareholders are taxable. In 2018, the tax rate was 15 to 20 percent. However, corporations that own stock in other corporations are permitted to exclude 50 percent of the dividend amounts they receive and are taxed on only the remaining 50 percent (the 50 percent exclusion was reduced from 70 percent by the Tax Cuts and Jobs Act of 2017).[5]

PREFERRED STOCK FEATURES

preferred stock
Stock with dividend priority over common stock, normally with a fixed dividend rate, sometimes without voting rights.

Preferred stock differs from common stock because it has preference over common stock in the payment of dividends and in the distribution of corporation assets in the event of liquidation. *Preference* means only that the holders of the preferred shares must receive a dividend (in the case of an ongoing firm) before holders of common shares are entitled to anything.

Preferred stock is a form of equity from a legal and tax standpoint. It is important to note that holders of preferred stock sometimes have no voting privileges.

Stated Value Preferred shares have a stated liquidating value, usually $100 per share. The cash dividend is described in terms of dollars per share. For example, General Motors "$5 preferred" easily translates into a dividend yield of 5 percent of stated value.

Cumulative and Noncumulative Dividends A preferred dividend is *not* like interest on a bond. The board of directors may decide not to pay the dividends on preferred shares, and their decision may have nothing to do with the current net income of the corporation.

Dividends payable on preferred stock are either *cumulative* or *noncumulative*; most are cumulative. If preferred dividends are cumulative and are not paid in a particular year, they will be carried forward as an *arrearage*. Usually, both the accumulated (past) preferred dividends and the current preferred dividends must be paid before the common shareholders can receive anything.

Unpaid preferred dividends are *not* debts of the firm. Directors elected by the common shareholders can defer preferred dividends indefinitely. In such cases, common shareholders must also forgo dividends. In addition, holders of preferred shares are often granted voting and other rights if preferred dividends have not been paid for some time. For example, at one point, USAir (now part of American Airlines) had failed to pay dividends on one of its preferred stock issues for six quarters. As a consequence, the holders of the shares were allowed to nominate two people to represent their interests on the airline's board. Because preferred stockholders receive no interest on the accumulated dividends, some have argued that firms have an incentive to delay paying preferred dividends; but, as we have seen, this may mean sharing control with preferred stockholders.

Is Preferred Stock Really Debt? A good case can be made that preferred stock is really debt in disguise, a kind of equity bond. Preferred shareholders receive a stated dividend only; and if the corporation is liquidated, preferred shareholders get a stated value. Often, preferred stocks carry credit ratings much like those of bonds. Furthermore,

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[5]For the record, the 70 percent exclusion applies when the recipient owns less than 20 percent of the outstanding stock in a corporation. If a corporation owns more than 20 percent but less than 80 percent, the exclusion is 80 percent. If more than 80 percent is owned, the corporation can file a single "consolidated" return and the exclusion is effectively 100 percent.

preferred stock is sometimes convertible into common stock, and preferred stocks are often callable.

In addition, many issues of preferred stock have obligatory sinking funds. The existence of such a sinking fund effectively creates a final maturity because it means that the entire issue will ultimately be retired. For these reasons, preferred stock seems to be a lot like debt. For tax purposes, preferred dividends are treated like common stock dividends.

In the 1990s, firms began to sell securities that looked a lot like preferred stocks but were treated as debt for tax purposes. The new securities were given interesting acronyms like TOPrS (trust-originated preferred securities, or toppers), MIPS (monthly income preferred securities), and QUIPS (quarterly income preferred securities), among others. Because of various specific features, these instruments can be counted as debt for tax purposes, making the interest payments tax deductible (up to certain limits). Payments made to investors in these instruments are treated as interest for personal income taxes. Until 2003, interest payments and dividends were taxed at the same marginal tax rate. When the tax rate on dividend payments was reduced, these instruments were not included, so individuals must still pay their higher income tax rate on dividend payments received from these instruments.

Concept Questions

8.2a What is a proxy?

8.2b What rights do stockholders have?

8.2c Why is preferred stock called *preferred*?

8.3 The Stock Markets

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Back in Chapter 1, we briefly mentioned that shares of stock are bought and sold on various stock exchanges, the two most important of which are the New York Stock Exchange and NASDAQ. From our earlier discussion, recall that the stock market consists of a **primary market** and a **secondary market**. In the primary, or new issue, market, shares of stock are first brought to the market and sold to investors. In the secondary market, existing shares are traded among investors.

primary market
The market in which new securities are originally sold to investors.

secondary market
The market in which previously issued securities are traded among investors.

In the primary market, companies sell securities to raise money. We will discuss this process in detail in a later chapter. We focus mainly on secondary market activity in this section. We conclude with a discussion of how stock prices are quoted in the financial press.

DEALERS AND BROKERS

Because most securities transactions involve dealers and brokers, it is important to understand exactly what is meant by the terms *dealer* and *broker*. A **dealer** maintains an inventory and stands ready to buy and sell at any time. In contrast, a **broker** brings buyers and sellers together but does not maintain an inventory. When we speak of used car dealers and real estate brokers, we recognize that the used car dealer maintains an inventory, whereas the real estate broker does not.

dealer
An agent who buys and sells securities from inventory.

broker
An agent who arranges security transactions among investors.

In the securities markets, a dealer stands ready to buy securities from investors wishing to sell them and sell securities to investors wishing to buy them. Recall from our previous chapter that the price the dealer is willing to pay is called the *bid price*. The price at which the dealer will sell is called the *ask price* (sometimes called the asked, offered, or offering price). The difference between the bid and ask prices is called the *spread,* and it is the basic source of dealer profits.

How big is the bid-ask spread on your favorite stock? Check out the latest quotes at **www.bloomberg.com**.

Dealers exist in all areas of the economy, not just the stock markets. For example, your local college bookstore is probably both a primary and a secondary market textbook dealer. If you buy a new book, this is a primary market transaction. If you buy a used book, this is a secondary market transaction, and you pay the store's ask price. If you sell the book back, you receive the store's bid price (often half of the ask price). The bookstore's spread is the difference between the two prices.

In contrast, a securities broker arranges transactions between investors, matching investors wishing to buy securities with investors wishing to sell securities. The distinctive characteristic of security brokers is that they do not buy or sell securities for their own accounts. Facilitating trades by others is their business.

ORGANIZATION OF THE NYSE

The New York Stock Exchange, or NYSE, popularly known as the Big Board, celebrated its bicentennial a few years ago. It has occupied its current location on Wall Street since the turn of the twentieth century. Measured in terms of the total value of shares listed, it is the largest stock market in the world.

members
As of 2006, a member is the owner of a trading license on the NYSE.

Members

The NYSE has 1,366 exchange **members**. Prior to 2006, the exchange members were said to own "seats" on the exchange, and collectively the members of the exchange were also the owners. For this and other reasons, seats were valuable and were bought and sold fairly regularly. Seat prices reached a record $4 million in 2005.

In 2006, all of this changed when the NYSE became a publicly owned corporation. Naturally, its stock was listed on the NYSE. Now, instead of purchasing seats, exchange members must purchase trading licenses, the number of which is still limited to 1,366. In 2017, a license would set you back a cool $40,000—per year. Having a license entitles you to buy and sell securities on the floor of the exchange. Different members play different roles in this regard.

On April 4, 2007, the NYSE grew even larger when it merged with Euronext to form NYSE Euronext. Euronext was a stock exchange in Amsterdam, with subsidiaries in Belgium, France, Portugal, and the United Kingdom. With the merger, NYSE Euronext became the world's "first global exchange." Further expansion occurred in 2008 when NYSE Euronext merged with the American Stock Exchange. Then, in November 2013, the acquisition of the NYSE by the Intercontinental Exchange (ICE) was completed. ICE, which was founded in May 2000, was originally a commodities exchange, but its rapid growth gave it the necessary $8.2 billion for the acquisition of the NYSE.

As we briefly describe how the NYSE operates, keep in mind that other markets owned by NYSE Euronext and ICE may function differently. What makes the NYSE somewhat unique is that it is a *hybrid market*. In a hybrid market, trading takes place both electronically and face-to-face.

designated market makers (DMMs)
NYSE members who act as dealers in particular stocks. Formerly known as "specialists."

floor brokers
NYSE members who execute customer buy and sell orders.

supplemental liquidity providers (SLPs)
Investment firms that are active participants in stocks assigned to them. Their job is to make a one-sided market (i.e., offering to either buy or sell). They trade purely for their own accounts.

With electronic trading, orders to buy and orders to sell are submitted to the exchange. Orders are compared by a computer and whenever there is a match, the orders are executed with no human intervention. Most trades on the NYSE occur this way. For orders that are not handled electronically, the NYSE relies on its license holders. There are three different types of license holders, **designated market makers (DMMs)**, **floor brokers**, and **supplemental liquidity providers (SLPs)**, and we now discuss the role played by each.

The DMMs, formerly known as "specialists," act as dealers in particular stocks. Typically, each stock on the NYSE is assigned to a single DMM. As a dealer, a DMM maintains a two-sided market, meaning that the DMM continually posts and updates bid and ask prices. By doing so, the DMM ensures that there is always a buyer or seller available, thereby promoting market liquidity.

The job of a floor broker is to execute trades for customers, with an emphasis on getting the best price possible. Floor brokers are generally employees of large brokerage firms such as Merrill Lynch, the wealth management division of Bank of America. The interaction between floor brokers and DMMs is the key to nonelectronic trading on the NYSE. We discuss this interaction in detail in just a moment.

The SLPs are essentially investment firms that agree to be active participants in stocks assigned to them. Their job is to regularly make a one-sided market (i.e., offering to either buy or sell). They trade purely for their own accounts (using their own money), so they do not represent customers. They are given a small rebate on their buys and sells, thereby encouraging them to be more aggressive. The NYSE's goal is to generate as much liquidity as possible, which makes it easier for ordinary investors to quickly buy and sell at prevailing prices. Unlike DMMs and floor brokers, SLPs do not operate on the floor of the stock exchange.

In recent years, floor brokers have become less important on the exchange floor because of the efficient Pillar system, which allows orders to be transmitted electronically directly to the DMM. Additionally, the NYSE has an electronic platform called Arca, which accounts for a substantial percentage of all trading on the NYSE, particularly for smaller orders. The average time for a trade on the NYSE Arca is less than 1 second.

Finally, a small number of NYSE members are floor traders who independently trade for their own accounts. Floor traders try to anticipate temporary price fluctuations and profit from them by buying low and selling high. In recent decades, the number of floor traders has declined substantially, suggesting that it has become increasingly difficult to profit from short-term trading on the exchange floor.

Operations Now that we have a basic idea of how the NYSE is organized and who the major players are, we turn to the question of how trading actually takes place. Fundamentally, the business of the NYSE is to attract and process **order flow**. The term *order flow* refers to the flow of customer orders to buy and sell stocks. The customers of the NYSE are the millions of individual investors and tens of thousands of institutional investors who place their orders to buy and sell shares in NYSE-listed companies. The NYSE has been quite successful in attracting order flow. Currently, it is not unusual for well over a billion shares to change hands in a single day.

order flow
The flow of customer orders to buy and sell securities.

Floor Activity It is quite likely that you have seen footage of the NYSE trading floor on television. If so, you would have seen a big room, about the size of a basketball gym. This big room is called, technically, "the Big Room." There are a few other, smaller rooms that you normally don't see, one of which is called "the Garage," because that is what it was before it was taken over for trading.

On the floor of the exchange are a number of stations, each with a roughly figure-eight shape. These stations have multiple counters with numerous terminal screens above and on the sides. People operate behind and in front of the counters in relatively stationary positions.

Take a virtual field trip to the New York Stock Exchange at **www.nyse.com**.

Other people move around on the exchange floor, frequently returning to the many telephones positioned along the exchange walls. In all, you may be reminded of worker ants moving around an ant colony. It is natural to wonder, "What are all those people doing down there (and why are so many wearing funny-looking coats)?"

As an overview of exchange floor activity, here is a quick look at what goes on. Each of the counters is a **DMM's post**. DMMs normally operate in front of their posts to monitor and manage trading in the stocks assigned to them. Clerical employees working for the DMMs operate behind the counter. Moving from the many workstations lining the walls of the exchange out to the exchange floor and back again are swarms of floor brokers, receiving customer orders, walking out to DMMs' posts where the orders can be executed, and returning to confirm order executions and receive new customer orders.

DMM's post
A fixed place on the exchange floor where the DMM operates.

To better understand activity on the NYSE trading floor, imagine yourself as a floor broker. Your phone clerk has just handed you an order to sell 20,000 shares of Walmart for a customer of the brokerage company that employs you. The customer wants to sell the stock at the best possible price as soon as possible. You immediately walk (running violates exchange rules) to the DMM's post where Walmart stock is traded.

As you approach the DMM's post where Walmart is traded, you check the terminal screen for information on the current market price. The screen reveals that the last executed trade was at $60.10 and that the DMM is bidding $60 per share. You could immediately sell to the DMM at $60, but that would be too easy.

Instead, as the customer's representative, you are obligated to get the best possible price. It is your job to "work" the order, and your job depends on providing satisfactory order execution service. So, you look around for another broker who represents a customer who wants to buy Walmart stock. Luckily, you quickly find another broker at the DMM's post with an order to buy 20,000 shares. Noticing that the DMM is asking $60.10 per share, you both agree to execute your orders with each other at a price of $60.05. This price is exactly halfway between the DMM's bid and ask prices, and it saves each of your customers $\$.05 \times 20{,}000 = \$1{,}000$ as compared to dealing at the posted prices.

For a very actively traded stock, there may be many buyers and sellers around the DMM's post, and most of the trading will be done directly between brokers. This is called trading in the "crowd." In such cases, the DMM's responsibility is to maintain order and to make sure that all buyers and sellers receive a fair price. In other words, the DMM essentially functions as a referee.

More often, there will be no crowd at the DMM's post. Going back to our Walmart example, suppose you are unable to quickly find another broker with an order to buy 20,000 shares. Because you have an order to sell immediately, you may have no choice but to sell to the DMM at the bid price of $60. In this case, the need to execute an order quickly takes priority, and the DMM provides the liquidity necessary to allow immediate order execution.

Finally, note that colored coats are worn by many of the people on the floor of the exchange. The color of the coat indicates the person's job or position. Clerks, runners, visitors, exchange officials, and so on wear particular colors to identify themselves. Also, things can get a little hectic on a busy day, with the result that good clothing doesn't last long; the cheap coats offer some protection.

NASDAQ OPERATIONS

In terms of total dollar volume of trading, the second largest stock market in the United States is NASDAQ (say "Naz-dak"). The somewhat odd name originally was an acronym for the National Association of Securities Dealers Automated Quotations system, but NASDAQ is now a name in its own right.

Introduced in 1971, the NASDAQ market is a computer network of securities dealers and others that disseminates timely security price quotes to computer screens worldwide. NASDAQ dealers act as market makers for securities listed on the NASDAQ. As market makers, NASDAQ dealers post bid and ask prices at which they accept sell and buy orders, respectively. With each price quote, they also post the number of shares that they obligate themselves to trade at their quoted prices.

Like NYSE DMMs, NASDAQ market makers trade on an inventory basis—that is, using their inventory as a buffer to absorb buy and sell order imbalances. Unlike the NYSE specialist system, NASDAQ features multiple market makers for actively traded stocks. There are two key differences between the NYSE and NASDAQ:

1. NASDAQ is a computer network and has no physical location where trading takes place.
2. NASDAQ has a multiple market maker system rather than a DMM system.

over-the-counter (OTC) market
Securities market in which trading is almost exclusively done through dealers who buy and sell for their own inventories.

Traditionally, a securities market largely characterized by dealers who buy and sell securities for their own inventories is called an **over-the-counter (OTC) market**. Consequently, NASDAQ is often referred to as an OTC market. In their efforts to promote a distinct image, NASDAQ officials prefer that the term OTC not be used when referring to the NASDAQ market. Nevertheless, old habits die hard, and many people still refer to NASDAQ as an OTC market.

The NASDAQ network operates with three levels of information access. Level 1 is designed to provide a timely, accurate source of price quotations. These prices are freely available over the Internet.

Level 2 allows users to view price quotes from all NASDAQ market makers. In particular, this level allows access to **inside quotes**. Inside quotes are the highest bid quotes and the lowest asked quotes for a NASDAQ-listed security. Level 2 is now available on the web, sometimes for a small fee. Level 3 is for the use of market makers only. This access level allows NASDAQ dealers to enter or change their price quote information. See our nearby *Work the Web* box for an example of inside quotes.

inside quotes
The highest bid quotes and the lowest ask quotes for a security.

NASDAQ is actually made up of three separate markets: The NASDAQ Global Select Market, the NASDAQ Global Market, and the NASDAQ Capital Market. As the market for NASDAQ's larger and more actively traded securities, the Global Select Market lists about 1,600 companies (as of early 2017), including some of the best-known companies in the world, such as Microsoft and Intel. Global Market companies are somewhat smaller in size, and NASDAQ lists about 810 of these. Finally, the smallest companies listed on NASDAQ are in the NASDAQ Capital Market; about 820 are currently listed. Of course, as Capital Market companies become more established, they may move up to the Global Market or Global Select Market.

NASDAQ (**www.nasdaq.com**) has a great website; check it out!

WORK THE WEB

You can actually watch trading taking place on the web by visiting www.batstrading.com. The BATS Exchange is somewhat unique in that the "order book," meaning the list of all buy and sell orders, is public in real time. As shown below, we have captured a sample of the order book for Intel (INTC). On the top in blue are sell orders (asks); buy orders (bids) are in green on the bottom. All orders are "limit" orders, which means the customer has specified the most he or she will pay (for buy orders) or the least he or she will accept (for sell orders). The inside quotes (the highest bid, or buy, and the lowest ask, or sell) in the market are in the middle of the quotes.

INTC	Orders Accepted	Total Volume
INTEL CORP COM	238,440	905,015

	TOP OF BOOK		LAST 10 TRADES		
	Shares	Price	Time	Price	Shares
ASKS	1,900	**36.8000**	13:51:33	36.7500	100
ASKS	2,302	36.7900	13:51:33	36.7500	200
ASKS	2,201	36.7800	13:51:33	36.7500	100
ASKS	2,723	36.7700	13:50:56	36.7500	100
ASKS	982	36.7600	13:50:56	36.7500	100
BIDS	801	**36.7500**	13:50:56	36.7500	100
BIDS	2,274	36.7400	13:50:56	36.7500	100
BIDS	2,262	36.7300	13:50:56	36.7500	100
BIDS	2,561	36.7200	13:50:56	36.7500	100
BIDS	2,602	36.7100	13:50:47	36.7550	66

If you visit the site, you can see trading take place as orders are entered and executed. Notice that on this particular day, about 905,000 shares of Intel had traded on BATS. At that time, the inside quotes for Intel were 801 shares bid at $36.75 and 982 shares offered at $36.76. This is not the entire order book for Intel, as there are more buy orders below $36.75 and more sell orders above $36.76.

Questions

1. *Go to www.bats.com/us/equities and look up the order book for Microsoft (MSFT). What are the inside quotes for Microsoft?*
2. *Go to www.bats.com/us/equities. The website shows the 25 most active stocks. Looking down through this list, what are the bid-ask spreads for these stocks?*

electronic communications networks (ECNs)
A website that allows investors to trade directly with each other.

ECNs In a very important development in the late 1990s, the NASDAQ system was opened to so-called **electronic communications networks (ECNs)**. ECNs are basically websites that allow investors to trade directly with one another. Investor buy and sell orders placed on ECNs are transmitted to the NASDAQ and displayed along with market maker bid and ask prices. As a result, the ECNs open up the NASDAQ by essentially allowing individual investors, not just market makers, to enter orders. As a result, the ECNs act to increase liquidity and competition.

Of course, the NYSE and the NASDAQ are not the only places stocks are traded. See our nearby *Work the Web* box for a discussion of somewhat wilder markets.

STOCK MARKET REPORTING

You can get real-time stock quotes on the web. See finance.yahoo.com for details.

In recent years, the reporting of stock prices and related information has increasingly moved from traditional print media, such as *The Wall Street Journal*, to various websites. Yahoo! Finance (finance.yahoo.com) is a good example. We went there and requested a stock quote on wholesale club Costco, which is listed on the NASDAQ. Here is a portion of what we found:

Costco Wholesale Corporation (COST)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD
Add to watchlist

160.63 -1.03 (-0.64%)
As of 1:49PM EST. Market open.

Summary | Conversations | Statistics | Profile | Financials | Options | Holders | Historical Data | Analysts

Previous Close	161.66	Market Cap	70.56B
Open	161.47	Beta	0.90
Bid	160.33 x 100	PE Ratio (TTM)	29.31
Ask	160.41 x 200	EPS (TTM)	5.48
Day's Range	160.35 - 162.35	Earnings Date	Mar 2, 2017
52 Week Range	138.57 - 169.59	Dividend & Yield	1.80 (1.12%)
Volume	686,350	Ex-Dividend Date	N/A
Avg. Volume	2,289,400	1y Target Est	173.12

WORK THE WEB

Where do companies trade when they can't (or don't want to) meet the listing requirements of the larger stock markets? Mostly, they trade on the OTCQX®, OTCQB®, and OTC Pink® marketplaces operated by OTC Markets Group. The OTCQX® marketplace includes qualitative and quantitative standards and the OTCQB® marketplace imposes some requirements as well, though these requirements are less restrictive than those enforced by the larger stock markets. OTC Pink® is called the "Open Marketplace" because there are no filing or financial requirements.

A small portion of companies also continue to trade on the Over-the-Counter Bulletin Board, or OTCBB, operated by the Financial Industry Regulatory Authority, known as FINRA. The OTCBB began as an electronic bulletin board that was created to facilitate OTC trading in non-listed stocks. It has effectively been replaced by OTC Markets Group's OTCQB® marketplace as the primary marketplace for these types of companies. Like the OTCQX® and OTCQB®, the OTCBB imposes some requirements, though they are not as restrictive as the larger markets. For example, OTCBB only requires that listed firms file financial statements with the SEC (or other relevant agency).

Trading at any of the OTC Markets Group marketplaces, as well as the OTCBB, is conducted under a dealer-driven framework. So, aside from the minimal requirements for inclusion on these marketplaces, all that is necessary for a particular security to begin trading is a registered broker-dealer willing (and approved) to quote and make a market in the security. Investors can trade OTCQX®, OTCQB®, and OTC Pink® securities in a manner similar to the trading in an exchange-listed stock. Given the ease of trading, these marketplaces (OTCQX®, in particular) are attractive to foreign firms that file with regulators in their home countries, but do not have interest in filing with U.S. regulators. These markets are also an option for companies that have been delisted from the larger markets either by choice or for failure to maintain their listing requirements.

Stocks traded on these markets often have very low prices and are frequently referred to as *penny stocks*, *microcaps*, or even *nanocaps*. Relatively few brokers do any research on these companies, so information is often spread through word of mouth or the Internet (not the most reliable of sources). To get a feel for what trading looks like, we captured a typical screen from the OTCBB website (http://finra-markets.morningstar.com/MarketData/EquityOptions/default.jsp):

OOTC Equity

Most Actives | % Gainers | % Losers — Exchange by OOTC

Symbol		Last	Chg	Chg %	Vol (mil)
MLCG	▲	0.0003	0.0000	0.0000	307.3956
TPAC	▲	0.0006	0.0001	20.0000	220.4887
GAWK	▲	0.0002	0.0000	0.0000	157.7228
ICNM	▲	0.0002	0.0001	100.0000	136.8407
GDGI	▲	0.0002	0.0001	100.0000	128.5851
SNMN	▲	0.0017	0.0010	142.8571	121.8124
SDVI	▼	0.0012	-0.0003	-20.0000	105.6642
KGET	▼	0.0001	-0.0001	-25.0000	103.3502
FWDG	▲	0.0001	0.0000	0.0000	99.8849
ASTI	▲	0.0019	0.0002	11.7647	94.4509

First, take a look at the returns. SNM Global Holdings (SNMN) had an intraday return on this day of 142.86 percent. That's not something you see very often. Of course, the big return was generated by a whopping price increase of $.0010 per share. A stock listed on the OTCBB is often the most actively traded stock on any particular day. For example, by the end of this particular day, Bank of America was the most active stock on the NYSE, trading about 81.3 million shares. In contrast, Alumifuel Power Corp. traded about 480 million shares. But, at an average price of, say, $.0001 per share, the total dollar volume in Alumifuel was all of $48,000. In contrast, trades in Bank of America amounted to about $1.88 billion.

All in all, the OTC markets can be pretty wild places to trade. Low stock prices allow for huge percentage returns on small stock price movements. Be advised that attempts at manipulation and fraud are possible. Also, stocks on these markets are often thinly traded, meaning there is little volume. It is not unusual for a stock listed on any of these markets to have no trades on a given day. Even two or three days in a row without a trade in a particular stock is not uncommon.

Questions

1. *After the close of the markets (4 p.m. Eastern time), go to finance.yahoo.com and find the stocks on the major exchanges that were the most active during the day. Now go to http://finra-markets.morningstar.com/MarketData/EquityOptions/default.jsp and find the most active stocks traded on the OTCBB for the same day. How many stocks on the OTCBB were more active than the most active stock on the NYSE? The NASDAQ?*
2. *What were the biggest percentage winners and losers on the OTCBB during the current day? How much did the stock price increase or decrease to account for this change?*

You can get real-time stock quotes on the web. See **finance.yahoo.com** for details.

Most of this information is self-explanatory. The price $160.63 is the real-time price of the last trade. Availability of real-time prices for free is a relatively new development. The reported change is from the previous day's closing price. The opening price is the first trade of the day. We see the bid and ask prices of $160.33 and $160.41, respectively, along with the market "depth," which is the number of shares sought at the bid price and offered at the ask price. The "1y Target Est" is the average estimated stock price one year ahead based on estimates from security analysts who follow the stock.

We also have the range of prices for this day, followed by the range over the previous 52 weeks. Volume is the number of shares traded today, followed by average daily volume over the last three months. In the second column, Market Cap is number of shares outstanding (from the most recent quarterly financial statements) multiplied by the current price per share. The PE ratio was discussed in Chapter 3. The earnings per share (EPS) used in the calculation is "TTM," meaning "trailing twelve months." Finally, we have the dividend on the stock, which is actually the most recent quarterly dividend multiplied by 4, and the dividend yield. Notice that the yield is the reported dividend divided by the stock price: $1.80/$160.63 = .0112, or 1.12%.

Concept Questions

8.3a What is the difference between a securities broker and a securities dealer?

8.3b Which is bigger, the bid price or the ask price? Why?

8.3c How does NASDAQ differ from the NYSE?

8.4 Summary and Conclusions

This chapter has covered the basics of stocks and stock valuation:

1. The cash flows from owning a share of stock come in the form of future dividends. We saw that in certain special cases it is possible to calculate the present value of all the future dividends and come up with a value for the stock.
2. As the owner of shares of common stock in a corporation, you have various rights, including the right to vote to elect corporate directors. Voting in corporate elections can be either cumulative or straight. Most voting is actually done by proxy, and a proxy battle breaks out when competing sides try to gain enough votes to elect their candidates for the board.
3. In addition to common stock, some corporations have issued preferred stock. The name stems from the fact that preferred stockholders must be paid first, before common stockholders can receive anything. Preferred stock has a fixed dividend.

4. The two biggest stock markets in the United States are the NYSE and the NASDAQ. We discussed the organization and operation of these two markets, and we saw how stock price information is reported.

This chapter completes Part 3 of our book. By now, you should have a good grasp of what we mean by *present value*. You should also be familiar with how to calculate present values, loan payments, and so on. In Part 4, we cover capital budgeting decisions. As you will see, the techniques you learned in Chapters 5–8 form the basis for our approach to evaluating business investment decisions.

CONNECT TO FINANCE

Can you answer the following *Connect* Quiz questions?

Section 8.1 A stock is selling for $11.90 a share given a market return of 14 percent and a capital gains yield of 5 percent. What was the amount of the last annual dividend that was paid?

Section 8.2 An 8 percent preferred stock sells for $54 a share. What is the rate of return?

Section 8.3 What kind of market is the NYSE?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

8.1 Dividend Growth and Stock Valuation The Brigapenski Co. has just paid a cash dividend of $2 per share. Investors require a 16 percent return from investments such as this. If the dividend is expected to grow at a steady 8 percent per year, what is the current value of the stock? What will the stock be worth in five years?

8.2 More Dividend Growth and Stock Valuation In Self-Test Problem 8.1, what would the stock sell for today if the dividend was expected to grow at 20 percent per year for the next three years and then settle down to 8 percent per year indefinitely?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

8.1 The last dividend, D_0, was $2. The dividend is expected to grow steadily at 8 percent. The required return is 16 percent. Based on the dividend growth model, we can say that the current price is:

$$\begin{aligned} P_0 &= D_1/(R - g) = D_0 \times (1 + g)/(R - g) \\ &= \$2 \times 1.08/(.16 - .08) \\ &= \$2.16/.08 \\ &= \$27 \end{aligned}$$

We could calculate the price in five years by calculating the dividend in five years and then using the growth model again. Alternatively, we could recognize that the stock price will increase by 8 percent per year and calculate the future price directly. We'll do both. First, the dividend in five years will be:

$$\begin{aligned} D_5 &= D_0 \times (1 + g)^5 \\ &= \$2 \times 1.08^5 \\ &= \$2.9387 \end{aligned}$$

The price in five years would therefore be:

$$\begin{aligned} P_5 &= D_5 \times (1 + g)/(R - g) \\ &= \$2.9387 \times 1.08/.08 \\ &= \$3.1738/.08 \\ &= \$39.67 \end{aligned}$$

Once we understand the dividend model, however, it's easier to notice that:

$$\begin{aligned} P_5 &= P_0 \times (1 + g)^5 \\ &= \$27 \times 1.08^5 \\ &= \$27 \times 1.4693 \\ &= \$39.67 \end{aligned}$$

Notice that both approaches yield the same price in five years.

8.2 In this scenario, we have supernormal growth for the next three years. We'll need to calculate the dividends during the rapid growth period and the stock price in three years. The dividends are:

$$\begin{aligned} D_1 &= \$2.00 \times 1.20 = \$2.400 \\ D_2 &= \$2.40 \times 1.20 = \$2.880 \\ D_3 &= \$2.88 \times 1.20 = \$3.456 \end{aligned}$$

After three years, the growth rate falls to 8 percent indefinitely. The price at that time, P_3, is thus:

$$\begin{aligned} P_3 &= D_3 \times (1 + g)/(R - g) \\ &= \$3.456 \times 1.08/(.16 - .08) \\ &= \$3.7325/.08 \\ &= \$46.656 \end{aligned}$$

To complete the calculation of the stock's present value, we have to determine the present value of the three dividends and the future price:

$$\begin{aligned} P_0 &= \frac{D_1}{(1 + R)^1} + \frac{D_2}{(1 + R)^2} + \frac{D_3}{(1 + R)^3} + \frac{P_3}{(1 + R)^3} \\ &= \frac{\$2.40}{1.16} + \frac{2.88}{1.16^2} + \frac{3.456}{1.16^3} + \frac{46.656}{1.16^3} \\ &= \$2.07 + 2.14 + 2.21 + 29.89 \\ &= \$36.31 \end{aligned}$$

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Stock Valuation [LO1]** Why does the value of a share of stock depend on dividends?
2. **Stock Valuation [LO1]** A substantial percentage of the companies listed on the NYSE and NASDAQ don't pay dividends, but investors are nonetheless willing to buy shares in them. How is this possible given your answer to the previous question?
3. **Dividend Policy [LO1]** Referring to the previous questions, under what circumstances might a company choose not to pay dividends?
4. **Dividend Growth Model [LO1]** Under what two assumptions can we use the dividend growth model presented in the chapter to determine the value of a share of stock? Comment on the reasonableness of these assumptions.

5. **Common versus Preferred Stock [LO1]** Suppose a company has a preferred stock issue and a common stock issue. Both have just paid a $2 dividend. Which do you think will have a higher price, a share of the preferred or a share of the common?
6. **Dividend Growth Model [LO1]** Based on the dividend growth model, what are the two components of the total return on a share of stock? Which do you think is typically larger?
7. **Growth Rate [LO1]** In the context of the dividend growth model, is it true that the growth rate in dividends and the growth rate in the price of the stock are identical?
8. **Voting Rights [LO3]** When it comes to voting in elections, what are the differences between U.S. political democracy and U.S. corporate democracy?
9. **Corporate Ethics [LO3]** Is it unfair or unethical for corporations to create classes of stock with unequal voting rights?
10. **Voting Rights [LO3]** Some companies, such as Alphabet, have created classes of stock with no voting rights at all. Why would investors buy such stock?
11. **Stock Valuation [LO1]** Evaluate the following statement: Managers should not focus on the current stock value because doing so will lead to an overemphasis on short-term profits at the expense of long-term profits.
12. **Two-Stage Dividend Growth Model [LO1]** One of the assumptions of the two-stage growth model is that the dividends drop immediately from the high growth rate to the perpetual growth rate. What do you think about this assumption? What happens if this assumption is violated?
13. **Voting Rights [LO3]** In the chapter, we mentioned that many companies have been under pressure to declassify their boards of directors. Why would investors want a board to be declassified? What are the advantages of a classified board?
14. **Price Ratio Valuation [LO2]** What are the difficulties in using the PE ratio to value stock?

QUESTIONS AND PROBLEMS

connect

BASIC
(Questions 1–13)

1. **Stock Values [LO1]** The Jackson-Timberlake Wardrobe Co. just paid a dividend of $2.15 per share on its stock. The dividends are expected to grow at a constant rate of 4 percent per year indefinitely. If investors require a return of 10.5 percent on the company's stock, what is the current price? What will the price be in three years? In 15 years?
2. **Stock Values [LO1]** The next dividend payment by Savitz, Inc., will be $2.34 per share. The dividends are anticipated to maintain a growth rate of 4.5 percent forever. If the stock currently sells for $37 per share, what is the required return?
3. **Stock Values [LO1]** For the company in the previous problem, what is the dividend yield? What is the expected capital gains yield?
4. **Stock Values [LO1]** Hudson Corporation will pay a dividend of $3.28 per share next year. The company pledges to increase its dividend by 3.75 percent per year indefinitely. If you require a return of 10 percent on your investment, how much will you pay for the company's stock today?
5. **Stock Valuation [LO1]** Grateful Eight Co. is expected to maintain a constant 3.7 percent growth rate in its dividends indefinitely. If the company has a dividend yield of 5.6 percent, what is the required return on the company's stock?
6. **Stock Valuation [LO1]** Suppose you know that a company's stock currently sells for $74 per share and the required return on the stock is 10.6 percent. You also know that the total return on the stock is evenly divided between a capital gains yield and a dividend yield. If it's the company's policy to always maintain a constant growth rate in its dividends, what is the current dividend per share?

7. **Stock Valuation [LO1]** Burnett Corp. pays a constant $8.25 dividend on its stock. The company will maintain this dividend for the next 13 years and will then cease paying dividends forever. If the required return on this stock is 11.2 percent, what is the current share price?

8. **Valuing Preferred Stock [LO1]** Bedekar, Inc., has an issue of preferred stock outstanding that pays a $3.40 dividend every year in perpetuity. If this issue currently sells for $91 per share, what is the required return?

9. **Stock Valuation and Required Return [LO1]** Red, Inc., Yellow Corp., and Blue Company each will pay a dividend of $3.65 next year. The growth rate in dividends for all three companies is 4 percent. The required return for each company's stock is 8 percent, 11 percent, and 14 percent, respectively. What is the stock price for each company? What do you conclude about the relationship between the required return and the stock price?

10. **Voting Rights [LO3]** After successfully completing your corporate finance class, you feel the next challenge ahead is to serve on the board of directors of Schenkel Enterprises. Unfortunately, you will be the only person voting for you. If the company has 650,000 shares outstanding, and the stock currently sells for $43, how much will it cost you to buy a seat if the company uses straight voting?

11. **Voting Rights [LO3]** In the previous problem, assume that the company uses cumulative voting, and there are four seats in the current election. How much will it cost you to buy a seat now?

12. **Stock Valuation and PE [LO2]** The Perfect Rose Co. has earnings of $3.18 per share. The benchmark PE for the company is 18. What stock price would you consider appropriate? What if the benchmark PE were 21?

13. **Stock Valuation and PS [LO2]** TwitterMe, Inc., is a new company and currently has negative earnings. The company's sales are $2.1 million and there are 130,000 shares outstanding. If the benchmark price-sales ratio is 4.3, what is your estimate of an appropriate stock price? What if the price-sales ratio were 3.6?

INTERMEDIATE
(Questions 14–31)

14. **Stock Valuation [LO1]** Moody Farms just paid a dividend of $2.65 on its stock. The growth rate in dividends is expected to be a constant 3.8 percent per year indefinitely. Investors require a return of 15 percent for the first three years, a return of 13 percent for the next three years, and a return of 11 percent thereafter. What is the current share price?

15. **Nonconstant Growth [LO1]** Metallica Bearings, Inc., is a young start-up company. No dividends will be paid on the stock over the next nine years because the firm needs to plow back its earnings to fuel growth. The company will pay a dividend of $17 per share 10 years from today and will increase the dividend by 3.9 percent per year thereafter. If the required return on this stock is 12.5 percent, what is the current share price?

16. **Nonconstant Dividends [LO1]** Maurer, Inc., has an odd dividend policy. The company has just paid a dividend of $2.75 per share and has announced that it will increase the dividend by $4.50 per share for each of the next five years and then never pay another dividend. If you require a return of 11 percent on the company's stock, how much will you pay for a share today?

17. **Nonconstant Dividends [LO1]** Lohn Corporation is expected to pay the following dividends over the next four years: $13, $9, $6, and $2.75. Afterward, the company pledges to maintain a constant 5 percent growth rate in dividends forever. If the required return on the stock is 10.75 percent, what is the current share price?

18. **Supernormal Growth [LO1]** Synovec Co. is growing quickly. Dividends are expected to grow at a rate of 30 percent for the next three years, with the growth rate falling off to a constant 4 percent thereafter. If the required return is 11 percent, and the company just paid a dividend of $2.45, what is the current share price?
19. **Supernormal Growth [LO1]** Mobray Corp. is experiencing rapid growth. Dividends are expected to grow at 25 percent per year during the next three years, 15 percent over the following year, and then 6 percent per year indefinitely. The required return on this stock is 10 percent, and the stock currently sells for $79 per share. What is the projected dividend for the coming year?
20. **Negative Growth [LO1]** Antiques R Us is a mature manufacturing firm. The company just paid a dividend of $9.80, but management expects to reduce the payout by 4 percent per year indefinitely. If you require a return of 9.5 percent on this stock, what will you pay for a share today?
21. **Finding the Dividend [LO1]** Mannix Corporation stock currently sells for $57 per share. The market requires a return of 11 percent on the firm's stock. If the company maintains a constant 3.75 percent growth rate in dividends, what was the most recent dividend per share paid on the stock?
22. **Valuing Preferred Stock [LO1]** E-Eyes.com just issued some new preferred stock. The issue will pay an annual dividend of $20 in perpetuity, beginning 20 years from now. If the market requires a return of 5.65 percent on this investment, how much does a share of preferred stock cost today?
23. **Using Stock Quotes [LO4]** You have found the following stock quote for RJW Enterprises, Inc., in the financial pages of today's newspaper. What was the closing price for this stock that appeared in *yesterday's* paper? If the company currently has 25 million shares of stock outstanding, what was net income for the most recent four quarters?

52-WEEK							
HI	LO	STOCK (DIV)	YLD %	PE	VOL 100s	CLOSE	NET CHG
84.13	53.17	RJW 1.75	2.35	19	17652	??	−.23

24. **Two-Stage Dividend Growth Model [LO1]** A7X Corp. just paid a dividend of $1.55 per share. The dividends are expected to grow at 21 percent for the next eight years and then level off to a growth rate of 3.5 percent indefinitely. If the required return is 12 percent, what is the price of the stock today?
25. **Two-Stage Dividend Growth Model [LO1]** Navel County Choppers, Inc., is experiencing rapid growth. The company expects dividends to grow at 18 percent per year for the next 11 years before leveling off at 4 percent into perpetuity. The required return on the company's stock is 10 percent. If the dividend per share just paid was $1.94, what is the stock price?
26. **Stock Valuation and PE [LO2]** Domergue Corp. currently has an EPS of $3.76, and the benchmark PE for the company is 21. Earnings are expected to grow at 5.1 percent per year.
    - **a.** What is your estimate of the current stock price?
    - **b.** What is the target stock price in one year?
    - **c.** Assuming the company pays no dividends, what is the implied return on the company's stock over the next year? What does this tell you about the implicit stock return using PE valuation?

27. Stock Valuation and PE [LO2] You have found the following historical information for the Daniela Company over the past four years:

	Year 1	Year 2	Year 3	Year 4
Stock price	$49.18	$53.18	$58.14	$56.32
EPS	2.35	2.47	2.78	3.04

Earnings are expected to grow at 11 percent for the next year. Using the company's historical average PE as a benchmark, what is the target stock price one year from today?

28. Stock Valuation and PE [LO2] In the previous problem, we assumed that the stock had a single stock price for the year. However, if you look at stock prices over any year, you will find a high and low stock price for the year. Instead of a single benchmark PE ratio, we now have a high and low PE ratio for each year. We can use these ratios to calculate a high and a low stock price for the next year. Suppose we have the following information on a particular company over the past four years:

	Year 1	Year 2	Year 3	Year 4
High price	$27.43	$26.32	$30.42	$37.01
Low price	19.86	20.18	25.65	26.41
EPS	1.35	1.58	1.51	1.85

Earnings are projected to grow at 9 percent over the next year. What are your high and low target stock prices over the next year?

29. Stock Valuation and PE [LO2] RAK, Inc., currently has an EPS of $2.45 and an earnings growth rate of 8 percent. If the benchmark PE ratio is 23, what is the target share price five years from now?

30. PE and Terminal Stock Price [LO2] In practice, a common way to value a share of stock when a company pays dividends is to value the dividends over the next five years or so, then find the "terminal" stock price using a benchmark PE ratio. Suppose a company just paid a dividend of $1.36. The dividends are expected to grow at 13 percent over the next five years. In five years, the estimated payout ratio is 40 percent and the benchmark PE ratio is 19. What is the target stock price in five years? What is the stock price today assuming a required return of 11 percent on this stock?

31. Stock Valuation and PE [LO2] Perine, Inc., has balance sheet equity of $6.8 million. At the same time, the income statement shows net income of $815,000. The company paid dividends of $285,000 and has 245,000 shares of stock outstanding. If the benchmark PE ratio is 16, what is the target stock price in one year?

CHALLENGE
(Questions 32–38)

32. Capital Gains versus Income [LO1] Consider four different stocks, all of which have a required return of 13 percent and a most recent dividend of $3.75 per share. Stocks W, X, and Y are expected to maintain constant growth rates in dividends for the foreseeable future of 10 percent, 0 percent, and −5 percent per year, respectively. Stock Z is a growth stock that will increase its dividend by 20 percent for the next two years and then maintain a constant 5 percent growth rate thereafter. What is the dividend yield for each of these four stocks? What is the expected capital gains yield? Discuss the relationship among the various returns that you find for each of these stocks.

33. Stock Valuation [LO1] Most corporations pay quarterly dividends on their common stock rather than annual dividends. Barring any unusual circumstances during the year, the board raises, lowers, or maintains the current dividend once a year and then pays this dividend out in equal quarterly installments to its shareholders.

a. Suppose a company currently pays an annual dividend of $3.40 on its common stock in a single annual installment, and management plans on raising this dividend by 3.8 percent per year indefinitely. If the required return on this stock is 10.5 percent, what is the current share price?

b. Now suppose the company in (a) actually pays its annual dividend in equal quarterly installments; thus, the company has just paid a dividend of $.85 per share, as it has for the previous three quarters. What is your value for the current share price now? (*Hint*: Find the equivalent annual end-of-year dividend for each year.) Comment on whether you think this model of stock valuation is appropriate.

34. Nonconstant Growth [LO1] Storico Co. just paid a dividend of $3.15 per share. The company will increase its dividend by 20 percent next year and then reduce its dividend growth rate by 5 percentage points per year until it reaches the industry average of 5 percent dividend growth, after which the company will keep a constant growth rate forever. If the required return on the company's stock is 12 percent, what will a share of stock sell for today?

35. Nonconstant Growth [LO1] This one's a little harder. Suppose the current share price for the firm in the previous problem is $54.50 and all the dividend information remains the same. What required return must investors be demanding on the company's stock? (*Hint*: Set up the valuation formula with all the relevant cash flows, and use trial and error to find the unknown rate of return.)

36. Constant Dividend Growth Model [LO1] Assume a stock has dividends that grow at a constant rate forever. If you value the stock using the constant dividend growth model, how many years worth of dividends constitute one-half of the stock's current price?

37. Two-Stage Dividend Growth [LO1] Regarding the two-stage dividend growth model in the chapter, show that the price of a share of stock today can be written as follows:

$$P_0 = \frac{D_0 \times (1 + g_1)}{R - g_1} \times \left[1 - \left(\frac{1 + g_1}{1 + R}\right)^t\right] + \left(\frac{1 + g_1}{1 + R}\right)^t \times \frac{D_0 \times (1 + g_2)}{R - g_2}$$

Can you provide an intuitive interpretation of this expression?

38. Two-Stage Dividend Growth [LO1] The chapter shows that in the two-stage dividend growth model, the growth rate in the first stage, g_1, can be greater than or less than the discount rate, R. Can they be exactly equal? (*Hint*: Yes, but what does the expression for the value of the stock look like?)

EXCEL MASTER IT! PROBLEM

In practice, the use of the dividend discount model is refined from the method we presented in the textbook. Many analysts will estimate the dividend for the next 5 years and then estimate a perpetual growth rate at some point in the future, typically 10 years. Rather than have the dividend growth fall dramatically from the fast growth period to the perpetual growth period, linear interpolation is applied. That is, the dividend growth is projected to fall by an equal amount each year. For example, if the fast growth period is 15 percent for the next 5 years and the dividends are expected to fall to a 5 percent perpetual growth rate 5 years later, the dividend growth rate would decline by 2 percent each year.

Suppose you find the following information about a particular stock:

Current dividend: \$3.95
5-year dividend growth rate: 9.5%
Perpetual growth rate: 4%
Required return: 11%

a. Assume that the perpetual growth rate begins 10 years from now and use linear interpolation between the high growth rate and perpetual growth rate. Construct a table that shows the dividend growth rate and dividend each year. What is the stock price at Year 10? What is the stock price today?

b. How sensitive is the current stock price to changes in the perpetual growth rate? Graph the current stock price against the perpetual growth rate in 10 years to find out.

Instead of applying the constant dividend growth model to find the stock price in the future, analysts will often combine the dividend discount method with price ratio valuation, often with the PE ratio. Remember that the PE ratio is the price per share divided by the earnings per share. So, if we know the PE ratio, the dividend, and the payout ratio, we can solve for the stock price. To illustrate, suppose we also have the following information about the company:

Payout ratio: 25%
PE ratio at constant growth rate: 15

c. Use the PE ratio to calculate the stock price when the company reaches a perpetual growth rate in dividends. Now find the value of the stock today using the present value of the dividends during the nonconstant growth period and the price you calculated using the PE ratio.

d. How sensitive is the current stock price to changes in the PE ratio when the stock reaches the perpetual growth rate? Graph the current stock price against the PE ratio in 10 years to find out.

MINICASE

Stock Valuation at Ragan, Inc.

Ragan, Inc., was founded nine years ago by brother and sister Carrington and Genevieve Ragan. The company manufactures and installs commercial heating, ventilation, and cooling (HVAC) units. Ragan, Inc., has experienced rapid growth because of a proprietary technology that increases the energy efficiency of its units. The company is equally owned by Carrington and Genevieve. The original partnership agreement between the siblings gave each 50,000 shares of stock. In the event either wished to sell stock, the shares first had to be offered to the other at a discounted price.

Although neither sibling wants to sell, they have decided they should value their holdings in the company. To get started, they have gathered the information about their main competitors in the table below.

Expert HVAC Corporation's negative earnings per share were the result of an accounting write-off last year. Without the write-off, earnings per share for the company would have been \$1.10. The ROE for Expert HVAC is based on net income excluding the write-off.

Last year, Ragan, Inc., had an EPS of \$3.15 and paid a dividend to Carrington and Genevieve of \$45,000 each. The company also had a return on equity of 17 percent. The siblings believe that 14 percent is an appropriate required return for the company.

Ragan, Inc., Competitors

	EPS	DPS	Stock Price	ROE	R
Arctic Cooling, Inc.	\$1.30	\$.16	\$25.34	8.50%	10.00%
National Heating & Cooling	1.95	.23	29.85	10.50	13.00
Expert HVAC Corp.	−.37	.14	22.13	9.78	12.00
Industry Average	\$ .96	\$.18	\$25.77	9.59%	11.67%

QUESTIONS

1. Assuming the company continues its current growth rate, what is the value per share of the company's stock?
2. To verify their calculations, Carrington and Genevieve have hired Josh Schlessman as a consultant. Josh was previously an equity analyst and covered the HVAC industry. Josh has examined the company's financial statements, as well as examining its competitors' financials. Although Ragan, Inc., currently has a technological advantage, his research indicates that other companies are investigating methods to improve efficiency. Given this, Josh believes that the company's technological advantage will last only for the next five years. After that period, the company's growth will likely slow to the industry growth average. Additionally, Josh believes that the required return used by the company is too high. He believes the industry average required return is more appropriate. Under this growth rate assumption, what is your estimate of the stock price?
3. What is the industry average price-earnings ratio? What is the price-earnings ratio for Ragan, Inc.? Is this the relationship you would expect between the two ratios? Why?
4. Carrington and Genevieve are unsure how to interpret the price-earnings ratio. After some head scratching, they've come up with the following expression for the price-earnings ratio:

   $$\frac{P_0}{E_1} = \frac{1 - b}{R - (\text{ROE} \times b)}$$

   Beginning with the constant dividend growth model, verify this result. What does this expression imply about the relationship between the dividend payout ratio, the required return on the stock, and the company's ROE?
5. Assume the company's growth rate slows to the industry average in five years. What future return on equity does this imply, assuming a constant payout ratio?
6. After discussing the stock value with Josh, Carrington and Genevieve agree that they would like to increase the value of the company stock. Like many small business owners, they want to retain control of the company, so they do not want to sell stock to outside investors. They also feel that the company's debt is at a manageable level and do not want to borrow more money. How can they increase the price of the stock? Are there any conditions under which this strategy would *not* increase the stock price?

Chapter 9 Net Present Value and Other Investment Criteria

ALTHOUGH KNOWN AS Apple's largest supplier, Foxconn does have other buyers. In December 2016, Foxconn announced a joint venture with Sharp to build an $8.8 billion plant in China. The new plant would be a Gen-10.5 facility used to manufacture large-screen LCDs. And while the price tag of the new LCD plant may seem large, it wasn't even the biggest project announced by Foxconn that year. Earlier, Foxconn announced that it was looking to invest $10 billion to build a new plant to manufacture iPhones in India.

Foxconn's new plants are examples of capital budgeting decisions. Decisions such as these, with price tags well over $1 billion, are obviously major undertakings, and the risks and rewards must be carefully weighed. In this chapter, we discuss the basic tools used in making such decisions.

In Chapter 1, we saw that increasing the value of the stock in a company is the goal of financial management. Thus, what we need to know is how to tell whether a particular investment will achieve that or not. This chapter considers a variety of techniques that are used in practice for this purpose. More important, it shows how many of these techniques can be misleading, and it explains why the net present value approach is the right one.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Show the reasons why the net present value criterion is the best way to evaluate proposed investments.

LO2 Discuss the payback rule and some of its shortcomings.

LO3 Discuss the discounted payback rule and some of its shortcomings.

LO4 Explain accounting rates of return and some of the problems with them.

LO5 Present the internal rate of return criterion and its strengths and weaknesses.

LO6 Calculate the modified internal rate of return.

LO7 Illustrate the profitability index and its relation to net present value.

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In Chapter 1, we identified the three key areas of concern to the financial manager. The first of these involved the question: What fixed assets should we buy? We called this the *capital budgeting decision*. In this chapter, we begin to deal with the issues that arise in answering this question.

The process of allocating or budgeting capital is usually more involved than deciding whether to buy a particular fixed asset. We frequently face broader issues, like whether we should launch a new product or enter a new market. Decisions such as these determine the nature of a firm's operations and products for years to come, primarily because fixed asset investments are generally long-lived and not easily reversed once they are made.

The most fundamental decision a business must make concerns its product line. What services will we offer or what will we sell? In what markets will we compete? What new products will we introduce? The answer to any of these questions will require that the firm commit its scarce and valuable capital to certain types of assets. As a result, all of these strategic issues fall under the general heading of capital budgeting. The process of capital budgeting could be given a more descriptive (not to mention impressive) name: *Strategic asset allocation*.

For the reasons we have discussed, the capital budgeting question is probably the most important issue in corporate finance. How a firm chooses to finance its operations (the capital structure question) and how a firm manages its short-term operating activities (the working capital question) are certainly issues of concern, but the fixed assets define the business of the firm. Airlines, for example, are airlines because they operate airplanes, regardless of how they finance them.

Any firm possesses a huge number of possible investments. Each possible investment is an option available to the firm. Some options are valuable and some are not. The essence of successful financial management, of course, is learning to identify which ones are which. With this in mind, our goal in this chapter is to introduce you to the techniques used to analyze potential business ventures to decide which are worth undertaking.

We present and compare a number of different procedures used in practice. Our primary goal is to acquaint you with the advantages and disadvantages of the various approaches. As we will see, the most important concept in this area is the idea of net present value. We consider this next.

9.1 Net Present Value

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In Chapter 1, we argued that the goal of financial management is to create value for the stockholders. The financial manager must examine a potential investment in light of its likely effect on the price of the firm's shares. In this section, we describe a widely used procedure for doing this: The net present value approach.

THE BASIC IDEA

An investment is worth undertaking if it creates value for its owners. In the most general sense, we create value by identifying an investment worth more in the marketplace than it costs us to acquire. How can something be worth more than it costs? It's a case of the whole being worth more than the cost of the parts.

For example, suppose you buy a run-down house for $25,000 and spend another $25,000 on painters, plumbers, and so on to get it fixed up. Your total investment is $50,000. When the work is completed, you place the house back on the market and find that it's worth $60,000. The market value ($60,000) exceeds the cost ($50,000) by $10,000. What you have done here is to act as a manager to bring together some fixed assets (a house), some labor (plumbers, carpenters, and others), and some materials (carpeting, paint, and so on). The net result is that you have created $10,000 in value. Put another way, this $10,000 is the *value added* by management.

With our house example, it turned out *after the fact* that $10,000 in value had been created. Things worked out nicely. The real challenge, of course, would have been to somehow identify *ahead of time* whether investing the necessary $50,000 was a good idea in the first place. This is what capital budgeting is all about—namely, trying to determine whether a proposed investment or project will be worth more, once it is in place, than it costs.

net present value (NPV)
The difference between an investment's market value and its cost.

For reasons that will be obvious in a moment, the difference between an investment's market value and its cost is called the **net present value** of the investment, abbreviated **NPV**. In other words, net present value is a measure of how much value is created or added today by undertaking an investment. Given our goal of creating value for the stockholders, the capital budgeting process can be viewed as a search for investments with positive net present values.

With our run-down house, you can probably imagine how we would go about making the capital budgeting decision. We would first look at what comparable, fixed-up properties were selling for in the market. We would then get estimates of the cost of buying a particular property and bringing it to market. At this point, we would have an estimated total cost and an estimated market value. If the difference was positive, then this investment would be worth undertaking because it would have a positive estimated net present value. There is risk, of course, because there is no guarantee that our estimates will turn out to be correct.

As our example illustrates, investment decisions are greatly simplified when there is a market for assets similar to the investment we are considering. Capital budgeting becomes much more difficult when we cannot observe the market price for at least roughly comparable investments. The reason is that we then face the problem of estimating the value of an investment using only indirect market information. Unfortunately, this is precisely the situation the financial manager usually encounters. We examine this issue next.

ESTIMATING NET PRESENT VALUE

Imagine we are thinking of starting a business to produce and sell a new product—say, organic fertilizer. We can estimate the start-up costs with reasonable accuracy because we know what we will need to buy to begin production. Would this be a good investment? Based on our discussion, you know that the answer depends on whether the value of the new business exceeds the cost of starting it. In other words, does this investment have a positive NPV?

This problem is much more difficult than our "fixer upper" house example because entire fertilizer companies are not routinely bought and sold in the marketplace, so it is essentially impossible to observe the market value of a similar investment. As a result, we must somehow estimate this value by other means.

Based on our work in Chapters 5 and 6, you may be able to guess how we will go about estimating the value of our fertilizer business. We will first try to estimate the future cash flows we expect the new business to produce. We will then apply our basic discounted cash flow procedure to estimate the present value of those cash flows. Once we have this estimate, we will then estimate NPV as the difference between the present value of the future cash flows and the cost of the investment. As we mentioned in Chapter 5, this procedure is often called **discounted cash flow (DCF) valuation**.

discounted cash flow (DCF) valuation
The process of valuing an investment by discounting its future cash flows.

To see how we might go about estimating NPV, suppose we believe the cash revenues from our fertilizer business will be $20,000 per year, assuming everything goes as expected. Cash costs (including taxes) will be $14,000 per year. We will wind down the business in eight years. The plant, property, and equipment will be worth $2,000 as salvage at that time. The project costs $30,000 to launch. We use a 15 percent discount rate on new projects such as this one. Is this a good investment? If there are 1,000 shares of stock outstanding, what will be the effect on the price per share of taking this investment?

Time (years)	0	1	2	3	4	5	6	7	8
Initial cost	−$30								
Inflows		$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20
Outflows		−14	−14	−14	−14	−14	−14	−14	−14
Net inflow		$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6
Salvage									2
Net cash flow	−$30	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	$ 8

FIGURE 9.1

Project Cash Flows ($000)

From a purely mechanical perspective, we need to calculate the present value of the future cash flows at 15 percent. The net cash inflow will be $20,000 cash income less $14,000 in costs per year for eight years. These cash flows are illustrated in Figure 9.1. As Figure 9.1 suggests, we effectively have an eight-year annuity of $20,000 − 14,000 = $6,000 per year, along with a single lump sum inflow of $2,000 in eight years. Calculating the present value of the future cash flows comes down to the same type of problem we considered in Chapter 6. The total present value is:

$$
\begin{aligned}
\text{Present value} &= \$6{,}000 \times [1 - (1/1.15^8)]/.15 + (2{,}000/1.15^8) \\
&= (\$6{,}000 \times 4.4873) + (2{,}000/3.0590) \\
&= \$26{,}924 + 654 \\
&= \$27{,}578
\end{aligned}
$$

When we compare this to the $30,000 estimated cost, we see that the NPV is:

$$\text{NPV} = -\$30{,}000 + 27{,}578 = -\$2{,}422$$

Therefore, this is *not* a good investment. Based on our estimates, taking it would *decrease* the total value of the stock by $2,422. With 1,000 shares outstanding, our best estimate of the impact of taking this project is a loss of value of $2,422/1,000 = $2.42 per share.

Our fertilizer example illustrates how NPV estimates can be used to determine whether an investment is desirable. From our example, notice that if the NPV is negative, the effect on share value will be unfavorable. If the NPV were positive, the effect would be favorable. As a consequence, all we need to know about a particular proposal for the purpose of making an accept–reject decision is whether the NPV is positive or negative.

Given that the goal of financial management is to increase share value, our discussion in this section leads us to the *net present value rule*:

An investment should be accepted if the net present value is positive and rejected if it is negative.

In the unlikely event that the net present value turned out to be exactly zero, we would be indifferent between taking the investment and not taking it.

Two comments about our example are in order. First and foremost, it is not the rather mechanical process of discounting the cash flows that is important. Once we have the cash flows and the appropriate discount rate, the required calculations are fairly straightforward. The task of coming up with the cash flows and the discount rate is much more challenging. We will have much more to say about this in the next several chapters. For the remainder of this chapter, we take it as a given that we have estimates of the cash revenues and costs and, where needed, an appropriate discount rate.

The second thing to keep in mind about our example is that the −$2,422 NPV is an estimate. Like any estimate, it can be high or low. The only way to find out the true NPV would be to place the investment up for sale and see what we could get for it. We generally won't be doing this, so it is important that our estimates be reliable. Once again, we will say more about this later. For the rest of this chapter, we will assume the estimates are accurate.

EXAMPLE 9.1 Using the NPV Rule

Suppose we are asked to decide whether a new consumer product should be launched. Based on projected sales and costs, we expect that the cash flows over the five-year life of the project will be \$2,000 in the first two years, \$4,000 in the next two, and \$5,000 in the last year. It will cost about \$10,000 to begin production. We use a 10 percent discount rate to evaluate new products. What should we do here?

Given the cash flows and discount rate, we can calculate the total value of the product by discounting the cash flows back to the present:

$$\begin{aligned}\text{Present value} &= (\$2{,}000/1.1) + (2{,}000/1.1^2) + (4{,}000/1.1^3) \\ &\quad + (4{,}000/1.1^4) + (5{,}000/1.1^5) \\ &= \$1{,}818 + 1{,}653 + 3{,}005 + 2{,}732 + 3{,}105 \\ &= \$12{,}313\end{aligned}$$

The present value of the expected cash flows is \$12,313, but the cost of getting those cash flows is only \$10,000, so the NPV is \$12,313 − 10,000 = \$2,313. This is positive; so, based on the net present value rule, we should take on the project.

As we have seen in this section, estimating NPV is one way of assessing the profitability of a proposed investment. It is certainly not the only way profitability is assessed, and we now turn to some alternatives. As we will see, when compared to NPV, each of the alternative ways of assessing profitability that we will examine is flawed in some key way; so NPV is the preferred approach in principle, if not always in practice.

SPREADSHEET STRATEGIES

Calculating NPVs with a Spreadsheet

Spreadsheets are commonly used to calculate NPVs. Examining the use of spreadsheets in this context also allows us to issue an important warning. Let's rework Example 9.1:

	A	B	C	D	E	F	G	H
1								
2	**Using a spreadsheet to calculate net present values**							
3								
4	From Example 9.1, the project's cost is \$10,000. The cash flows are \$2,000 per year for the first							
5	two years, \$4,000 per year for the next two, and \$5,000 in the last year. The discount rate is							
6	10 percent; what's the NPV?							
7								
8		Year	Cash Flow					
9		0	−\$10,000		Discount rate =	10%		
10		1	2,000					
11		2	2,000		**NPV =**	**\$2,102.72**	(*wrong* answer)	
12		3	4,000		**NPV =**	**\$2,312.99**	(*right* answer)	
13		4	4,000					
14		5	5,000					
15								
16	The formula entered in cell F11 is =NPV(F9, C9:C14). This gives the wrong answer because the							
17	NPV function actually calculates present values, not *net* present values.							
18								
19	The formula entered in cell F12 is =NPV(F9, C10:C14) + C9. This gives the right answer because the							
20	NPV function is used to calculate the present value of the cash flows and then the initial cost is							
21	subtracted to calculate the answer. Notice that we added cell C9 because it is already negative.							

SOURCE: Microsoft Excel

You can get a freeware NPV calculator at **www.wheatworks.com**

In our spreadsheet example, notice that we have provided two answers. By comparing the answers to that found in Example 9.1, we see that the first answer is wrong even though we used the spreadsheet's NPV formula. What happened is that the "NPV" function in our spreadsheet is actually a PV function; unfortunately, one of the original spreadsheet programs many years ago got the definition wrong, and subsequent spreadsheets have copied it! Our second answer shows how to use the formula properly.

The example here illustrates the danger of blindly using calculators or computers without understanding what is going on; we shudder to think of how many capital budgeting decisions in the real world are based on incorrect use of this particular function. We will see another example of something that can go wrong with a spreadsheet later in the chapter.

Concept Questions

9.1a What is the net present value rule?

9.1b If we say an investment has an NPV of $1,000, what exactly do we mean?

9.2 The Payback Rule

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It is common in practice to talk of the payback on a proposed investment. Loosely, the *payback* is the length of time it takes to recover our initial investment or "get our bait back." Because this idea is widely understood and used, we will examine it in some detail.

DEFINING THE RULE

We can illustrate how to calculate a payback with an example. Figure 9.2 shows the cash flows from a proposed investment. How many years do we have to wait until the accumulated cash flows from this investment equal or exceed the cost of the investment? As Figure 9.2 indicates, the initial investment is $50,000. After the first year, the firm has recovered $30,000, leaving $20,000. The cash flow in the second year is exactly $20,000, so this investment "pays for itself" in exactly two years. Put another way, the **payback period** is two years. If we require a payback of, say, three years or less, then this investment is acceptable. This illustrates the *payback period rule*:

payback period
The amount of time required for an investment to generate cash flows sufficient to recover its initial cost.

> **Based on the payback rule, an investment is acceptable if its calculated payback period is less than some prespecified number of years.**

In our example, the payback works out to be exactly two years. This won't usually happen, of course. When the numbers don't work out exactly, it is customary to work with fractional years. For example, suppose the initial investment is $60,000, and the cash flows are $20,000 in the first year and $90,000 in the second. The cash flows over the first two years

FIGURE 9.2
Net Project Cash Flows

Year	0	1	2	3	4
	−$50,000	$30,000	$20,000	$10,000	$5,000

are \$110,000, so the project obviously pays back sometime in the second year. After the first year, the project has paid back \$20,000, leaving \$40,000 to be recovered. To figure out the fractional year, note that this \$40,000 is \$40,000/\$90,000 = 4/9 of the second year's cash flow. Assuming that the \$90,000 cash flow is received uniformly throughout the year, the payback would be $1\frac{4}{9}$ years.

EXAMPLE 9.2 Calculating Payback

Here are the projected cash flows from a proposed investment:

Year	Cash Flow
1	\$100
2	200
3	500

This project costs \$500. What is the payback period for this investment?

The initial cost is \$500. After the first two years, the cash flows total \$300. After the third year, the total cash flow is \$800, so the project pays back sometime between the end of Year 2 and the end of Year 3. Because the accumulated cash flows for the first two years are \$300, we need to recover \$200 in the third year. The third-year cash flow is \$500, so we will have to wait \$200/\$500 = .4 years to do this. The payback period is thus 2.4 years, or about two years and five months.

Now that we know how to calculate the payback period on an investment, using the payback period rule for making decisions is straightforward. A particular cutoff time is selected—say, two years—and all investment projects that have payback periods of two years or less are accepted, whereas any that pay off in more than two years are rejected.

Table 9.1 illustrates cash flows for five different projects. The figures shown as the Year 0 cash flows are the costs of the investments. We examine these to indicate some peculiarities that can, in principle, arise with payback periods.

The payback for the first project, A, is easily calculated. The sum of the cash flows for the first two years is \$70, leaving us with \$100 − 70 = \$30 to go. Because the cash flow in the third year is \$50, the payback occurs sometime in that year. When we compare the \$30 we need to the \$50 that will be coming in, we get \$30/\$50 = .6; so, payback will occur 60 percent of the way into the year. The payback period is thus 2.6 years.

Project B's payback is also easy to calculate: It *never* pays back because the cash flows never total up to the original investment. Project C has a payback of exactly four years because it supplies the \$130 that B is missing in Year 4. Project D is a little strange. Because of the negative cash flow in Year 3, you can easily verify that it has two different payback periods, two years and four years. Which of these is correct? Both of them; the way the

TABLE 9.1

Expected Cash Flows for Projects A through E

Year	A	B	C	D	E
0	−\$100	−\$200	−\$200	−\$200	−\$ 50
1	30	40	40	100	100
2	40	20	20	100	−50,000,000
3	50	10	10	−200	
4	60		130	200	

payback period is calculated doesn't guarantee a single answer. Finally, Project E is obviously unrealistic, but it does pay back in six months, thereby illustrating the point that a rapid payback does not guarantee a good investment.

ANALYZING THE RULE

When compared to the NPV rule, the payback period rule has some rather severe shortcomings. First, we calculate the payback period by adding up the future cash flows. There is no discounting involved, so the time value of money is completely ignored. The payback rule also fails to consider any risk differences. The payback would be calculated the same way for both very risky and very safe projects.

Perhaps the biggest problem with the payback period rule is coming up with the right cutoff period: We don't really have an objective basis for choosing a particular number. Put another way, there is no economic rationale for looking at payback in the first place, so we have no guide for how to pick the cutoff. As a result, we end up using a number that is arbitrarily chosen.

Suppose we have somehow decided on an appropriate payback period of two years or less. As we have seen, the payback period rule ignores the time value of money for the first two years. More seriously, cash flows after the second year are ignored entirely. To see this, consider the two investments, Long and Short, in Table 9.2. Both projects cost \$250. Based on our discussion, the payback on Long is 2 + (\$50/\$100) = 2.5 years, and the payback on Short is 1 + (\$150/\$200) = 1.75 years. With a cutoff of two years, Short is acceptable and Long is not.

Is the payback period rule guiding us to the right decisions? Maybe not. Suppose we require a 15 percent return on this type of investment. We can calculate the NPV for these two investments as:

$$\text{NPV(Short)} = -\$250 + (100/1.15) + (200/1.15^2) = -\$11.81$$
$$\text{NPV(Long)} = -\$250 + (100 \times \{[1 - (1/1.15^4)]/.15\}) = \$35.50$$

Now we have a problem. The NPV of the shorter-term investment is actually negative, meaning that taking it diminishes the value of the shareholders' equity. The opposite is true for the longer-term investment—it increases share value.

Our example illustrates two primary shortcomings of the payback period rule. First, by ignoring time value, we may be led to take investments (like Short) that actually are worth less than they cost. Second, by ignoring cash flows beyond the cutoff, we may be led to reject profitable longer-term investments (like Long). More generally, using a payback period rule will tend to bias us toward shorter-term investments.

REDEEMING QUALITIES OF THE RULE

Despite its shortcomings, the payback period rule is often used by large and sophisticated companies when they are making relatively minor decisions. There are several reasons for this. The primary reason is that many decisions do not warrant detailed analysis because

TABLE 9.2
Investment Projected Cash Flows

Year	Long	Short
0	−\$250	−\$250
1	100	100
2	100	200
3	100	0
4	100	0

the cost of the analysis would exceed the possible loss from a mistake. As a practical matter, it can be said that an investment that pays back rapidly and has benefits extending beyond the cutoff period probably has a positive NPV.

Small investment decisions are made by the hundreds every day in large organizations. Moreover, they are made at all levels. As a result, it would not be uncommon for a corporation to require, for example, a two-year payback on all investments of less than $10,000. Investments larger than this would be subjected to greater scrutiny. The requirement of a two-year payback is not perfect for reasons we have seen, but it does exercise some control over expenditures and limits possible losses.

In addition to its simplicity, the payback rule has two other positive features. First, because it is biased toward short-term projects, it is biased toward liquidity. In other words, a payback rule tends to favor investments that free up cash for other uses quickly. This could be important for a small business; it would be less so for a large corporation. Second, the cash flows that are expected to occur later in a project's life are probably more uncertain. Arguably, a payback period rule adjusts for the extra riskiness of later cash flows, but it does so in a rather draconian fashion—by ignoring them altogether.

We should note here that some of the apparent simplicity of the payback rule is an illusion. The reason is that we still must come up with the cash flows first, and, as we discussed earlier, this is not at all easy to do. It would probably be more accurate to say that the *concept* of a payback period is both intuitive and easy to understand.

SUMMARY OF THE RULE

To summarize, the payback period is a kind of "break-even" measure. Because time value is ignored, you can think of the payback period as the length of time it takes to break even in an accounting sense, but not in an economic sense. The biggest drawback to the payback period rule is that it doesn't ask the right question. The relevant issue is the impact an investment will have on the value of the stock, not how long it takes to recover the initial investment.

Nevertheless, because it is so simple, companies often use it as a screen for dealing with the myriad minor investment decisions they have to make. There is certainly nothing wrong with this practice. As with any simple rule of thumb, there will be some errors in using it; but it wouldn't have survived all this time if it weren't useful. Now that you understand the rule, you can be on the alert for circumstances under which it might lead to problems. To help you remember, the following table lists the pros and cons of the payback period rule:

Advantages and Disadvantages of the Payback Period Rule

Advantages	Disadvantages
1. Easy to understand.	1. Ignores the time value of money.
2. Adjusts for uncertainty of later cash flows.	2. Requires an arbitrary cutoff point.
3. Biased toward liquidity.	3. Ignores cash flows beyond the cutoff date.
	4. Biased against long-term projects, such as research and development, and new projects.

Concept Questions

9.2a In words, what is the payback period? The payback period rule?

9.2b Why do we say that the payback period is, in a sense, an accounting break-even measure?

The Discounted Payback

9.3

We saw that one shortcoming of the payback period rule was that it ignored time value. A variation of the payback period, the discounted payback period, fixes this particular problem. The **discounted payback period** is the length of time until the sum of the discounted cash flows is equal to the initial investment. The *discounted payback rule* is therefore:

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Based on the discounted payback rule, an investment is acceptable if its discounted payback is less than some prespecified number of years.

discounted payback period
The length of time required for an investment's discounted cash flows to equal its initial cost.

To see how we might calculate the discounted payback period, suppose we require a 12.5 percent return on new investments. We have an investment that costs $300 and has cash flows of $100 per year for five years. To get the discounted payback, we have to discount each cash flow at 12.5 percent and then start adding them. We do this in Table 9.3. In Table 9.3, we have both the discounted and the undiscounted cash flows. Looking at the accumulated cash flows, we see that the regular payback is almost exactly three years (look for the highlighted figure in Year 3). The discounted cash flows total $301 only after four years, so the discounted payback is four years, as shown.[1]

How do we interpret the discounted payback? Recall that the ordinary payback is the time it takes to break even in an accounting sense. Because it includes the time value of money, the discounted payback is the time it takes to break even in an economic or financial sense. Loosely speaking, in our example, we get our money back, along with the interest we could have earned elsewhere, in four years.

Figure 9.3 illustrates this idea by comparing the *future* value of the $300 investment at 12.5 percent to the *future* value of the $100 annual cash flows at 12.5 percent. Notice that the two lines cross at exactly four years. This tells us that the value of the project's cash flows catches up and then passes the original investment in four years.

Table 9.3 and Figure 9.3 illustrate another interesting feature of the discounted payback period. If a project ever pays back on a discounted basis, then it must have a positive NPV.[2] This is true because, by definition, the NPV is zero when the sum of the discounted cash flows equals the initial investment. For example, the present value of all the cash flows in

TABLE 9.3
Ordinary and Discounted Payback

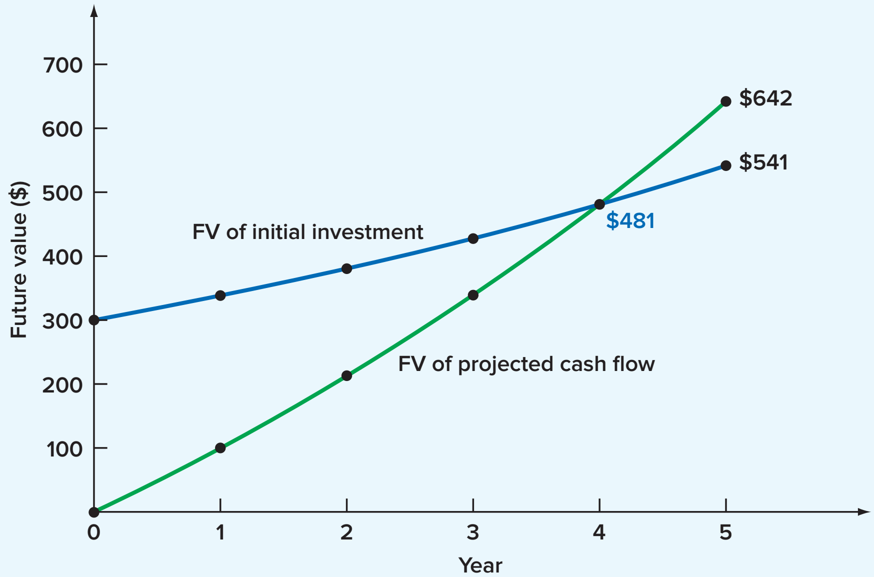
	Cash Flow		Accumulated Cash Flow	
Year	Undiscounted	Discounted	Undiscounted	Discounted
1	$100	$89	$100	$ 89
2	100	79	200	168
3	100	70	300	238
4	100	62	400	301
5	100	55	500	356

[1]In this case, the discounted payback is an even number of years. This won't ordinarily happen, of course. Calculating a fractional year for the discounted payback period is more involved than it is for the ordinary payback, and it is not commonly done.

[2]This argument assumes the cash flows, other than the first, are all positive. If they are not, then these statements are not necessarily correct. Also, there may be more than one discounted payback.

FIGURE 9.3

Future Value of Project Cash Flows



Future Value at 12.5%		
Year	$100 Annuity (Projected Cash Flow)	$300 Lump Sum (Projected Investment)
0	$ 0	$300
1	100	338
2	213	380
3	339	427
4	481	481
5	642	541

Table 9.3 is $356. The cost of the project was $300, so the NPV is obviously $56. This $56 is the value of the cash flow that occurs *after* the discounted payback (see the last line in Table 9.3). In general, if we use a discounted payback rule, we won't accidentally take any projects with a negative estimated NPV.

Based on our example, the discounted payback would seem to have much to recommend it. You may be surprised to find out that it is rarely used in practice. Why? Probably because it really isn't any simpler to use than NPV. To calculate a discounted payback, you have to discount cash flows, add them up, and compare them to the cost, just as you do with NPV. So, unlike an ordinary payback, the discounted payback is not especially simple to calculate.

A discounted payback period rule has a couple of other significant drawbacks. The biggest one is that the cutoff still has to be arbitrarily set, and cash flows beyond that point are ignored.[3] As a result, a project with a positive NPV may be found unacceptable because the cutoff is too short. Also, just because one project has a shorter discounted payback than another does not mean it has a larger NPV.

All things considered, the discounted payback is a compromise between a regular payback and NPV that lacks the simplicity of the first and the conceptual rigor of the second. Nonetheless, if we need to assess the time it will take to recover the investment required by a project, then the discounted payback is better than the ordinary payback because it

[3]If the cutoff were forever, then the discounted payback rule would be the same as the NPV rule. It would also be the same as the profitability index rule considered in a later section.

considers time value. In other words, the discounted payback recognizes that we could have invested the money elsewhere and earned a return on it. The ordinary payback does not take this into account. The advantages and disadvantages of the discounted payback rule are summarized in the following table:

Advantages and Disadvantages of the Discounted Payback Period Rule	
Advantages	**Disadvantages**
1. Includes time value of money.	1. May reject positive NPV investments.
2. Easy to understand.	2. Requires an arbitrary cutoff point.
3. Does not accept negative estimated NPV investments.	3. Ignores cash flows beyond the cutoff date.
4. Biased toward liquidity.	4. Biased against long-term projects, such as research and development, and new projects.

Calculating Discounted Payback — EXAMPLE 9.3

Consider an investment that costs \$400 and pays \$100 per year forever. We use a 20 percent discount rate on this type of investment. What is the ordinary payback? What is the discounted payback? What is the NPV?

The NPV and ordinary payback are easy to calculate in this case because the investment is a perpetuity. The present value of the cash flows is \$100/.2 = \$500, so the NPV is \$500 – 400 = \$100. The ordinary payback is obviously four years.

To get the discounted payback, we need to find the number of years such that a \$100 annuity has a present value of \$400 at 20 percent. In other words, the present value annuity factor is \$400/\$100 = 4, and the interest rate is 20 percent per period; so what's the number of periods? If we solve for the number of periods, we find that the answer is a little less than nine years, so this is the discounted payback.

Concept Questions

9.3a In words, what is the discounted payback period? Why do we say it is, in a sense, a financial or economic break-even measure?

9.3b What advantage(s) does the discounted payback have over the ordinary payback?

9.4 The Average Accounting Return

Another attractive, but flawed, approach to making capital budgeting decisions involves the **average accounting return (AAR)**. There are many different definitions of the AAR. However, in one form or another, the AAR is always defined as:

$$\frac{\text{Some measure of average accounting profit}}{\text{Some measure of average accounting value}}$$

The specific definition we will use is:

$$\frac{\text{Average net income}}{\text{Average book value}}$$

To see how we might calculate this number, suppose we are deciding whether to open a store in a new shopping mall. The required investment in improvements is \$500,000.

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average accounting return (AAR)
An investment's average net income divided by its average book value.

TABLE 9.4
Projected Yearly Revenue and Costs for Average Accounting Return

	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	$433,333	$450,000	$266,667	$200,000	$133,333
Expenses	200,000	150,000	100,000	100,000	100,000
Earnings before depreciation	$233,333	$300,000	$166,667	$100,000	$ 33,333
Depreciation	100,000	100,000	100,000	100,000	100,000
Earnings before taxes	$133,333	$200,000	$ 66,667	$ 0	−$ 66,667
Taxes (25%)	33,333	50,000	16,667	0	− 16,667
Net income	$100,000	$150,000	$ 50,000	$ 0	−$ 50,000

$$\text{Average net income} = \frac{\$100{,}000 + 150{,}000 + 50{,}000 + 0 - 50{,}000}{5} = \$50{,}000$$

$$\text{Average book value} = \frac{\$500{,}000 + 0}{2} = \$250{,}000$$

The store would have a five-year life because everything reverts to the mall owners after that time. The required investment would be 100 percent depreciated (straight-line) over five years, so the depreciation would be $500,000/5 = $100,000 per year. The tax rate is 25 percent. Table 9.4 contains the projected revenues and expenses. Net income in each year, based on these figures, is also shown.

To calculate the average book value for this investment, we note that we started out with a book value of $500,000 (the initial cost) and ended up at $0. The average book value during the life of the investment is ($500,000 + 0)/2 = $250,000. As long as we use straight-line depreciation, the average investment will always be one-half of the initial investment.[4]

Looking at Table 9.4, we see that net income is $100,000 in the first year, $150,000 in the second year, $50,000 in the third year, $0 in Year 4, and −$50,000 in Year 5. The average net income, then, is:

$$[\$100{,}000 + 150{,}000 + 50{,}000 + 0 + (-50{,}000)]/5 = \$50{,}000$$

The average accounting return is:

$$\text{AAR} = \frac{\text{Average net income}}{\text{Average book value}} = \frac{\$50{,}000}{\$250{,}000} = .20, \text{ or } 20\%$$

If the firm has a target AAR of less than 20 percent, then this investment is acceptable; otherwise, it is not. The *average accounting return rule* is:

Based on the average accounting return rule, a project is acceptable if its average accounting return exceeds a target average accounting return.

As we will now see, the use of this rule has a number of problems.

You should recognize the chief drawback to the AAR immediately. Above all else, the AAR is not a rate of return in any meaningful economic sense. Instead, it is the ratio of

[4]We could, of course, calculate the average of the six book values directly. In thousands, we would have ($500 + 400 + 300 + 200 + 100 + 0)/6 = $250.

two accounting numbers, and it is not comparable to the returns offered, for example, in financial markets.[5]

One of the reasons the AAR is not a true rate of return is that it ignores time value. When we average figures that occur at different times, we are treating the near future and the more distant future in the same way. There was no discounting involved when we computed the average net income, for example.

The second problem with the AAR is similar to the problem we had with the payback period rule concerning the lack of an objective cutoff period. Because a calculated AAR is really not comparable to a market return, the target AAR must somehow be specified. There is no generally agreed-upon way to do this. One way of doing it is to calculate the AAR for the firm as a whole and use this as a benchmark, but there are lots of other ways as well.

The third, and perhaps worst, flaw in the AAR is that it doesn't even look at the right things. Instead of cash flow and market value, it uses net income and book value. These are both poor substitutes. As a result, an AAR doesn't tell us what we really want to know—which is, What effect will taking this investment have on share price?

Does the AAR have any redeeming features? About the only one is that it almost always can be computed. The reason is that accounting information will almost always be available, both for the project under consideration and for the firm as a whole. We hasten to add that once the accounting information is available, we can always convert it to cash flows, so even this is not a particularly important fact. The AAR is summarized in the following table:

Advantages and Disadvantages of the Average Accounting Return

Advantages	Disadvantages
1. Easy to calculate. 2. Needed information will usually be available.	1. Not a true rate of return; time value of money is ignored. 2. Uses an arbitrary benchmark cutoff rate. 3. Based on accounting (book) values, not cash flows and market values.

Concept Questions

9.4a What is an average accounting rate of return (AAR)?

9.4b What are the weaknesses of the AAR rule?

9.5 The Internal Rate of Return

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We now come to the most important alternative to NPV, the **internal rate of return**, universally known as the **IRR**. As we will see, the IRR is closely related to NPV. With the IRR, we try to find a single rate of return that summarizes the merits of a project. Furthermore, we want this rate to be an "internal" rate in the sense that it depends only on the cash flows of a particular investment, not on rates offered elsewhere.

internal rate of return (IRR)
The discount rate that makes the NPV of an investment zero.

To illustrate the idea behind the IRR, consider a project that costs $100 today and pays $110 in one year. Suppose you were asked, "What is the return on this investment?" What would you say? It seems both natural and obvious to say that the return is 10 percent

[5]The AAR is closely related to the return on assets (ROA) discussed in Chapter 3. In practice, the AAR is sometimes computed by first calculating the ROA for each year and then averaging the results. This produces a number that is similar, but not identical, to the one we computed.

because, for every dollar we put in, we get \$1.10 back. In fact, as we will see in a moment, 10 percent is the internal rate of return, or IRR, on this investment.

Is this project with its 10 percent IRR a good investment? Once again, it would seem apparent that this is a good investment only if our required return is less than 10 percent. This intuition is also correct and illustrates the *IRR rule*:

Based on the IRR rule, an investment is acceptable if the IRR exceeds the required return. It should be rejected otherwise.

Imagine that we want to calculate the NPV for our simple investment. At a discount rate of R, the NPV is:

$$\text{NPV} = -\$100 + [110/(1 + R)]$$

Now, suppose we don't know the discount rate. This presents a problem, but we can still ask how high the discount rate would have to be before this project would be deemed unacceptable. We know that we are indifferent between taking and not taking this investment when its NPV is just equal to zero. In other words, this investment is *economically* a break-even proposition when the NPV is zero because value is neither created nor destroyed. To find the break-even discount rate, we set NPV equal to zero and solve for R:

$$\begin{aligned} \text{NPV} = 0 &= -\$100 + [110/(1 + R)] \\ \$100 &= \$110/(1 + R) \\ 1 + R &= \$110/\$100 = 1.1 \\ R &= .10, \text{ or } 10\% \end{aligned}$$

This 10 percent is what we already have called the return on this investment. What we have now illustrated is that the internal rate of return on an investment (or just "return" for short) is the discount rate that makes the NPV equal to zero. This is an important observation, so it bears repeating:

The IRR on an investment is the required return that results in a zero NPV when it is used as the discount rate.

The fact that the IRR is the discount rate that makes the NPV equal to zero is important because it tells us how to calculate the returns on more complicated investments. As we have seen, finding the IRR turns out to be relatively easy for a single-period investment. Suppose you were now looking at an investment with the cash flows shown in Figure 9.4. As illustrated, this investment costs \$100 and has a cash flow of \$60 per year for two years, so it's only slightly more complicated than our single-period example. If you were asked for the return on this investment, what would you say? There doesn't seem to be any obvious answer (at least not to us). Based on what we now know, we can set the NPV equal to zero and solve for the discount rate:

$$\text{NPV} = 0 = -\$100 + [60/(1 + \text{IRR})] + [60/(1 + \text{IRR})^2]$$

FIGURE 9.4
Project Cash Flows

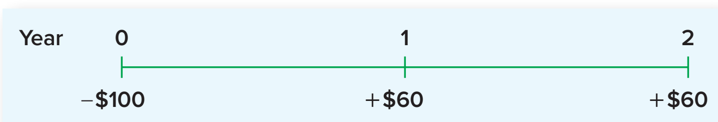


TABLE 9.5
NPV at Different Discount Rates

Discount Rate	NPV
0%	$20.00
5	11.56
10	4.13
15	− 2.46
20	− 8.33

Unfortunately, the only way to find the IRR in general is by trial and error, either by hand or by calculator. This is precisely the same problem that came up in Chapter 5, when we found the unknown rate for an annuity, and in Chapter 7, when we found the yield to maturity on a bond. In fact, we now see that in both of those cases, we were finding an IRR.

In this particular case, the cash flows form a two-period, $60 annuity. To find the unknown rate, we can try some different rates until we get the answer. If we were to start with a 0 percent rate, the NPV would obviously be $120 − 100 = $20. At a 10 percent discount rate, we would have:

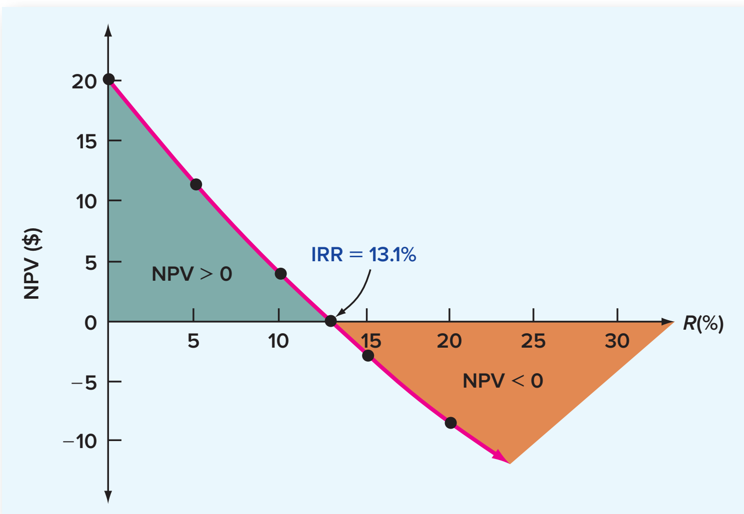
$$\text{NPV} = -\$100 + (60/1.1) + (60/1.1^2) = \$4.13$$

Now, we're getting close. We can summarize these and some other possibilities as shown in Table 9.5. From our calculations, the NPV appears to be zero with a discount rate between 10 percent and 15 percent, so the IRR is somewhere in that range. With a little more effort, we can find that the IRR is about 13.1 percent.[6] So, if our required return were less than 13.1 percent, we would take this investment. If our required return exceeded 13.1 percent, we would reject it.

By now, you have probably noticed that the IRR rule and the NPV rule appear to be quite similar. In fact, the IRR is sometimes called the *discounted cash flow*, or *DCF*, *return*. The easiest way to illustrate the relationship between NPV and IRR is to plot the numbers we calculated for Table 9.5. We put the different NPVs on the vertical axis, or *y*-axis, and the discount rates on the horizontal axis, or *x*-axis. If we had a very large number of points, the resulting picture would be a smooth curve called a **net present value profile**. Figure 9.5 illustrates the NPV profile for this project. Beginning with a 0 percent discount

net present value profile
A graphical representation of the relationship between an investment's NPVs and various discount rates.

FIGURE 9.5
An NPV Profile



[6]With a lot more effort (or a personal computer), we can find that the IRR is approximately (to 9 decimal places) 13.066238629 percent—not that anybody would ever want this many decimal places!

rate, we have $20 plotted directly on the *y*-axis. As the discount rate increases, the NPV declines smoothly. Where will the curve cut through the *x*-axis? This will occur where the NPV is just equal to zero, so it will happen right at the IRR of 13.1 percent.

In our example, the NPV rule and the IRR rule lead to identical accept–reject decisions. We will accept an investment using the IRR rule if the required return is less than 13.1 percent. As Figure 9.5 illustrates, the NPV is positive at any discount rate less than 13.1 percent, so we would accept the investment using the NPV rule as well. The two rules give equivalent results in this case.

EXAMPLE 9.4 Calculating the IRR

A project has a total up-front cost of $435.44. The cash flows are $100 in the first year, $200 in the second year, and $300 in the third year. What's the IRR? If we require an 18 percent return, should we take this investment?

We'll describe the NPV profile and find the IRR by calculating some NPVs at different discount rates. You should check our answers for practice. Beginning with 0 percent, we have:

Discount Rate	NPV
0%	$164.56
5	100.36
10	46.15
15	.00
20	– 39.61

The NPV is zero at 15 percent, so 15 percent is the IRR. If we require an 18 percent return, then we should not take the investment. The reason is that the NPV is negative at 18 percent (verify that it is −$24.47). The IRR rule tells us the same thing in this case. We shouldn't take this investment because its 15 percent return is below our required 18 percent return.

At this point, you may be wondering if the IRR and NPV rules always lead to identical decisions. The answer is yes, as long as two very important conditions are met. First, the project's cash flows must be *conventional*, meaning that the first cash flow (the initial investment) is negative and all the rest are positive. Second, the project must be *independent*, meaning that the decision to accept or reject this project does not affect the decision to accept or reject any other. The first of these conditions is typically met, but the second often is not. In any case, when one or both of these conditions are not met, problems can arise. We discuss some of these next.

SPREADSHEET STRATEGIES

Calculating IRRs with a Spreadsheet

Because IRRs are so tedious to calculate by hand, financial calculators and especially spreadsheets are generally used. The procedures used by various financial calculators are too different for us to illustrate here, so we will focus on using a spreadsheet (financial calculators are covered in Appendix D). As the following example illustrates, using a spreadsheet is easy.

	A	B	C	D	E	F	G	H
1								
2	**Using a spreadsheet to calculate internal rates of return**							
3								
4	Suppose we have a four-year project that costs $500. The cash flows over the four-year life will be							
5	$100, $200, $300, and $400. What is the IRR?							
6								
7		Year	Cash Flow					
8		0	−$500					
9		1	100		**IRR =**	27.3%		
10		2	200					
11		3	300					
12		4	400					
13								
14								
15	The formula entered in cell F9 is =IRR(C8:C12). Notice that the Year 0 cash flow has a negative							
16	sign representing the initial cost of the project.							
17								

SOURCE: Microsoft Excel

PROBLEMS WITH THE IRR

The problems with the IRR come about when the cash flows are not conventional or when we are trying to compare two or more investments to see which is best. In the first case, surprisingly, the simple question "What's the return?" can become difficult to answer. In the second case, the IRR can be a misleading guide.

Nonconventional Cash Flows Suppose we have a strip-mining project that requires a $60 investment. Our cash flow in the first year will be $155. In the second year, the mine will be depleted, but we will have to spend $100 to restore the terrain. As Figure 9.6 illustrates, both the first and third cash flows are negative.

To find the IRR on this project, we can calculate the NPV at various rates:

Discount Rate	NPV
0%	−$5.00
10	− 1.74
20	− .28
30	.06
40	− .31

The NPV appears to be behaving in a peculiar fashion here. First, as the discount rate increases from 0 percent to 30 percent, the NPV starts out negative and becomes positive. This seems backward because the NPV is rising as the discount rate rises. It then starts getting smaller and becomes negative again. What's the IRR? To find out, we draw the NPV profile as shown in Figure 9.7.

In Figure 9.7, notice that the NPV is zero when the discount rate is 25 percent, so this is the IRR. Or is it? The NPV is also zero at $33\frac{1}{3}$ percent. Which of these is correct? The answer is both or neither; more precisely, there is no unambiguously correct answer.

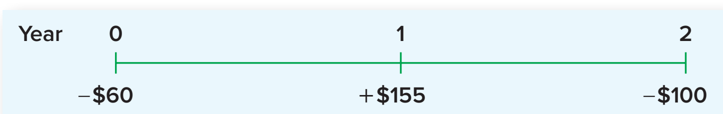
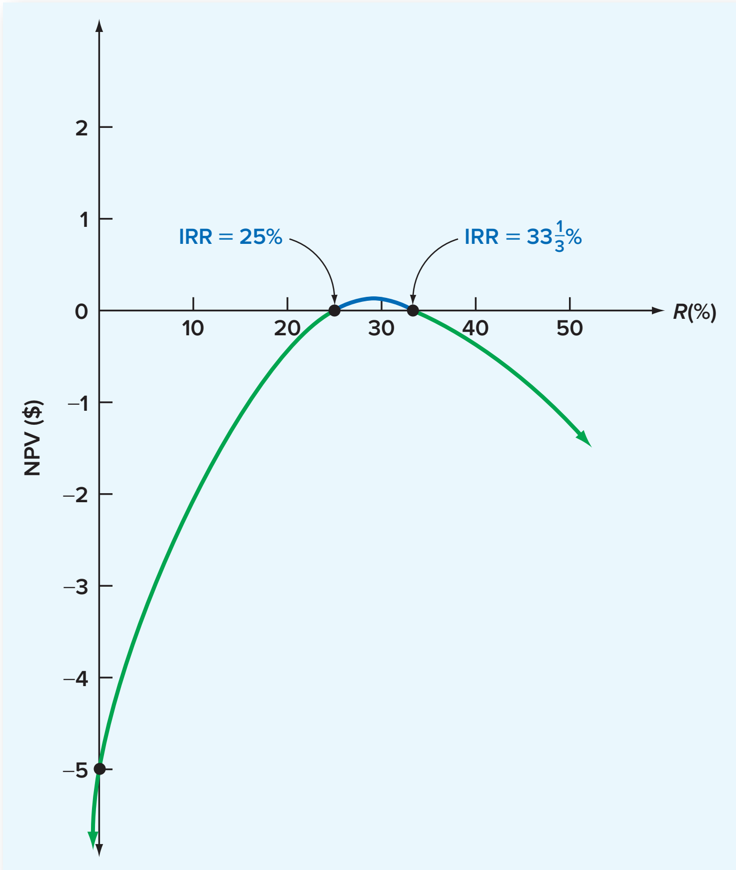


FIGURE 9.6
Project Cash Flows

FIGURE 9.7

NPV Profile



multiple rates of return
The possibility that more than one discount rate will make the NPV of an investment zero.

This is the **multiple rates of return** problem. Many financial computer packages (including a best seller for personal computers) aren't aware of this problem and just report the first IRR that is found. Others report only the smallest positive IRR, even though this answer is no better than any other.

In our current example, the IRR rule breaks down completely. Suppose our required return is 10 percent. Should we take this investment? Both IRRs are greater than 10 percent, so, by the IRR rule, maybe we should. As Figure 9.7 shows, the NPV is negative at any discount rate less than 25 percent, so this is not a good investment. When should we take it? Looking at Figure 9.7 one last time, we see that the NPV is positive only if our required return is between 25 percent and $33\frac{1}{3}$ percent.

Nonconventional cash flows can occur in a variety of ways. For example, Northeast Utilities, owner of the Connecticut-located Millstone nuclear power plant, had to shut down the plant's three reactors in November 1995. The reactors were expected to be back online in January 1997. By some estimates, the cost of the shutdown would run about $334 million. In fact, all nuclear plants eventually have to be shut down forever, and the costs associated with decommissioning a plant are enormous, creating large negative cash flows at the end of the project's life. The four companies in Germany that operate nuclear power plants have set aside $45 billion to decommission nuclear plants in that country.

The moral of the story is that when the cash flows aren't conventional, strange things can start to happen to the IRR. This is not anything to get upset about because the NPV rule, as always, works just fine. This illustrates the fact that, oddly enough, the obvious question—What's the rate of return?—may not always have a good answer.

What's the IRR? — EXAMPLE 9.5

You are looking at an investment that requires you to invest \$51 today. You'll get \$100 in one year, but you must pay out \$50 in two years. What is the IRR on this investment?

You're on the alert now for the nonconventional cash flow problem, so you probably wouldn't be surprised to see more than one IRR. If you start looking for an IRR by trial and error, it will take you a long time. The reason is that there is no IRR. The NPV is negative at every discount rate, so we shouldn't take this investment under any circumstances. What's the return on this investment? Your guess is as good as ours.

"I Think; Therefore, I Know How Many IRRs There Can Be." — EXAMPLE 9.6

We've seen that it's possible to get more than one IRR. If you wanted to make sure that you had found all of the possible IRRs, how could you do it? The answer comes from the great mathematician, philosopher, and financial analyst Descartes (of "I think; therefore, I am" fame). Descartes' Rule of Sign says that the maximum number of IRRs that there can be is equal to the number of times that the cash flows change sign from positive to negative and/or negative to positive.[7]

In our example with the 25 percent and $33\frac{1}{3}$ percent IRRs, could there be yet another IRR? The cash flows flip from negative to positive, then back to negative, for a total of two sign changes. Therefore, according to Descartes' rule, the maximum number of IRRs is two, and we don't need to look for any more. Note that the actual number of IRRs can be less than the maximum (see Example 9.5).

Mutually Exclusive Investments Even if there is a single IRR, another problem can arise concerning **mutually exclusive investment decisions**. If two investments, X and Y, are mutually exclusive, then taking one of them means that we cannot take the other. Two projects that are not mutually exclusive are said to be independent. For example, if we own one corner lot, then we can build a gas station or an apartment building, but not both. These are mutually exclusive alternatives.

mutually exclusive investment decisions
A situation in which taking one investment prevents the taking of another.

Thus far, we have asked whether a given investment is worth undertaking. A related question comes up often: Given two or more mutually exclusive investments, which one is the best? The answer is simple enough: The best one is the one with the largest NPV. Can we also say that the best one has the highest return? As we show, the answer is no.

To illustrate the problem with the IRR rule and mutually exclusive investments, consider the following cash flows from two mutually exclusive investments:

Year	Investment A	Investment B
0	−\$100	−\$100
1	50	20
2	40	40
3	40	50
4	30	60

[7] To be more precise, the number of IRRs that are bigger than −100 percent is equal to the number of sign changes, or it differs from the number of sign changes by an even number. Thus, for example, if there are five sign changes, there are five IRRs, three IRRs, or one IRR. If there are two sign changes, there are either two IRRs or no IRRs.

The IRR for A is 24 percent, and the IRR for B is 21 percent. Because these investments are mutually exclusive, we can take only one of them. Simple intuition suggests that Investment A is better because of its higher return. Unfortunately, simple intuition is not always correct.

To see why Investment A is not necessarily the better of the two investments, we've calculated the NPV of these investments for different required returns:

Discount Rate	NPV(A)	NPV(B)
0%	$60.00	$70.00
5	43.13	47.88
10	29.06	29.79
15	17.18	14.82
20	7.06	2.31
25	− 1.63	− 8.22

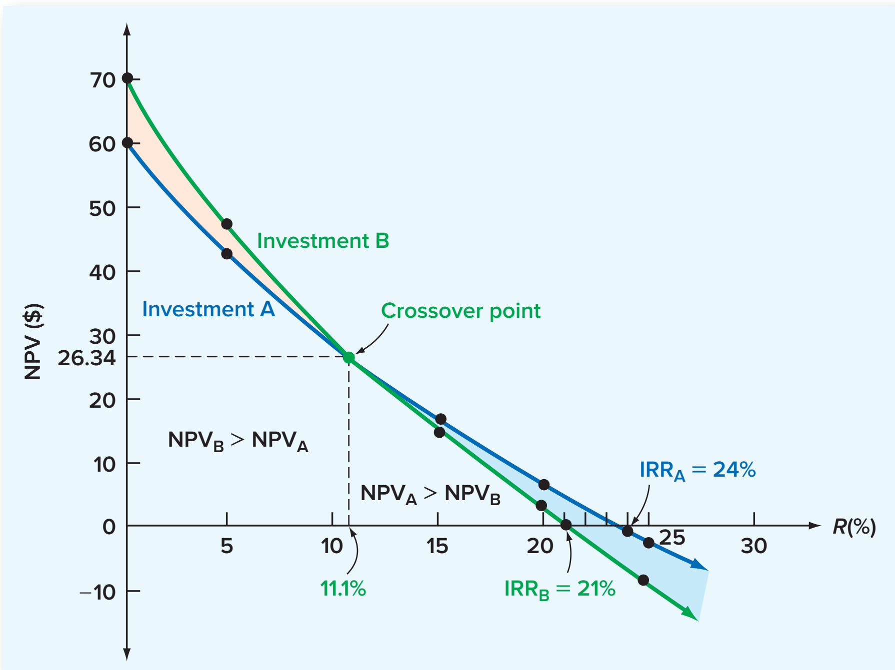
The IRR for A (24 percent) is larger than the IRR for B (21 percent). However, if you compare the NPVs, you'll see that which investment has the higher NPV depends on our required return. B has greater total cash flow, but it pays back more slowly than A. As a result, it has a higher NPV at lower discount rates.

In our example, the NPV and IRR rankings conflict for some discount rates. If our required return is 10 percent, for instance, then B has the higher NPV and is the better of the two even though A has the higher return. If our required return is 15 percent, then there is no ranking conflict: A is better.

The conflict between the IRR and NPV for mutually exclusive investments can be illustrated by plotting the investments' NPV profiles as we have done in Figure 9.8. In Figure 9.8, notice that the NPV profiles cross at about 11.1 percent. Notice also that at any discount rate less than 11.1 percent, the NPV for B is higher. In this range, taking B benefits us more than taking A, even though A's IRR is higher. At any rate greater than 11.1 percent, Investment A has the greater NPV.

FIGURE 9.8

NPV Profiles for Mutually Exclusive Investments



This example illustrates that when we have mutually exclusive projects, we shouldn't rank them based on their returns. More generally, anytime we are comparing investments to determine which is best, looking at IRRs can be misleading. Instead, we need to look at the relative NPVs to avoid the possibility of choosing incorrectly. Remember, we're ultimately interested in creating value for the shareholders, so the option with the higher NPV is preferred, regardless of the relative returns.

If this seems counterintuitive, think of it this way. Suppose you have two investments. One has a 10 percent return and makes you $100 richer immediately. The other has a 20 percent return and makes you $50 richer immediately. Which one do you like better? We would rather have $100 than $50, regardless of the returns, so we like the first one better.

Calculating the Crossover Rate — EXAMPLE 9.7

In Figure 9.8, the NPV profiles cross at about 11 percent. How can we determine just what this crossover point is? The *crossover rate*, by definition, is the discount rate that makes the NPVs of two projects equal. To illustrate, suppose we have the following two mutually exclusive investments:

Year	Investment A	Investment B
0	−$400	−$500
1	250	320
2	280	340

What's the crossover rate?

To find the crossover, first consider moving out of Investment A and into Investment B. If you make the move, you'll have to invest an extra $100 (= $500 − 400). For this $100 investment, you'll get an extra $70 (= $320 − 250) in the first year and an extra $60 (= $340 − 280) in the second year. Is this a good move? In other words, is it worth investing the extra $100?

Based on our discussion, the NPV of the switch, NPV(B − A), is:

$$\text{NPV(B} - \text{A)} = -\$100 + [70/(1 + R)] + [60/(1 + R)^2]$$

We can calculate the return on this investment by setting the NPV equal to zero and solving for the IRR:

$$\text{NPV(B} - \text{A)} = 0 = -\$100 + [70/(1 + IRR)] + [60/(1 + IRR)^2]$$

If you go through this calculation, you will find the IRR is exactly 20 percent. What this tells us is that at a 20 percent discount rate, we are indifferent between the two investments because the NPV of the difference in their cash flows is zero. As a consequence, the two investments have the same value, so this 20 percent is the crossover rate. Check to see that the NPV at 20 percent is $2.78 for both investments.

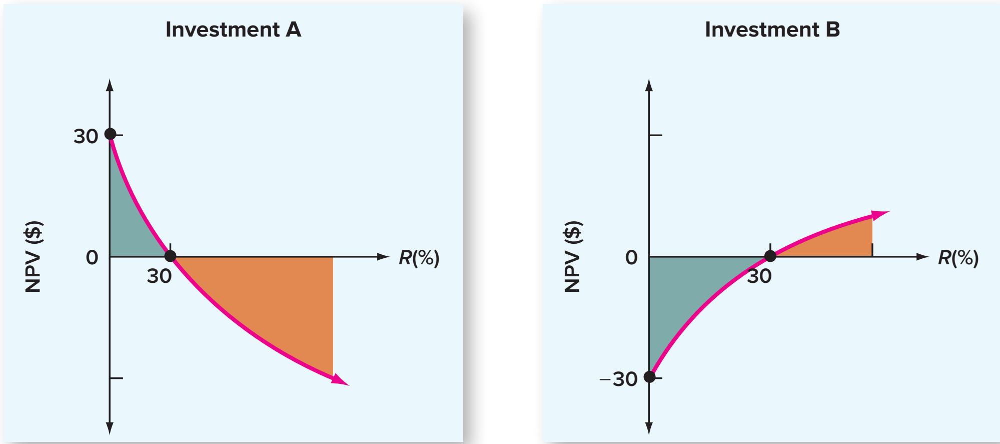
In general, you can find the crossover rate by taking the difference in the cash flows and calculating the IRR using the difference. It doesn't make any difference which one you subtract from which. To see this, find the IRR for (A − B); you'll see it's the same number. Also, for practice, you might want to find the exact crossover in Figure 9.8. (*Hint:* It's 11.0704 percent.)

Investing or Financing?

Consider the following two independent investments:

Year	Investment A	Investment B
0	−$100	$100
1	130	− 130

FIGURE 9.9 NPV Profile for Investing and Financing Investments



The company initially pays out cash with Investment A and initially receives cash for Investment B. While most projects are more like Investment A, projects like Investment B also occur. For example, consider a corporation conducting a seminar where the participants pay in advance. Because large expenses are frequently incurred at the seminar date, cash inflows precede cash outflows.

For these two projects, suppose the required return for each investment project is 12 percent. According to the IRR decision rule, which, if either, project should we accept? If you calculate the IRRs, you will find that they are 30 percent for both projects.

According to the IRR decision rule, we should accept both projects. However, if we calculate the NPV of B at 12 percent, we get:

$$\$100 - \frac{\$130}{1.12} = -\$16.07$$

In this case, the NPV and IRR decision rules disagree. To see what's going on, Figure 9.9 shows the NPV profile for each project. As you can see, the NPV profile for B is upward sloping. The project should be accepted if the required return is *greater* than 30 percent.

When a project has cash flows like Investment B's, the IRR is really a rate that you are paying, not receiving. For this reason, we say that the project has *financing type* cash flows, whereas Investment A has *investing type* cash flows. You should take a project with financing-type cash flows only if it is an inexpensive source of financing, meaning that its IRR is *lower* than your required return.

REDEEMING QUALITIES OF THE IRR

Despite its flaws, the IRR is very popular in practice—more so than even the NPV. It probably survives because it fills a need that the NPV does not. In analyzing investments, people in general, and financial analysts in particular, seem to prefer talking about rates of return rather than dollar values.

In a similar vein, the IRR also appears to provide a simple way of communicating information about a proposal. One manager might say to another, "Remodeling the clerical wing has a 20 percent return." This may somehow seem simpler than saying, "At a 10 percent discount rate, the net present value is $4,000."

Finally, under certain circumstances, the IRR may have a practical advantage over the NPV. We can't estimate the NPV unless we know the appropriate discount rate, but we can still estimate the IRR. Suppose we didn't know the required return on an investment, but we found, for example, that it had a 40 percent return. We would probably be inclined to take it because it would be unlikely that the required return would be that high. The advantages and disadvantages of the IRR are summarized as follows:

Advantages and Disadvantages of the Internal Rate of Return	
Advantages	**Disadvantages**
1. Closely related to NPV, often leading to identical decisions.	1. May result in multiple answers or not deal with nonconventional cash flows.
2. Easy to understand and communicate.	2. May lead to incorrect decisions in comparisons of mutually exclusive investments.

THE MODIFIED INTERNAL RATE OF RETURN (MIRR)

To address some of the problems that can crop up with the standard IRR, it is often proposed that a modified version be used. As we will see, there are several different ways of calculating a modified IRR, or MIRR, but the basic idea is to modify the cash flows first and then calculate an IRR using the modified cash flows.

To illustrate, let's go back to the cash flows in Figure 9.6: −\$60, +\$155, and −\$100. As we saw, there are two IRRs, 25 percent and $33\frac{1}{3}$ percent. We next illustrate three different MIRRs, all of which have the property that only one answer will result, thereby eliminating the multiple IRR problem.

Method #1: The Discounting Approach With the discounting approach, the idea is to discount all negative cash flows back to the present at the required return and add them to the initial cost. Then, calculate the IRR. Because only the first modified cash flow is negative, there will be only one IRR. The discount rate used might be the required return, or it might be some other externally supplied rate. We will use the project's required return.

If the required return on the project is 20 percent, then the modified cash flows look like this:

$$\text{Time 0:} \quad -\$60 + \frac{-\$100}{1.20^2} = -\$129.44$$

$$\text{Time 1:} \quad +\$155$$

$$\text{Time 2:} \quad +\$0$$

If you calculate the MIRR now, you should get 19.74 percent.

Method #2: The Reinvestment Approach With the reinvestment approach, we compound *all* cash flows (positive and negative) except the first out to the end of the project's life and then calculate the IRR. In a sense, we are "reinvesting" the cash flows and not taking them out of the project until the very end. The rate we use could be the required return on the project, or it could be a separately specified "reinvestment rate." We will use the project's required return. When we do, here are the modified cash flows:

$$\text{Time 0:} \quad -\$60$$

$$\text{Time 1:} \quad +0$$

$$\text{Time 2:} \quad -\$100 + (\$155 \times 1.2) = \$86$$

The MIRR on this set of cash flows is 19.72 percent, or a little lower than we got using the discounting approach.

Method #3: The Combination Approach As the name suggests, the combination approach blends our first two methods. Negative cash flows are discounted back to the present, and positive cash flows are compounded to the end of the project. In practice, different discount or compounding rates might be used, but we will again stick with the project's required return.

With the combination approach, the modified cash flows are as follows:

$$\text{Time 0:} \quad -\$60 + \frac{-\$100}{1.20^2} = -\$129.44$$

$$\text{Time 1:} \quad +0$$

$$\text{Time 2:} \quad \$155 \times 1.2 = \$186$$

See if you don't agree that the MIRR is 19.87 percent, the highest of the three.

MIRR or IRR: Which Is Better? MIRRs are controversial. At one extreme are those who claim that MIRRs are superior to IRRs, period. For example, by design, they clearly don't suffer from the multiple rate of return problem.

At the other end, detractors say that MIRR should stand for "meaningless internal rate of return." As our example makes clear, one problem with MIRRs is that there are different ways of calculating them, and there is no clear reason to say one of our three methods is better than any other. The differences are small with our simple cash flows, but they could be much larger for a more complex project. Further, it's not clear how to interpret an MIRR. It may look like a rate of return, but it's a rate of return on a modified set of cash flows, not the project's actual cash flows.

We're not going to take sides. However, notice that calculating an MIRR requires discounting, compounding, or both, which leads to two obvious observations. First, if we have the relevant discount rate, why not calculate the NPV and be done with it? Second, because an MIRR depends on an externally supplied discount (or compounding) rate, the answer you get is not truly an "internal" rate of return, which, by definition, depends on only the project's cash flows.

We *will* take a stand on one issue that frequently comes up in this context. The value of a project does not depend on what the firm does with the cash flows generated by that project. A firm might use a project's cash flows to fund other projects, to pay dividends, or to buy an executive jet. It doesn't matter: How the cash flows are spent in the future does not affect their value today. As a result, there is generally no need to consider reinvestment of interim cash flows.

Concept Questions

9.5a Under what circumstances will the IRR and NPV rules lead to the same accept-reject decisions? When might they conflict?

9.5b Is it generally true that an advantage of the IRR rule over the NPV rule is that we don't need to know the required return to use the IRR rule?

9.6 The Profitability Index

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Another tool used to evaluate projects is called the **profitability index (PI)** or benefit-cost ratio. This index is defined as the present value of the future cash flows divided by the initial investment. So, if a project costs \$200 and the present value of its future cash flows is \$220, the profitability index value would be \$220/\$200 = 1.1. Notice that the NPV for this investment is \$20, so it is a desirable investment.

More generally, if a project has a positive NPV, then the present value of the future cash flows must be bigger than the initial investment. The profitability index will be bigger than 1 for a positive NPV investment and less than 1 for a negative NPV investment.

profitability index (PI)
The present value of an investment's future cash flows divided by its initial cost. Also called the benefit-cost ratio.

How do we interpret the profitability index? In our example, the PI was 1.1. This tells us that, per dollar invested, $1.10 in value or $.10 in NPV results. The profitability index measures "bang for the buck"—that is, the value created per dollar invested. For this reason, it is often proposed as a measure of performance for government or other not-for-profit investments. Also, when capital is scarce, it may make sense to allocate it to projects with the highest PIs. We will return to this issue in a later chapter.

The PI is obviously similar to the NPV. However, consider an investment that costs $5 and has a $10 present value and an investment that costs $100 with a $150 present value. The first of these investments has an NPV of $5 and a PI of 2. The second has an NPV of $50 and a PI of 1.5. If these are mutually exclusive investments, then the second one is preferred even though it has a lower PI. This ranking problem is similar to the IRR ranking problem we saw in the previous section. In all, there seems to be little reason to rely on the PI instead of the NPV. Our discussion of the PI is summarized as follows:

Advantages and Disadvantages of the Profitability Index

Advantages	Disadvantages
1. Closely related to NPV, generally leading to identical decisions. 2. Easy to understand and communicate. 3. May be useful when available investment funds are limited.	1. May lead to incorrect decisions in comparisons of mutually exclusive investments.

Concept Questions

9.6a What does the profitability index measure?

9.6b How would you state the profitability index rule?

The Practice of Capital Budgeting 9.7

Given that NPV seems to be telling us directly what we want to know, you might be wondering why there are so many other procedures and why alternative procedures are commonly used. Recall that we are trying to make an investment decision and that we are frequently operating under considerable uncertainty about the future. We can only *estimate* the NPV of an investment in this case. The resulting estimate can be very "soft," meaning that the true NPV might be quite different.

Because the true NPV is unknown, the astute financial manager seeks clues to help in assessing whether the estimated NPV is reliable. For this reason, firms would typically use multiple criteria for evaluating a proposal. For example, suppose we have an investment with a positive estimated NPV. Based on our experience with other projects, this one appears to have a short payback and a very high AAR. In this case, the different indicators seem to agree that it's "all systems go." Put another way, the payback and the AAR are consistent with the conclusion that the NPV is positive.

On the other hand, suppose we had a positive estimated NPV, a long payback, and a low AAR. This could still be a good investment, but it looks like we need to be much more careful in making the decision because we are getting conflicting signals. If the estimated

NPV is based on projections in which we have little confidence, then further analysis is probably in order. We will consider how to evaluate NPV estimates in more detail in the next two chapters.

Large firms often have huge capital budgets. For example, for 2017, ExxonMobil announced that it expected to have about $22 billion in capital outlays during the year, down from its record $42.5 billion in 2013. About the same time, competitor Chevron announced that it would decrease its capital budgeting for 2017 to $19.8 billion, down from $26.6 billion in 2016. Other companies with large capital spending budgets included Walmart, which projected capital spending of about $11 billion for 2017, and Apple, which projected capital spending of about $16 billion for 2017.

According to information released by the Census Bureau in 2017, capital investment for the economy as a whole was $1.401 trillion in 2013, $1.507 trillion in 2014, and $1.545 trillion in 2015. The total for the three years therefore exceeded $4.4 trillion! Given the sums at stake, it is not too surprising that careful analysis of capital expenditures is something at which successful businesses seek to become adept.

There have been a number of surveys conducted asking firms what types of investment criteria they actually use. Table 9.6 summarizes the results of several of these. Panel A of the table is a historical comparison looking at the primary capital budgeting techniques used by large firms through time. In 1959, only 19 percent of the firms surveyed used either IRR or NPV, and 68 percent used either payback periods or accounting returns. It is clear that by the 1980s, IRR and NPV had become the dominant criteria.

Panel B of Table 9.6 summarizes the results of a 1999 survey of chief financial officers (CFOs) at both large and small firms in the United States. A total of 392 CFOs responded. What is shown is the percentage of CFOs who always or almost always used

TABLE 9.6 Capital Budgeting Techniques in Practice

A. Historical Comparison of the Primary Use of Various Capital Budgeting Techniques

	1959	1964	1970	1975	1977	1979	1981
Payback period	34%	24%	12%	15%	9%	10%	5%
Average accounting return (AAR)	34	30	26	10	25	14	11
Internal rate of return (IRR)	19	38	57	37	54	60	65
Net present value (NPV)	—	—	—	26	10	14	17
IRR or NPV	19	38	57	63	64	74	82

B. Percentage of CFOs Who Always or Almost Always Used a Given Technique in 1999

Capital Budgeting Technique	Percentage Always or Almost Always Using	Average Score [Scale is 4 (always) to 0 (never)]		
		Overall	Large Firms	Small Firms
Internal rate of return	76%	3.09	3.41	2.87
Net present value	75	3.08	3.42	2.83
Payback period	57	2.53	2.25	2.72
Discounted payback period	29	1.56	1.55	1.58
Accounting rate of return	20	1.34	1.25	1.41
Profitability index	12	.83	.75	.88

SOURCES: Graham, J. R., and Harvey, C. R., "The Theory and Practice of Corporate Finance: Evidence from the Field," Journal of Financial Economics, May–June 2001, 187–243; Moore, J. S, and Reichert, A. K., "An Analysis of the Financial Management Techniques Currently Employed by Large U.S. Corporations," Journal of Business Finance and Accounting, Winter 1983, 623–45; and Stanley, M. T., and Block, S. R., "A Survey of Multinational Capital Budgeting," The Financial Review, March 1984, 36–51.

the various capital budgeting techniques we describe in this chapter. Not surprisingly, IRR and NPV were the two most widely used techniques, particularly at larger firms. However, over half of the respondents always, or almost always, used the payback criterion as well. In fact, among smaller firms, payback was used just about as much as NPV and IRR. Less commonly used were discounted payback, accounting rates of return, and the profitability index. For future reference, the various criteria we have discussed are summarized in Table 9.7.

TABLE 9.7

Summary of Investment Criteria

I. Discounted Cash Flow Criteria

A. *Net present value (NPV)*: The NPV of an investment is the difference between its market value and its cost. The NPV rule is to take a project if its NPV is positive. NPV is frequently estimated by calculating the present value of the future cash flows (to estimate market value) and then subtracting the cost. NPV has no serious flaws; it is the preferred decision criterion.

B. *Internal rate of return (IRR)*: The IRR is the discount rate that makes the estimated NPV of an investment equal to zero; it is sometimes called the *discounted cash flow (DCF) return*. The IRR rule is to take a project when its IRR exceeds the required return. IRR is closely related to NPV, and it leads to exactly the same decisions as NPV for conventional, independent projects. When project cash flows are not conventional, there may be no IRR or there may be more than one. More seriously, the IRR cannot be used to rank mutually exclusive projects; the project with the highest IRR is not necessarily the preferred investment.

C. *Modified internal rate of return (MIRR)*: The MIRR is a modification to the IRR. A project's cash flows are modified by (1) discounting the negative cash flows back to the present; (2) compounding cash flows to the end of the project's life; or (3) combining (1) and (2). An IRR is then computed on the modified cash flows. MIRRs are guaranteed to avoid the multiple rate of return problem, but it is unclear how to interpret them; and they are not truly "internal" because they depend on externally supplied discounting or compounding rates.

D. *Profitability index (PI)*: The PI, also called the *benefit-cost ratio*, is the ratio of present value to cost. The PI rule is to take an investment if the index exceeds 1. The PI measures the present value of an investment per dollar invested. It is quite similar to NPV; but, like IRR, it cannot be used to rank mutually exclusive projects. However, it is sometimes used to rank projects when a firm has more positive NPV investments than it can currently finance.

II. Payback Criteria

A. *Payback period*: The payback period is the length of time until the sum of an investment's cash flows equals its cost. The payback period rule is to take a project if its payback is less than some cutoff. The payback period is a flawed criterion, primarily because it ignores risk, the time value of money, and cash flows beyond the cutoff point.

B. *Discounted payback period*: The discounted payback period is the length of time until the sum of an investment's discounted cash flows equals its cost. The discounted payback period rule is to take an investment if the discounted payback is less than some cutoff. The discounted payback rule is flawed, primarily because it ignores cash flows after the cutoff.

III. Accounting Criterion

A. *Average accounting return (AAR)*: The AAR is a measure of accounting profit relative to book value. It is not related to the IRR, but it is similar to the accounting return on assets (ROA) measure in Chapter 3. The AAR rule is to take an investment if its AAR exceeds a benchmark AAR. The AAR is seriously flawed for a variety of reasons, and it has little to recommend it.

Concept Questions

9.7a What are the most commonly used capital budgeting procedures?

9.7b If NPV is conceptually the best procedure for capital budgeting, why do you think multiple measures are used in practice?

9.8 Summary and Conclusions

This chapter has covered the different criteria used to evaluate proposed investments. The seven criteria, in the order we discussed them, are these:

1. Net present value (NPV).
2. Payback period.
3. Discounted payback period.
4. Average accounting return (AAR).
5. Internal rate of return (IRR).
6. Modified internal rate of return (MIRR).
7. Profitability index (PI).

We illustrated how to calculate each of these and discussed the interpretation of the results. We also described the advantages and disadvantages of each of them. Ultimately a good capital budgeting criterion must tell us two things. First, is a particular project a good investment? Second, if we have more than one good project, but we can take only one of them, which one should we take? The main point of this chapter is that only the NPV criterion can always provide the correct answer to both questions.

For this reason, NPV is one of the two or three most important concepts in finance, and we will refer to it many times in the chapters ahead. When we do, keep two things in mind: (1) NPV is always the difference between the market value of an asset or project and its cost and (2) the financial manager acts in the shareholders' best interests by identifying and taking positive NPV projects.

Finally, we noted that NPVs can't normally be observed in the market; instead, they must be estimated. Because there is always the possibility of a poor estimate, financial managers use multiple criteria for examining projects. The other criteria provide additional information about whether a project truly has a positive NPV.

CONNECT TO FINANCE

If you are using *Connect Finance* in your course, get online to take a Practice Test, check out study tools, and find out where you need additional practice.

Can you answer the following *Connect* Quiz questions?

Section 9.1 The net present value rule states that you should accept a project if its net present value ______.

Section 9.2 A drawback of the payback method of project analysis is ______.

Section 9.3 The discounted payback period for a project will be ______ the payback period for the project given a positive, nonzero discount rate.

Section 9.4 What is an advantage of the average accounting return method of project analysis?

Section 9.6 What is a benefit-cost ratio?

Section 9.7 What method of analysis tends to be least utilized by CFOs, according to the survey conducted in 1999 as presented in your textbook?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

9.1 **Investment Criteria** This problem will give you some practice calculating NPVs and paybacks. A proposed overseas expansion has the following cash flows:

Year	Cash Flow
0	−$200
1	50
2	60
3	70
4	200

Calculate the payback, the discounted payback, and the NPV at a required return of 10 percent.

9.2 **Mutually Exclusive Investments** Consider the following two mutually exclusive investments. Calculate the IRR for each and the crossover rate. Under what circumstances will the IRR and NPV criteria rank the two projects differently?

Year	Investment A	Investment B
0	−$75	−$75
1	20	60
2	40	50
3	70	15

9.3 **Average Accounting Return** You are looking at a three-year project with a projected net income of $2,000 in Year 1, $4,000 in Year 2, and $6,000 in Year 3. The cost is $12,000, which will be depreciated straight-line to zero over the three-year life of the project. What is the average accounting return (AAR)?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

9.1 In the following table, we have listed the cash flow, cumulative cash flow, discounted cash flow (at 10 percent), and cumulative discounted cash flow for the proposed project.

	Cash Flow		Accumulated Cash Flow	
Year	Undiscounted	Discounted	Undiscounted	Discounted
1	$ 50	$ 45.45	$ 50	$ 45.45
2	60	49.59	110	95.04
3	70	52.59	180	147.63
4	200	136.60	380	284.24

Recall that the initial investment was $200. When we compare this to accumulated undiscounted cash flows, we see that payback occurs between Years 3 and 4. The cash flows for the first three years are $180 total, so, going into the fourth year, we are short by $20. The total cash flow in Year 4 is $200, so the payback is 3 + ($20/200) = 3.10 years.

Looking at the accumulated discounted cash flows, we see that the discounted payback occurs between Years 3 and 4. The sum of the discounted cash flows is $284.24, so the NPV is $84.24. Notice that this is the present value of the cash flows that occur after the discounted payback.

9.2 To calculate the IRR, we might try some guesses, as in the following table:

Discount Rate	NPV(A)	NPV(B)
0%	$55.00	$50.00
10	28.83	32.14
20	9.95	18.40
30	− 4.09	7.57
40	− 14.80	− 1.17

Several things are immediately apparent from our guesses. First, the IRR for A must be between 20 percent and 30 percent (why?). With some more effort, we find that it's 26.79 percent. For B, the IRR must be a little less than 40 percent (again, why?); it works out to be 38.54 percent. Also, notice that at rates between 0 percent and 10 percent, the NPVs are very close, indicating that the crossover is in that vicinity.

To find the crossover exactly, we can compute the IRR on the difference in the cash flows. If we take the cash flows from A minus the cash flows from B, the resulting cash flows are:

Year	A − B
0	$ 0
1	− 40
2	− 10
3	55

These cash flows look a little odd; but the sign changes only once, so we can find an IRR. With some trial and error, you'll see that the NPV is zero at a discount rate of 5.42 percent, so this is the crossover rate.

The IRR for B is higher. However, as we've seen, A has the larger NPV for any discount rate less than 5.42 percent, so the NPV and IRR rankings will conflict in that range. Remember, if there's a conflict, we will go with the higher NPV. Our decision rule is thus simple: Take A if the required return is less than 5.42 percent, take B if the required return is between 5.42 percent and 38.54 percent (the IRR on B), and take neither if the required return is more than 38.54 percent.

9.3 Here we need to calculate the ratio of average net income to average book value to get the AAR. Average net income is:

Average net income = ($2,000 + 4,000 + 6,000)/3 = $4,000

Average book value is:

Average book value = $12,000/2 = $6,000

So the average accounting return is:

AAR = $4,000/6,000 = .6667, or 66.67%

This is an impressive return. Remember, however, that it isn't really a rate of return like an interest rate or an IRR, so the size doesn't tell us a lot. In particular, our money is probably not going to grow at a rate of 66.67 percent per year, sorry to say.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Payback Period and Net Present Value** [LO1, 2] If a project with conventional cash flows has a payback period less than the project's life, can you definitively state the algebraic sign of the NPV? Why or why not? If you know that the discounted payback period is less than the project's life, what can you say about the NPV? Explain.
2. **Net Present Value** [LO1] Suppose a project has conventional cash flows and a positive NPV. What do you know about its payback? Its discounted payback? Its profitability index? Its IRR? Explain.
3. **Payback Period** [LO2] Concerning payback:
   a. Describe how the payback period is calculated, and describe the information this measure provides about a sequence of cash flows. What is the payback criterion decision rule?
   b. What are the problems associated with using the payback period to evaluate cash flows?
   c. What are the advantages of using the payback period to evaluate cash flows? Are there any circumstances under which using payback might be appropriate? Explain.
4. **Discounted Payback** [LO3] Concerning discounted payback:
   a. Describe how the discounted payback period is calculated, and describe the information this measure provides about a sequence of cash flows. What is the discounted payback criterion decision rule?
   b. What are the problems associated with using the discounted payback period to evaluate cash flows?
   c. What conceptual advantage does the discounted payback method have over the regular payback method? Can the discounted payback ever be longer than the regular payback? Explain.
5. **Average Accounting Return** [LO4] Concerning AAR:
   a. Describe how the average accounting return is usually calculated, and describe the information this measure provides about a sequence of cash flows. What is the AAR criterion decision rule?
   b. What are the problems associated with using the AAR to evaluate a project's cash flows? What underlying feature of AAR is most troubling to you from a financial perspective? Does the AAR have any redeeming qualities?

6. **Net Present Value [LO1]** Concerning NPV:
   a. Describe how NPV is calculated, and describe the information this measure provides about a sequence of cash flows. What is the NPV criterion decision rule?
   b. Why is NPV considered a superior method of evaluating the cash flows from a project? Suppose the NPV for a project's cash flows is computed to be $2,500. What does this number represent with respect to the firm's shareholders?
7. **Internal Rate of Return [LO5]** Concerning IRR:
   a. Describe how the IRR is calculated, and describe the information this measure provides about a sequence of cash flows. What is the IRR criterion decision rule?
   b. What is the relationship between IRR and NPV? Are there any situations in which you might prefer one method over the other? Explain.
   c. Despite its shortcomings in some situations, why do most financial managers use IRR along with NPV when evaluating projects? Can you think of a situation in which IRR might be a more appropriate measure to use than NPV? Explain.
8. **Profitability Index [LO7]** Concerning the profitability index:
   a. Describe how the profitability index is calculated, and describe the information this measure provides about a sequence of cash flows. What is the profitability index decision rule?
   b. What is the relationship between the profitability index and NPV? Are there any situations in which you might prefer one method over the other? Explain.
9. **Payback and Internal Rate of Return [LO2, 5]** A project has perpetual cash flows of C per period, a cost of I, and a required return of R. What is the relationship between the project's payback and its IRR? What implications does your answer have for long-lived projects with relatively constant cash flows?
10. **International Investment Projects [LO1]** In 2016, automobile manufacturer BMW completed its $1 billion investment to increase production at its South Carolina plant by 50 percent. BMW apparently felt that it would be better able to compete and create value with U.S-based facilities. Other companies such as Fuji Film and Swiss chemical company Lonza have reached similar conclusions and taken similar actions. What are some of the reasons that foreign manufacturers of products as diverse as automobiles, film, and chemicals might arrive at this same conclusion?
11. **Capital Budgeting Problems [LO1]** What difficulties might come up in actual applications of the various criteria we discussed in this chapter? Which one would be the easiest to implement in actual applications? The most difficult?
12. **Capital Budgeting in Not-for-Profit Entities [LO1]** Are the capital budgeting criteria we discussed applicable to not-for-profit corporations? How should such entities make capital budgeting decisions? What about the U.S. government? Should it evaluate spending proposals using these techniques?
13. **Modified Internal Rate of Return [LO6]** One of the less flattering interpretations of the acronym MIRR is "meaningless internal rate of return." Why do you think this term is applied to MIRR?
14. **Net Present Value [LO1]** It is sometimes stated that "the net present value approach assumes reinvestment of the intermediate cash flows at the required return." Is this claim correct? To answer, suppose you calculate the NPV of a project in the usual way. Next, suppose you do the following:
   a. Calculate the future value (as of the end of the project) of all the cash flows other than the initial outlay assuming they are reinvested at the required return, producing a single future value figure for the project.

b. Calculate the NPV of the project using the single future value calculated in the previous step and the initial outlay. It is easy to verify that you will get the same NPV as in your original calculation only if you use the required return as the reinvestment rate in the previous step.

15. **Internal Rate of Return [LO5]** It is sometimes stated that "the internal rate of return approach assumes reinvestment of the intermediate cash flows at the internal rate of return." Is this claim correct? To answer, suppose you calculate the IRR of a project in the usual way. Next, suppose you do the following:

a. Calculate the future value (as of the end of the project) of all the cash flows other than the initial outlay assuming they are reinvested at the IRR, producing a single future value figure for the project.

b. Calculate the IRR of the project using the single future value calculated in the previous step and the initial outlay. It is easy to verify that you will get the same IRR as in your original calculation only if you use the IRR as the reinvestment rate in the previous step.

QUESTIONS AND PROBLEMS

connect

BASIC

(Questions 1–19)

1. **Calculating Payback [LO2]** What is the payback period for the following set of cash flows?

Year	Cash Flow
0	−$8,300
1	2,100
2	3,000
3	2,300
4	1,700

2. **Calculating Payback [LO2]** An investment project provides cash inflows of $745 per year for eight years. What is the project payback period if the initial cost is $1,700? What if the initial cost is $3,300? What if it is $6,100?

3. **Calculating Payback [LO2]** Bronco, Inc., imposes a payback cutoff of three years for its international investment projects. If the company has the following two projects available, should it accept either of them?

Year	Cash Flow (A)	Cash Flow (B)
0	−$35,000	−$ 45,000
1	12,000	11,000
2	17,000	13,000
3	14,000	16,000
4	9,000	255,000

4. **Calculating Discounted Payback [LO3]** An investment project has annual cash inflows of $2,800, $3,700, $5,100, and $4,300, for the next four years, respectively. The discount rate is 11 percent. What is the discounted payback period for these cash flows if the initial cost is $5,200? What if the initial cost is $6,400? What if it is $10,400?

5. **Calculating Discounted Payback [LO3]** An investment project costs $17,000 and has annual cash flows of $4,700 for six years. What is the discounted payback period if the discount rate is zero percent? What if the discount rate is 5 percent? If it is 19 percent?

6. **Calculating AAR** [LO4] You're trying to determine whether to expand your business by building a new manufacturing plant. The plant has an installation cost of $13.5 million, which will be depreciated straight-line to zero over its four-year life. If the plant has projected net income of $1,570,000, $1,684,200, $1,716,300, and $1,097,400 over these four years, respectively, what is the project's average accounting return (AAR)?

7. **Calculating IRR** [LO5] A firm evaluates all of its projects by applying the IRR rule. If the required return is 14 percent, should the firm accept the following project?

Year	Cash Flow
0	–$34,000
1	15,000
2	17,000
3	13,000

8. **Calculating NPV** [LO1] For the cash flows in the previous problem, suppose the firm uses the NPV decision rule. At a required return of 11 percent, should the firm accept this project? What if the required return is 24 percent?

9. **Calculating NPV and IRR** [LO1, 5] A project that provides annual cash flows of $11,700 for nine years costs $63,000 today. Is this a good project if the required return is 8 percent? What if it's 20 percent? At what discount rate would you be indifferent between accepting the project and rejecting it?

10. **Calculating IRR** [LO5] What is the IRR of the following set of cash flows?

Year	Cash Flow
0	–$15,400
1	7,300
2	9,100
3	5,900

11. **Calculating NPV** [LO1] For the cash flows in the previous problem, what is the NPV at a discount rate of zero percent? What if the discount rate is 10 percent? If it is 20 percent? If it is 30 percent?

12. **NPV versus IRR** [LO1, 5] Bruin, Inc., has identified the following two mutually exclusive projects:

Year	Cash Flow (A)	Cash Flow (B)
0	–$37,500	–$37,500
1	17,300	5,700
2	16,200	12,900
3	13,800	16,300
4	7,600	27,500

a. What is the IRR for each of these projects? Using the IRR decision rule, which project should the company accept? Is this decision necessarily correct?

b. If the required return is 11 percent, what is the NPV for each of these projects? Which project will the company choose if it applies the NPV decision rule?

c. Over what range of discount rates would the company choose Project A? Project B? At what discount rate would the company be indifferent between these two projects? Explain.

13. NPV versus IRR [LO1, 5] Consider the following two mutually exclusive projects:

Year	Cash Flow (X)	Cash Flow (Y)
0	−$23,000	−$23,000
1	10,490	12,000
2	10,900	9,360
3	10,500	10,400

Sketch the NPV profiles for X and Y over a range of discount rates from zero to 25 percent. What is the crossover rate for these two projects?

14. Problems with IRR [LO5] Light Sweet Petroleum, Inc., is trying to evaluate a generation project with the following cash flows:

Year	Cash Flow
0	−$48,000,000
1	71,000,000
2	− 13,000,000

a. If the company requires a return of 12 percent on its investments, should it accept this project? Why?

b. Compute the IRR for this project. How many IRRs are there? Using the IRR decision rule, should the company accept the project? What's going on here?

15. Calculating Profitability Index [LO7] What is the profitability index for the following set of cash flows if the relevant discount rate is 10 percent? What if the discount rate is 15 percent? If it is 22 percent?

Year	Cash Flow
0	−$16,700
1	9,700
2	7,800
3	4,300

16. Problems with Profitability Index [LO1, 7] The Sloan Corporation is trying to choose between the following two mutually exclusive design projects:

Year	Cash Flow (I)	Cash Flow (II)
0	−$63,000	−$15,500
1	28,900	7,900
2	28,900	7,900
3	28,900	7,900

a. If the required return is 10 percent and the company applies the profitability index decision rule, which project should the firm accept?

b. If the company applies the NPV decision rule, which project should it take?

c. Explain why your answers in (a) and (b) are different.

17. Comparing Investment Criteria [LO1, 2, 3, 5, 7] Consider the following two mutually exclusive projects:

Year	Cash Flow (A)	Cash Flow (B)
0	−$364,000	−$52,000
1	46,000	25,000
2	68,000	22,000
3	68,000	21,500
4	458,000	17,500

Whichever project you choose, if any, you require a return of 11 percent on your investment.

a. If you apply the payback criterion, which investment will you choose? Why?

b. If you apply the discounted payback criterion, which investment will you choose? Why?

c. If you apply the NPV criterion, which investment will you choose? Why?

d. If you apply the IRR criterion, which investment will you choose? Why?

e. If you apply the profitability index criterion, which investment will you choose? Why?

f. Based on your answers in (a) through (e), which project will you finally choose? Why?

18. NPV and Discount Rates [LO1] An investment has an installed cost of $527,630. The cash flows over the four-year life of the investment are projected to be $212,200, $243,800, $203,500, and $167,410, respectively. If the discount rate is zero, what is the NPV? If the discount rate is infinite, what is the NPV? At what discount rate is the NPV just equal to zero? Sketch the NPV profile for this investment based on these three points.

19. MIRR [LO6] Solo Corp. is evaluating a project with the following cash flows:

Year	Cash Flow
0	−$47,000
1	16,900
2	20,300
3	25,800
4	19,600
5	− 9,500

The company uses an interest rate of 10 percent on all of its projects. Calculate the MIRR of the project using all three methods.

INTERMEDIATE
(Questions 20–22)

20. MIRR [LO6] Suppose the company in the previous problem uses a discount rate of 11 percent and a reinvestment rate of 8 percent on all of its projects. Calculate the MIRR of the project using all three methods using these interest rates.

21. NPV and the Profitability Index [LO1, 7] If we define the NPV index as the ratio of NPV to cost, what is the relationship between this index and the profitability index?

22. Cash Flow Intuition [LO1, 2] A project has an initial cost of *I*, a required return of *R*, and pays *C* annually for *N* years.

a. Find *C* in terms of *I* and *N* such that the project has a payback period just equal to its life.

b. Find C in terms of I, N, and R such that this is a profitable project according to the NPV decision rule.

c. Find C in terms of I, N, and R such that the project has a benefit-cost ratio of 2.

CHALLENGE (Questions 23–28)

23. Payback and NPV [LO1, 2] An investment under consideration has a payback of seven years and a cost of $685,000. If the required return is 11 percent, what is the worst-case NPV? The best-case NPV? Explain. Assume the cash flows are conventional.

24. Multiple IRRs [LO5] This problem is useful for testing the ability of financial calculators and spreadsheets. Consider the following cash flows. How many different IRRs are there? (*Hint*: Search between 20 percent and 70 percent.) When should we take this project?

Year	Cash Flow
0	–$ 3,024
1	17,172
2	– 36,420
3	34,200
4	– 12,000

25. NPV Valuation [LO1] The Yurdone Corporation wants to set up a private cemetery business. According to the CFO, Barry M. Deep, business is "looking up." As a result, the cemetery project will provide a net cash inflow of $145,000 for the firm during the first year, and the cash flows are projected to grow at a rate of 4 percent per year forever. The project requires an initial investment of $1,900,000.

a. If the company requires an 11 percent return on such undertakings, should the cemetery business be started?

b. The company is somewhat unsure about the assumption of a growth rate of 4 percent in its cash flows. At what constant growth rate would the company just break even if it still required a return of 11 percent on investment?

26. Problems with IRR [LO5] A project has the following cash flows:

Year	Cash Flow
0	$59,000
1	– 34,000
2	– 39,000

What is the IRR for this project? If the required return is 12 percent, should the firm accept the project? What is the NPV of this project? What is the NPV of the project if the required return is 0 percent? 24 percent? What is going on here? Sketch the NPV profile to help you with your answer.

27. Problems with IRR [LO5] McKeekin Corp. has a project with the following cash flows:

Year	Cash Flow
0	$25,000
1	– 11,000
2	7,000

What is the IRR of the project? What is happening here?

28. NPV and IRR [LO1, 5] Anderson International Limited is evaluating a project in Erewhon. The project will create the following cash flows:

Year	Cash Flow
0	−$1,275,000
1	435,000
2	505,000
3	415,000
4	345,000

All cash flows will occur in Erewhon and are expressed in dollars. In an attempt to improve its economy, the Erewhonian government has declared that all cash flows created by a foreign company are "blocked" and must be reinvested with the government for one year. The reinvestment rate for these funds is 4 percent. If Anderson uses a required return of 11 percent on this project, what are the NPV and IRR of the project? Is the IRR you calculated the MIRR of the project? Why or why not?

EXCEL MASTER IT! PROBLEM

xlsx

As you have already seen, Excel does not have a function to calculate the payback period, so you will create your own. Below, the cash flows for a project are shown. You need to calculate the payback period using two different methods.

a. Calculate the payback period in a table. The first three columns of the table will be the year, the cash flow for that year, and the cumulative cash flow. The fourth column will show the whole year for the payback. In other words, if the payback period is three-plus years, this column will have a 3, otherwise it will be a 0. The next column will calculate the fractional part of the payback period, or else it will display 0. The last column will add the previous two columns and display the final payback period calculation. You should also have a cell that displays the final payback period by itself and a cell that returns the correct accept or reject decision based on the payback criteria.

b. Write a nested IF statement that calculates the payback period using only the project cash flow column. The IF statement should return a value of "Never" if the project has no payback period. In contrast to the example we showed previously, the nested IF function should test for the payback period starting with shorter payback periods and working toward longer payback periods. Another cell should display the correct accept or reject decision based on the payback criteria.

t	Cash Flow
0	−$250,000
1	41,000
2	48,000
3	63,000
4	79,000
5	88,000
6	64,000
7	41,000
Required payback:	5

MINICASE

Bullock Gold Mining

Seth Bullock, the owner of Bullock Gold Mining, is evaluating a new gold mine in South Dakota. Dan Dority, the company's geologist, has just finished his analysis of the mine site. He has estimated that the mine would be productive for eight years, after which the gold would be completely mined. Dan has taken an estimate of the gold deposits to Alma Garrett, the company's financial officer. Alma has been asked by Seth to perform an analysis of the new mine and present her recommendation on whether the company should open the new mine.

Alma has used the estimates provided by Dan to determine the revenues that could be expected from the mine. She has also projected the expense of opening the mine and the annual operating expenses. If the company opens the mine, it will cost $635 million today, and it will have a cash outflow of $45 million nine years from today in costs associated with closing the mine and reclaiming the area surrounding it. The expected cash flows each year from the mine are shown in the table. Bullock Mining has a required return of 12 percent on all of its gold mines.

Year	Cash Flow
0	–$635,000,000
1	89,000,000
2	105,000,000
3	130,000,000
4	173,000,000
5	205,000,000
6	155,000,000
7	145,000,000
8	122,000,000
9	– 45,000,000

QUESTIONS

1. Construct a spreadsheet to calculate the payback period, internal rate of return, modified internal rate of return, and net present value of the proposed mine.
2. Based on your analysis, should the company open the mine?
3. Bonus question: Most spreadsheets do not have a built-in formula to calculate the payback period. Write a VBA script that calculates the payback period for a project.

Chapter

10 Making Capital Investment Decisions

IS THERE GREEN IN GREEN? General Electric (GE) thinks so. Through its "Ecomagination" program, the company planned to double research and development spending on green products. By 2015, GE had invested over $13 billion in its Ecomagination program, and currently about one-half of the company's R&D budget is spent on green projects. As an example, GE's Evolution® Series Locomotive required over $600 million in development, but it allows railroads to move one ton of freight more than 480 miles with a single gallon of fuel. GE's green initiative seems to be paying off. Revenue from green products has totaled more than $230 billion since its launch in 2005, with $36 billion in 2015 alone. Even further, revenues from Ecomagination products were growing at twice the rate of the rest of the company's revenues. The company's internal commitment to green was increased when it announced its goal to decrease greenhouse gas emissions and water consumption by an additional 20 percent by 2020.

As you no doubt recognize from your study of the previous chapter, GE's decision to develop and market green technology represents a capital budgeting decision. In this chapter, we further investigate such decisions, how they are made, and how to look at them objectively.

This chapter follows up on our previous one by delving more deeply into capital budgeting. We have two main tasks. First, recall that in the last chapter, we saw that cash flow estimates are the critical input in a net present value analysis, but we didn't say much about where these cash flows come from; so we will now examine this question in some detail. Our second goal is to learn how to critically examine NPV estimates, and, in particular, how to evaluate the sensitivity of NPV estimates to assumptions made about the uncertain future.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Determine the relevant cash flows for a proposed project.

LO2 Evaluate whether a project is acceptable.

LO3 Explain how to set a bid price for a project.

LO4 Evaluate the equivalent annual cost of a project.

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So far, we've covered various parts of the capital budgeting decision. Our task in this chapter is to start bringing these pieces together. In particular, we will show you how to "spread the numbers" for a proposed investment or project and, based on those numbers, make an initial assessment about whether the project should be undertaken.

In the discussion that follows, we focus on the process of setting up a discounted cash flow analysis. From the last chapter, we know that the projected future cash flows are the key element in such an evaluation. Accordingly, we emphasize working with financial and accounting information to come up with these figures.

In evaluating a proposed investment, we pay special attention to deciding what information is relevant to the decision at hand and what information is not. As we will see, it is easy to overlook important pieces of the capital budgeting puzzle.

We will wait until the next chapter to describe in detail how to go about evaluating the results of our discounted cash flow analysis. Also, where needed, we will assume that we know the relevant required return, or discount rate. We continue to defer in-depth discussion of this subject to Part 5.

10.1 Project Cash Flows: A First Look

The effect of taking a project is to change the firm's overall cash flows today and in the future. To evaluate a proposed investment, we must consider these changes in the firm's cash flows and then decide whether they add value to the firm. The first (and most important) step, therefore, is to decide which cash flows are relevant.

RELEVANT CASH FLOWS

What is a relevant cash flow for a project? The general principle is simple enough: A relevant cash flow for a project is a change in the firm's overall future cash flow that comes about as a direct consequence of the decision to take that project. Because the relevant cash flows are defined in terms of changes in, or increments to, the firm's existing cash flow, they are called the **incremental cash flows** associated with the project.

incremental cash flows
The difference between a firm's future cash flows with a project and those without the project.

The concept of incremental cash flow is central to our analysis, so we will state a general definition and refer back to it as needed:

The incremental cash flows for project evaluation consist of *any and all* changes in the firm's future cash flows that are a direct consequence of taking the project.

This definition of incremental cash flows has an obvious and important corollary: Any cash flow that exists regardless of *whether or not* a project is undertaken is *not* relevant.

THE STAND-ALONE PRINCIPLE

In practice, it would be cumbersome to actually calculate the future total cash flows to the firm with and without a project, especially for a large firm. Fortunately, it is not really necessary to do so. Once we identify the effect of undertaking the proposed project on the firm's cash flows, we need focus only on the project's resulting incremental cash flows. This is called the **stand-alone principle**.

stand-alone principle
The assumption that evaluation of a project may be based on the project's incremental cash flows.

What the stand-alone principle says is that once we have determined the incremental cash flows from undertaking a project, we can view that project as a kind of "minifirm" with its own future revenues and costs, its own assets, and, of course, its own cash flows. We will then be primarily interested in comparing the cash flows from this minifirm to the cost of acquiring it. An important consequence of this approach is that we will be evaluating the proposed project purely on its own merits, in isolation from any other activities or projects.

Concept Questions

10.1a What are the relevant incremental cash flows for project evaluation?

10.1b What is the stand-alone principle?

10.2 Incremental Cash Flows

We are concerned here with only cash flows that are incremental and that result from a project. Looking back at our general definition, we might think it would be easy enough to decide whether a cash flow is incremental. Even so, in a few situations it is easy to make mistakes. In this section, we describe some common pitfalls and how to avoid them.

SUNK COSTS

sunk cost
A cost that has already been incurred and cannot be removed and therefore should not be considered in an investment decision.

A **sunk cost**, by definition, is a cost we have already paid or have already incurred the liability to pay. Such a cost cannot be changed by the decision today to accept or reject a project. Put another way, the firm will have to pay this cost no matter what. Based on our general definition of incremental cash flow, such a cost is clearly irrelevant to the decision at hand. So, we will always be careful to exclude sunk costs from our analysis.

That a sunk cost is irrelevant seems obvious given our discussion. Nonetheless, it's easy to fall prey to the fallacy that a sunk cost should be associated with a project. Suppose General Milk Company hires a financial consultant to help evaluate whether a line of chocolate milk should be launched. When the consultant turns in the report, General Milk objects to the analysis because the consultant did not include the hefty consulting fee as a cost of the chocolate milk project.

Who is correct? By now, we know that the consulting fee is a sunk cost: It must be paid whether or not the chocolate milk line is actually launched (this is an attractive feature of the consulting business).

OPPORTUNITY COSTS

opportunity cost
The most valuable alternative that is given up if a particular investment is undertaken.

When we think of costs, we normally think of out-of-pocket costs—namely those that require us to actually spend some amount of cash. An **opportunity cost** is slightly different; it requires us to give up a benefit. A common situation arises in which a firm already owns some of the assets a proposed project will be using. For example, we might be thinking of converting an old rustic cotton mill we bought years ago for \$100,000 into upmarket condominiums.

If we undertake this project, there will be no direct cash outflow associated with buying the old mill because we already own it. For purposes of evaluating the condo project, should we then treat the mill as "free"? The answer is no. The mill is a valuable resource used by the project. If we didn't use it here, we could do something else with it. Like what? The obvious answer is that, at a minimum, we could sell it. Using the mill for the condo complex has an opportunity cost: We give up the valuable opportunity to do something else with the mill.[1]

There is another issue here. Once we agree that the use of the mill has an opportunity cost, how much should we charge the condo project for this use? Given that we paid \$100,000, it might seem that we should charge this amount to the condo project. Is this correct? The answer is no, and the reason is based on our discussion concerning sunk costs.

The fact that we paid \$100,000 some years ago is irrelevant. That cost is sunk. At a minimum, the opportunity cost that we charge the project is what the mill would sell for today

[1]Economists sometimes use the acronym TANSTAAFL, which is short for "There ain't no such thing as a free lunch," to describe the fact that only very rarely is something truly free.

(net of any selling costs) because this is the amount we give up by using the mill instead of selling it.[2]

SIDE EFFECTS

Remember that the incremental cash flows for a project include all the resulting changes in the *firm's* future cash flows. It would not be unusual for a project to have side, or spillover, effects, both good and bad. For example, in 2017, the time between the theatrical release of a feature film and the release of the DVD had shrunk to 17 weeks compared to 29 weeks in 1998, although several studios have shorter times. This shortened release time was blamed for at least part of the decline in movie theater box office receipts. Of course, retailers cheered the move because it was credited with increasing DVD sales. A negative impact on the cash flows of an existing product from the introduction of a new product is called **erosion**.[3] In this case, the cash flows from the new line should be adjusted downward to reflect lost profits on other lines.

erosion
The cash flows of a new project that come at the expense of a firm's existing projects.

In accounting for erosion, it is important to recognize that any sales lost as a result of launching a new product might be lost anyway because of future competition. Erosion is relevant only when the sales would not otherwise be lost.

Side effects show up in a lot of different ways. For example, one of The Walt Disney Company's concerns when it built Euro Disney (now known as Disneyland Paris) was that the new park would drain visitors from the Florida park, a popular vacation destination for Europeans.

There are beneficial spillover effects, of course. For example, you might think that Hewlett-Packard would have been concerned when the price of a printer that sold for \$500 to \$600 in 1994 declined to below \$100 by 2017, but such was not the case. HP realized that the big money is in the consumables that printer owners buy to keep their printers going, such as ink-jet cartridges, laser toner cartridges, and special paper. The profit margins for these products are substantial.

NET WORKING CAPITAL

Normally a project will require that the firm invest in net working capital in addition to long-term assets. For example, a project will generally need some amount of cash on hand to pay any expenses that arise. In addition, a project will need an initial investment in inventories and accounts receivable (to cover credit sales). Some of the financing for this will be in the form of amounts owed to suppliers (accounts payable), but the firm will have to supply the balance. This balance represents the investment in net working capital.

It's easy to overlook an important feature of net working capital in capital budgeting. As a project winds down, inventories are sold, receivables are collected, bills are paid, and cash balances can be drawn down. These activities free up the net working capital originally invested. So the firm's investment in project net working capital closely resembles a loan. The firm supplies working capital at the beginning and recovers it toward the end.

FINANCING COSTS

In analyzing a proposed investment, we will *not* include interest paid or any other financing costs such as dividends or principal repaid because we are interested in the cash flow generated by the assets of the project. As we mentioned in Chapter 2, interest paid, for example, is a component of cash flow to creditors, not cash flow from assets.

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[2]If the asset in question is unique, then the opportunity cost might be higher because there might be other valuable projects we could undertake that would use it. However, if the asset in question is of a type that is routinely bought and sold (a used car, perhaps), then the opportunity cost is always the going price in the market because that is the cost of buying another similar asset.

[3]More colorfully, erosion is sometimes called *piracy* or *cannibalism*.

More generally, our goal in project evaluation is to compare the cash flow from a project to the cost of acquiring that project in order to estimate NPV. The particular mixture of debt and equity a firm actually chooses to use in financing a project is a managerial variable and primarily determines how project cash flow is divided between owners and creditors. This is not to say that financing arrangements are unimportant. They are just something to be analyzed separately. We will cover this in later chapters.

OTHER ISSUES

There are some other things to watch out for. First, we are interested only in measuring cash flow. Moreover, we are interested in measuring it when it actually occurs, not when it accrues in an accounting sense. Second, we are always interested in *aftertax* cash flow because taxes are definitely a cash outflow. In fact, whenever we write *incremental cash flows*, we mean aftertax incremental cash flows. Remember, aftertax cash flow and accounting profit, or net income, are entirely different things.

Concept Questions

10.2a What is a sunk cost? An opportunity cost?

10.2b Explain what erosion is and why it is relevant.

10.2c Explain why interest paid is an irrelevant cash flow for project evaluation.

10.3 Pro Forma Financial Statements and Project Cash Flows

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The first thing we need when we begin evaluating a proposed investment is a set of pro forma, or projected, financial statements. Given these, we can develop the projected cash flows from the project. Once we have the cash flows, we can estimate the value of the project using the techniques we described in the previous chapter.

GETTING STARTED: PRO FORMA FINANCIAL STATEMENTS

pro forma financial statements
Financial statements projecting future years' operations.

Pro forma financial statements are a convenient and easily understood means of summarizing much of the relevant information for a project. To prepare these statements, we will need estimates of quantities such as unit sales, the selling price per unit, the variable cost per unit, and total fixed costs. We will also need to know the total investment required, including any investment in net working capital.

To illustrate, suppose we think we can sell 50,000 cans of shark attractant per year at a price of $4 per can. It costs us about $2.50 per can to make the attractant, and a new product such as this one typically has only a three-year life (perhaps because the customer base dwindles rapidly). We require a 20 percent return on new products.

Fixed costs for the project, including such things as rent on the production facility, will run $17,430 per year.[4] Further, we will need to invest a total of $90,000 in manufacturing equipment. For simplicity, we will assume that this $90,000 will be 100 percent depreciated over the three-year life of the project.[5] Furthermore, the cost of removing the equipment will roughly equal its actual value in three years, so it will be essentially worthless on

[4]By *fixed cost*, we literally mean a cash outflow that will occur regardless of the level of sales. This should not be confused with some sort of accounting period charge.

[5]We will also assume that a full year's depreciation can be taken in the first year.

TABLE 10.1

Projected Income Statement, Shark Attractant Project

Sales (50,000 units at $4/unit)	$200,000
Variable costs ($2.50/unit)	125,000
Fixed costs	17,430
Depreciation ($90,000/3)	30,000
EBIT	$ 27,570
Taxes (21%)	5,790
Net income	$ 21,780

TABLE 10.2

Projected Capital Requirements, Shark Attractant Project

	Year			
	0	1	2	3
Net working capital	$ 20,000	$20,000	$20,000	$20,000
Net fixed assets	90,000	60,000	30,000	0
Total investment	$110,000	$80,000	$50,000	$20,000

a market value basis as well. Finally, the project will require an initial $20,000 investment in net working capital, and the tax rate is 21 percent.

In Table 10.1, we organize these initial projections by first preparing the pro forma income statement. Once again, notice that we have *not* deducted any interest expense. This will always be so. As we described earlier, interest paid is a financing expense, not a component of operating cash flow.

We can also prepare a series of abbreviated balance sheets that show the capital requirements for the project as we've done in Table 10.2. Here we have net working capital of $20,000 in each year. Fixed assets are $90,000 at the start of the project's life (Year 0), and they decline by the $30,000 in depreciation each year, ending up at zero. Notice that the total investment given here for future years is the total book, or accounting, value—not market value.

At this point, we need to start converting this accounting information into cash flows. We consider how to do this next.

PROJECT CASH FLOWS

To develop the cash flows from a project, we need to recall (from Chapter 2) that cash flow from assets has three components: Operating cash flow, capital spending, and changes in net working capital. To evaluate a project, or minifirm, we need to estimate each of these.

Once we have estimates of the components of cash flow, we will calculate cash flow for our minifirm just as we did in Chapter 2 for an entire firm:

$$\begin{aligned}\text{Project cash flow} = {} & \text{Project operating cash flow} \\ & - \text{Project change in net working capital} \\ & - \text{Project capital spending}\end{aligned}$$

We consider these components next.

Project Operating Cash Flow

To determine the operating cash flow associated with a project, we first need to recall the definition of operating cash flow:

$$\begin{aligned}\text{Operating cash flow} = {} & \text{Earnings before interest and taxes} \\ & + \text{Depreciation} \\ & - \text{Taxes}\end{aligned}$$

TABLE 10.3

Projected Income Statement, Abbreviated, Shark Attractant Project

Sales	$200,000
Variable costs	125,000
Fixed costs	17,430
Depreciation	30,000
EBIT	$ 27,570
Taxes (21%)	5,790
Net income	$ 21,780

TABLE 10.4

Projected Operating Cash Flow, Shark Attractant Project

EBIT	$27,570
Depreciation	+ 30,000
Taxes	− 5,790
Operating cash flow	$51,780

TABLE 10.5

Projected Total Cash Flows, Shark Attractant Project

	Year			
	0	1	2	3
Operating cash flow		$51,780	$51,780	$51,780
Changes in NWC	−$ 20,000			+ 20,000
Capital spending	− 90,000			
Total project cash flow	−$110,000	$51,780	$51,780	$71,780

To illustrate the calculation of operating cash flow, we will use the projected information from the shark attractant project. For ease of reference, Table 10.3 repeats the income statement in more abbreviated form.

Given the income statement in Table 10.3, calculating the operating cash flow is straightforward. As we see in Table 10.4, projected operating cash flow for the shark attractant project is $51,780.

Project Net Working Capital and Capital Spending We next need to take care of the fixed asset and net working capital requirements. Based on our balance sheets, we know that the firm must spend $90,000 up front for fixed assets and invest an additional $20,000 in net working capital. The immediate outflow is a total of $110,000. At the end of the project's life, the fixed assets will be worthless, but the firm will recover the $20,000 that was tied up in working capital.[6] This will lead to a $20,000 *inflow* in the last year.

On a purely mechanical level, notice that whenever we have an investment in net working capital, that same investment has to be recovered; in other words, the same number needs to appear at some time in the future with the opposite sign.

PROJECTED TOTAL CASH FLOW AND VALUE

Given the information we've accumulated, we can finish the preliminary cash flow analysis as illustrated in Table 10.5.

[6]In reality, the firm would probably recover something less than 100 percent of this amount because of bad debts, inventory loss, and so on. If we wanted to, we could just assume that, for example, only 90 percent was recovered and proceed from there.

Now that we have cash flow projections, we are ready to apply the various criteria we discussed in the last chapter. First, the NPV at the 20 percent required return is:

$$\begin{aligned} \text{NPV} &= -\$110{,}000 + 51{,}780/1.2 + 51{,}780/1.2^2 + 71{,}780/1.2^3 \\ &= \$10{,}648 \end{aligned}$$

Based on these projections, the project creates over $10,000 in value and should be accepted. Also, the return on this investment obviously exceeds 20 percent (because the NPV is positive at 20 percent). After some trial and error, we find that the IRR works out to be about 25.8 percent.

In addition, if required, we could calculate the payback and the average accounting return, or AAR. Inspection of the cash flows shows that the payback on this project is a little over two years (verify that it's about 2.1 years).[7]

From the last chapter, we know that the AAR is average net income divided by average book value. The net income each year is $21,780. The average (in thousands) of the four book values (from Table 10.2) for total investment is ($110 + 80 + 50 + 20)/4 = $65. So the AAR is $21,780/$65,000 = .3351, or 33.51 percent.[8] We've already seen that the return on this investment (the IRR) is about 26 percent. The fact that the AAR is larger illustrates again why the AAR cannot be meaningfully interpreted as the return on a project.

Concept Questions

10.3a What is the definition of project operating cash flow? How does this differ from net income?

10.3b For the shark attractant project, why did we add back the firm's net working capital investment in the final year?

More about Project Cash Flow

10.4

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In this section, we take a closer look at some aspects of project cash flow. In particular, we discuss project net working capital in more detail. We then examine current tax laws regarding depreciation. Finally, we work through a more involved example of the capital investment decision.

A CLOSER LOOK AT NET WORKING CAPITAL

In calculating operating cash flow, we did not explicitly consider the fact that some of our sales might be on credit. Also, we may not have actually paid some of the costs shown. In either case, the cash flow in question would not yet have occurred. We show here that these possibilities are not a problem as long as we don't forget to include changes in net working capital in our analysis. This discussion emphasizes the importance and the effect of doing so.

[7]We're guilty of a minor inconsistency here. When we calculated the NPV and the IRR, we assumed that all the cash flows occurred at end of year. When we calculated the payback, we assumed that the cash flows occurred uniformly throughout the year.

[8]Notice that the average total book value is not the initial total of $110,000 divided by 2. The reason is that the $20,000 in working capital doesn't "depreciate."

Suppose that during a particular year of a project we have the following simplified income statement:

Sales	$500
Costs	310
Net income	$190

Depreciation and taxes are zero. No fixed assets are purchased during the year. Also, to illustrate a point, we assume that the only components of net working capital are accounts receivable and payable. The beginning and ending amounts for these accounts are as follows:

	Beginning of Year	End of Year	Change
Accounts receivable	$880	$910	+$30
Accounts payable	550	605	+ 55
Net working capital	$330	$305	−$25

Based on this information, what is total cash flow for the year? We can first just mechanically apply what we have been discussing to come up with the answer. Operating cash flow in this particular case is the same as EBIT because there are no taxes or depreciation; thus, it equals $190. Also, notice that net working capital actually *declined* by $25. This just means that $25 was freed up during the year. There was no capital spending, so the total cash flow for the year is:

$$\begin{aligned}\text{Total cash flow} &= \text{Operating cash flow} - \text{Change in NWC} - \text{Capital spending}\\ &= \$190 - (-25) - 0\\ &= \$215\end{aligned}$$

Now, we know that this $215 total cash flow has to be "dollars in" less "dollars out" for the year. We could therefore ask a different question: What were cash revenues for the year? Also, what were cash costs?

To determine cash revenues, we need to look more closely at net working capital. During the year, we had sales of $500. However, accounts receivable rose by $30 over the same time period. What does this mean? The $30 increase tells us that sales exceeded collections by $30. In other words, we haven't yet received the cash from $30 of the $500 in sales. As a result, our cash inflow is $500 − 30 = $470. In general, cash income is sales minus the increase in accounts receivable.

Cash outflows can be similarly determined. We show costs of $310 on the income statement, but accounts payable increased by $55 during the year. This means that we have not yet paid $55 of the $310, so cash costs for the period are just $310 − 55 = $255. In other words, in this case, cash costs equal costs less the increase in accounts payable.[9]

Putting this information together, we calculate that cash inflows less cash outflows are $470 − 255 = $215, just as we had before. Notice that:

$$\begin{aligned}\text{Cash flow} &= \text{Cash inflow} - \text{Cash outflow}\\ &= (\$500 - 30) - (310 - 55)\\ &= (\$500 - 310) - (30 - 55)\\ &= \text{Operating cash flow} - \text{Change in NWC}\\ &= \$190 - (-25)\\ &= \$215\end{aligned}$$

[9]If there were other accounts, we might have to make some further adjustments. For example, a net increase in inventory would be a cash outflow.

IN THEIR OWN WORDS ...

Samuel Weaver on Capital Budgeting at The Hershey Company

The capital program at The Hershey Company and most Fortune 500 or Fortune 1,000 companies involves a three-phase approach: Planning or budgeting, evaluation, and postcompletion reviews.

The first phase involves identification of likely projects at strategic planning time. These are selected to support the strategic objectives of the corporation. This identification is generally broad in scope with minimal financial evaluation attached. Projects are classified as new product, cost savings, capacity expansion, etc. As the planning process focuses more closely on the short-term plans (or budgets), major capital expenditures are discussed more rigorously. Project costs are more closely honed, and specific projects may be reconsidered.

Each project is then individually reviewed and authorized. Planning, developing, and refining cash flows underlie capital analysis at Hershey. Once the cash flows have been determined, the application of capital evaluation techniques such as those using net present value, internal rate of return, and payback period is routine. Presentation of the results is enhanced using sensitivity analysis, which plays a major role for management in assessing the critical assumptions and resulting impact.

The final phase relates to postcompletion reviews in which the original forecasts of the project's performance are compared to actual results and/or revised expectations.

Capital expenditure analysis is only as good as the assumptions that underlie the project. The old cliché of GIGO (garbage in, garbage out) applies in this case. Incremental cash flows primarily result from incremental sales or margin improvements (cost savings). For the most part, a range of incremental cash flows can be identified from marketing research or engineering studies. However, for a number of projects, correctly discerning the implications and the relevant cash flows is analytically challenging. For example, when a new product is introduced and is expected to generate millions of dollars' worth of sales, the appropriate analysis focuses on the incremental sales after accounting for cannibalization of existing products.

One of the problems that we face at Hershey deals with the application of net present value, NPV, versus internal rate of return, IRR. NPV offers us the correct investment indication when dealing with mutually exclusive alternatives. However, decision makers at all levels sometimes find it difficult to comprehend the result. Specifically, an NPV of, say, $535,000 needs to be interpreted. It is not enough to know that the NPV is positive or even that it is more positive than an alternative. Decision makers seek to determine a level of "comfort" regarding how profitable the investment is by relating it to other standards.

Although the IRR may provide a misleading indication of which project to select, the result is provided in a way that can be interpreted by all parties. The resulting IRR can be mentally compared to expected inflation, current borrowing rates, the cost of capital, an equity portfolio's return, and so on. An IRR of, say, 18 percent is readily interpretable by management. Perhaps this ease of understanding is why surveys indicate that many Fortune 500 or Fortune 1,000 companies use the IRR method (in conjunction with NPV) as a primary evaluation technique.

In addition to the NPV versus IRR problem, there are a limited number of projects for which traditional capital expenditure analysis is difficult to apply because the cash flows can't be determined. When new computer equipment is purchased, an office building is renovated, or a parking lot is repaved, it is essentially impossible to identify the cash flows, so the use of traditional evaluation techniques is limited. These types of "capital expenditure" decisions are made using other techniques that hinge on management's judgment.

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More generally, this example illustrates that including net working capital changes in our calculations has the effect of adjusting for the discrepancy between accounting sales and costs and actual cash receipts and payments.

Cash Collections and Costs — EXAMPLE 10.1

For the year just completed, the Combat Wombat Telestat Co. (CWT) reports sales of $998 and costs of $734. You have collected the following beginning and ending balance sheet information:

	Beginning	Ending
Accounts receivable	$100	$110
Inventory	100	80
Accounts payable	100	70
Net working capital	$100	$120

Based on these figures, what are cash inflows? Cash outflows? What happened to each account? What is net cash flow?

Sales were $998, but receivables rose by $10. So cash collections were $10 less than sales, or $988. Costs were $734, but inventories fell by $20. This means that we didn't replace $20 worth of inventory, so costs are actually overstated by this amount. Also, payables fell by $30. This means that, on a net basis, we actually paid our suppliers $30 more than we received from them, resulting in a $30 understatement of costs. Adjusting for these events, we calculate that cash costs are $734 − 20 + 30 = $744. Net cash flow is $988 − 744 = $244.

Finally, notice that net working capital increased by $20 overall. We can check our answer by noting that the original accounting sales less costs (= $998 − 734) are $264. In addition, CWT spent $20 on net working capital, so the net result is a cash flow of $264 − 20 = $244, as we calculated.

DEPRECIATION

As we note elsewhere, accounting depreciation is a noncash deduction. As a result, depreciation has cash flow consequences only because it influences the tax bill. The way that depreciation is computed for tax purposes is the relevant method for capital investment decisions. Not surprisingly, the procedures are governed by tax law. We now discuss some specifics of the depreciation system enacted by the Tax Reform Act of 1986. This system is a modification of the **accelerated cost recovery system (ACRS)** instituted in 1981.

accelerated cost recovery system (ACRS)
A depreciation method under U.S. tax law allowing for the accelerated write-off of property under various classifications.

Modified ACRS Depreciation (MACRS) Calculating depreciation is normally mechanical. Although there are a number of *ifs*, *ands*, and *buts* involved, the basic idea under MACRS is that every asset is assigned to a particular class. An asset's class establishes its life for tax purposes. Once an asset's tax life is determined, the depreciation for each year is computed by multiplying the cost of the asset by a fixed percentage.[10] The expected salvage value (what we think the asset will be worth when we dispose of it) and the expected economic life (how long we expect the asset to be in service) are not explicitly considered in the calculation of depreciation.

Some typical depreciation classes are given in Table 10.6, and associated percentages (as specified by the IRS) are shown in Table 10.7.[11]

A nonresidential real property, such as an office building, is depreciated over 31.5 years using straight-line depreciation. A residential real property, such as an apartment building, is depreciated straight-line over 27.5 years. Remember that land cannot be depreciated.[12]

[10]Under certain circumstances, the cost of the asset may be adjusted before computing depreciation. The result is called the *depreciable basis*, and depreciation is calculated using this number instead of the actual cost.

[11]For the curious, these depreciation percentages are derived from a double-declining balance scheme with a switch to straight-line when the latter becomes advantageous. Further, there is a half-year convention, meaning that all assets are assumed to be placed in service midway through the tax year. This convention is maintained unless more than 40 percent of an asset's cost is incurred in the final quarter. In this case, a midquarter convention is used. The odd-looking rounding is courtesy of the IRS.

[12]There are, however, depletion allowances for firms in extraction-type lines of business (such as mining). These are somewhat similar to depreciation allowances.

TABLE 10.6
Modified ACRS Property Classes

Class	Examples
Three-year	Equipment used in research
Five-year	Autos, computers
Seven-year	Most industrial equipment

TABLE 10.7
Modified ACRS Depreciation Allowances

	Property Class		
Year	Three-Year	Five-Year	Seven-Year
1	33.33%	20.00%	14.29%
2	44.45	32.00	24.49
3	14.81	19.20	17.49
4	7.41	11.52	12.49
5		11.52	8.93
6		5.76	8.92
7			8.93
8			4.46

To illustrate how depreciation is calculated, we consider an automobile costing $12,000. Autos are normally classified as five-year property. Looking at Table 10.7, we see that the relevant figure for the first year of a five-year asset is 20 percent.[13] The depreciation in the first year is thus $12,000 × .20 = $2,400. The relevant percentage in the second year is 32 percent, so the depreciation in the second year is $12,000 × .32 = $3,840, and so on. We can summarize these calculations as follows:

Year	MACRS Percentage	Depreciation
1	20.00%	.2000 × $12,000 = $ 2,400.00
2	32.00	.3200 × 12,000 = 3,840.00
3	19.20	.1920 × 12,000 = 2,304.00
4	11.52	.1152 × 12,000 = 1,382.40
5	11.52	.1152 × 12,000 = 1,382.40
6	5.76	.0576 × 12,000 = 691.20
	100.00%	$12,000.00

Notice that the MACRS percentages sum up to 100 percent. As a result, we write off 100 percent of the cost of the asset, or $12,000 in this case.

Bonus Depreciation For a number of years prior to 2018, various tax rules and regulations were enacted that allowed "bonus" depreciation. Based on the Protecting Americans from Tax Hikes (PATH) Act of 2015, the size of the bonus in 2017 was 50%. What this means is that a firm can take a depreciation deduction of 50% of the cost on an eligible asset in the first year and then depreciate the remaining 50% using the MACRS schedules as we have just described. Significantly, in late 2017, Congress passed the Tax Cuts and Jobs Act, which increased the bonus depreciation to 100% for 2018, lasting until the end of 2022. After that it, drops by 20% per year until it reaches zero after 2026. The implication is that most firms will not use the MACRS schedules until 2023 unless they wish to (taking the bonus depreciation is optional). Of course, future legislation may change things.

Book Value versus Market Value In calculating depreciation under current tax law, the economic life and future market value of the asset are not an issue. As a result, the

[13] It may appear odd that five-year property is depreciated over six years. The tax accounting reason is that it is assumed we have the asset for only six months in the first year and, consequently, six months in the last year. As a result, there are five 12-month periods, but we have some depreciation in each of six different tax years.

TABLE 10.8
MACRS Book Values

Year	Beginning Book Value	Depreciation	Ending Book Value
1	$12,000.00	$2,400.00	$9,600.00
2	9,600.00	3,840.00	5,760.00
3	5,760.00	2,304.00	3,456.00
4	3,456.00	1,382.40	2,073.60
5	2,073.60	1,382.40	691.20
6	691.20	691.20	.00

book value of an asset can differ substantially from its actual market value. For example, with our $12,000 car, book value after the first year is $12,000 less the first year's depreciation of $2,400, or $9,600. The remaining book values are summarized in Table 10.8. After six years, the book value of the car is zero.

Suppose we wanted to sell the car after five years. Based on historical averages, it would be worth, say, 25 percent of the purchase price, or .25 × $12,000 = $3,000. If we actually sold it for this, then we would have to pay taxes at the ordinary income tax rate on the difference between the sale price of $3,000 and the book value of $691.20. For a corporation in the 21 percent bracket, the tax liability would be .21 × $2,308.80 = $484.85.[14]

The reason taxes must be paid in this case is that the difference between market value and book value is "excess" depreciation, and it must be "recaptured" when the asset is sold. What this means is that, as it turns out, we overdepreciated the asset by $3,000 − 691.20 = $2,308.80. Because we deducted $2,308.80 too much in depreciation, we paid $484.85 too little in taxes, and we have to make up the difference.

Notice that this is *not* a tax on a capital gain. As a general (albeit rough) rule, a capital gain occurs only if the market price exceeds the original cost. However, what is and what is not a capital gain is ultimately up to taxing authorities, and the specific rules can be complex. We will ignore capital gains taxes for the most part.

Finally, if the book value exceeds the market value, then the difference is treated as a loss for tax purposes. For example, if we sell the car after two years for $4,000, then the book value exceeds the market value by $1,760. In this case, a tax savings of .21 × $1,760 = $369.60 occurs.

[14]The rules are different and more complicated with real property. Essentially, in this case, only the difference between the actual book value and the book value that would have existed if straight-line depreciation had been used is recaptured. Anything above the straight-line book value is considered a capital gain.

EXAMPLE 10.2 MACRS Depreciation

The Staple Supply Co. has just purchased a new computerized information system with an installed cost of $160,000. The computer is treated as five-year property. What are the yearly depreciation allowances? Based on historical experience, we think that the system will be worth only $10,000 when Staple gets rid of it in four years. What are the tax consequences of the sale? What is the total aftertax cash flow from the sale?

The yearly depreciation allowances are calculated by multiplying $160,000 by the five-year percentages found in Table 10.7:

Year	MACRS Percentage	Depreciation	Ending Book Value
1	20.00%	.2000 × $160,000 = $ 32,000	$128,000
2	32.00	.3200 × 160,000 = 51,200	76,800
3	19.20	.1920 × 160,000 = 30,720	46,080
4	11.52	.1152 × 160,000 = 18,432	27,648
5	11.52	.1152 × 160,000 = 18,432	9,216
6	5.76	.0576 × 160,000 = 9,216	0
	100.00%	$160,000	

Notice that we have also computed the book value of the system as of the end of each year. The book value at the end of Year 4 is $27,648. If Staple sells the system for $10,000 at that time, it will have a loss of $17,648 (the difference) for tax purposes. This loss, of course, is like depreciation because it isn't a cash expense.

What really happens? Two things. First, Staple gets $10,000 from the buyer. Second, it saves .21 × $17,648 = $3,706 in taxes. So, the total aftertax cash flow from the sale is a $13,706 cash inflow.

AN EXAMPLE: THE MAJESTIC MULCH AND COMPOST COMPANY (MMCC)

At this point, we want to go through a somewhat more involved capital budgeting analysis. Keep in mind as you read that the basic approach here is exactly the same as that in the shark attractant example used earlier. We have just added some real-world detail (and a lot more numbers).

MMCC is investigating the feasibility of a new line of power mulching tools aimed at the growing number of home composters. Based on exploratory conversations with buyers for large garden shops, MMCC projects unit sales as follows:

Year	Unit Sales
1	3,000
2	5,000
3	6,000
4	6,500
5	6,000
6	5,000
7	4,000
8	3,000

The new power mulcher will sell for $120 per unit to start. When the competition catches up after three years, however, MMCC anticipates that the price will drop to $110.

The power mulcher project will require $20,000 in net working capital at the start. Subsequently, total net working capital at the end of each year will be about 15 percent of sales for that year. The variable cost per unit is $60, and total fixed costs are $25,000 per year.

It will cost about $800,000 to buy the equipment necessary to begin production. This investment is primarily in industrial equipment, which qualifies as seven-year MACRS property. We assume there is no bonus depreciation, so we apply MACRS to the entire cost. The equipment will actually be worth about 20 percent of its cost in eight years, or .20 × $800,000 = $160,000. The relevant tax rate is 21 percent, and the required return is 15 percent. Based on this information, should MMCC proceed?

Operating Cash Flows There is a lot of information here that we need to organize. The first thing we can do is calculate projected sales. Sales in the first year are projected at 3,000 units at $120 apiece, or $360,000 total. The remaining figures are shown in Table 10.9.

Next, we compute the depreciation on the $800,000 investment in Table 10.10 (remember, there is no bonus depreciation in this case). With this information, we can prepare the pro forma income statements, as shown in Table 10.11. From here, computing the operating cash flows is straightforward. The results are shown in the first part of Table 10.13.

TABLE 10.9
Projected Revenues, Power Mulcher Project

Year	Unit Price	Unit Sales	Revenues
1	$120	3,000	$360,000
2	120	5,000	600,000
3	120	6,000	720,000
4	110	6,500	715,000
5	110	6,000	660,000
6	110	5,000	550,000
7	110	4,000	440,000
8	110	3,000	330,000

TABLE 10.10
Annual Depreciation, Power Mulcher Project

Year	MACRS Percentage	Depreciation	Ending Book Value
1	14.29%	.1429 × $800,000 = $114,320	$685,680
2	24.49	.2449 × 800,000 = 195,920	489,760
3	17.49	.1749 × 800,000 = 139,920	349,840
4	12.49	.1249 × 800,000 = 99,920	249,920
5	8.93	.0893 × 800,000 = 71,440	178,480
6	8.92	.0892 × 800,000 = 71,360	107,120
7	8.93	.0893 × 800,000 = 71,440	35,680
8	4.46	.0446 × 800,000 = 35,680	0
	100.00%	$800,000	

TABLE 10.11 **Projected Income Statements, Power Mulcher Project**

	Year							
	1	2	3	4	5	6	7	8
Unit price	$ 120	$ 120	$ 120	$ 110	$ 110	$ 110	$ 110	$ 110
Unit sales	3,000	5,000	6,000	6,500	6,000	5,000	4,000	3,000
Revenues	$360,000	$600,000	$720,000	$715,000	$660,000	$550,000	$440,000	$330,000
Variable costs	180,000	300,000	360,000	390,000	360,000	300,000	240,000	180,000
Fixed costs	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Depreciation	114,320	195,920	139,920	99,920	71,440	71,360	71,440	35,680
EBIT	$ 40,680	$ 79,080	$195,080	$200,080	$203,560	$153,640	$103,560	$ 89,320
Taxes (21%)	8,543	16,607	40,967	42,017	42,748	32,264	21,748	18,757
Net income	$ 32,137	$ 62,473	$154,113	$158,063	$160,812	$121,376	$ 81,812	$ 70,563

Change in NWC Now that we have the operating cash flows, we need to determine the changes in NWC. By assumption, net working capital requirements change as sales change. In each year, MMCC will generally either add to or recover some of its project net working capital. Recalling that NWC starts out at $20,000 and then rises to 15 percent of sales, we can calculate the amount of NWC for each year as shown in Table 10.12.

As illustrated, during the first year, net working capital grows from $20,000 to .15 × $360,000 = $54,000. The increase in net working capital for the year is thus $54,000 − 20,000 = $34,000. The remaining figures are calculated in the same way.

TABLE 10.12

Changes in Net Working Capital, Power Mulcher Project

Year	Revenues	Net Working Capital	Cash Flow
0		$ 20,000	−$20,000
1	$360,000	54,000	− 34,000
2	600,000	90,000	− 36,000
3	720,000	108,000	− 18,000
4	715,000	107,250	750
5	660,000	99,000	8,250
6	550,000	82,500	16,500
7	440,000	66,000	16,500
8	330,000	49,500	16,500

TABLE 10.13 **Projected Cash Flows, Power Mulcher Project**

	Year								
	0	1	2	3	4	5	6	7	8
I. Operating Cash Flow									
EBIT		$ 40,680	$ 79,080	$195,080	$200,080	$203,560	$153,640	$103,560	$ 89,320
Depreciation		114,320	195,920	139,920	99,920	71,440	71,360	71,440	35,680
Taxes		− 8,543	− 16,607	− 40,967	− 42,017	− 42,748	− 32,264	− 21,748	− 18,757
Operating cash flow		$146,457	$258,393	$294,033	$257,983	$232,252	$192,736	$153,252	$106,243
II. Net Working Capital									
Initial NWC	−$ 20,000								
Change in NWC		−$ 34,000	−$ 36,000	−$ 18,000	$ 750	$ 8,250	$ 16,500	$ 16,500	$ 16,500
NWC recovery									49,500
Total change in NWC	−$ 20,000	−$ 34,000	−$ 36,000	−$ 18,000	$ 750	$ 8,250	$ 16,500	$ 16,500	$ 66,000
III. Capital Spending									
Initial outlay	−$800,000								
Aftertax salvage									$126,400
Capital spending	−$800,000								$126,400

Remember that an increase in net working capital is a cash outflow, so we use a negative sign in this table to indicate an additional investment that the firm makes in net working capital. A positive sign represents net working capital returning to the firm. For example, $16,500 in NWC flows back to the firm in Year 6. Over the project's life, net working capital builds to a peak of $108,000 and declines from there as sales begin to drop off.

We show the result for changes in net working capital in the second part of Table 10.13. Notice that at the end of the project's life, there is $49,500 in net working capital still to be recovered. Therefore, in the last year, the project returns $16,500 of NWC during the year and then returns the remaining $49,500 at the end of the year, for a total of $66,000.

TABLE 10.14 **Projected Total Cash Flows, Power Mulcher Project**

	Year								
	0	1	2	3	4	5	6	7	8
Operating cash flow		$146,457	$258,393	$ 294,033	$257,983	$232,252	$192,736	$153,252	$ 106,243
Change in NWC	–$ 20,000	– 34,000	– 36,000	– 18,000	750	8,250	16,500	16,500	66,000
Capital spending	– 800,000								126,400
Total project cash flow	–$820,000	$112,457	$222,393	$276,033	$258,733	$240,502	$209,236	$169,752	$298,643
Cumulative cash flow	–$820,000	–$707,543	–$485,150	–$209,116	–$ 49,617	$290,119	$499,355	$669,107	$967,750
Discounted cash flow @ 15%	– 820,000	97,789	168,161	181,496	147,932	119,572	90,458	63,816	97,627
Net present value (15%) = $146,852									
Internal rate of return = 19.86%									
Payback = 3.81 years									

Capital Spending Finally, we have to account for the long-term capital invested in the project. In this case, MMCC invests $800,000 at Year 0. By assumption, this equipment will be worth $160,000 at the end of the project. It will have a book value of zero at that time. As we discussed earlier, this $160,000 excess of market value over book value is taxable, so the aftertax proceeds will be $160,000 × (1 − .21) = $126,400. These figures are shown in the third part of Table 10.13.

Total Cash Flow and Value We now have all the cash flow pieces, and we put them together in Table 10.14. If you notice, the project cash flows each year are the same as the cash flow from assets that we calculated in Chapter 3. In addition to the total project cash flows, we have calculated the cumulative cash flows and the discounted cash flows. At this point, it's essentially plug-and-chug to calculate the net present value, internal rate of return, and payback.

If we sum the discounted flows and the initial investment, the net present value (at 15 percent) works out to be $146,852. This is positive, so, based on these preliminary projections, the power mulcher project is acceptable. The internal, or DCF, rate of return is greater than 15 percent because the NPV is positive. It works out to be 19.86 percent, again indicating that the project is acceptable.

Looking at the cumulative cash flows, we can see that the project is paid back between three and four years because the table shows that the cumulative cash flow becomes positive at that time. As indicated, the fractional year works out to be $209,116/$258,733 = .81, so the payback is 3.81 years. We can't say whether or not this is good because we don't have a benchmark for MMCC. This is the usual problem with payback periods.

Conclusion This completes our preliminary DCF analysis. Where do we go from here? If we have a great deal of confidence in our projections, there is no further analysis to be done. MMCC should begin production and marketing immediately. It is unlikely that this will be the case. It is important to remember that the result of our analysis is an estimate of NPV, and we will usually have less than complete confidence in our projections. This means we have more work to do. In particular, we will almost surely want to spend some time evaluating the quality of our estimates. We will take up this subject in the next chapter. For now, we look at some alternative definitions of operating cash flow, and we illustrate some different cases that arise in capital budgeting.

Concept Questions

10.4a Why is it important to consider changes in net working capital in developing cash flows? What is the effect of doing so?

10.4b How is depreciation calculated for fixed assets under current tax law? What effects do expected salvage value and estimated economic life have on the calculated depreciation deduction?

Alternative Definitions of Operating Cash Flow 10.5

The analysis we went through in the previous section is quite general and can be adapted to almost any capital investment problem. In the next section, we illustrate some particularly useful variations. Before we do so, we need to discuss the fact that there are different definitions of project operating cash flow that are commonly used, both in practice and in finance texts.

As we will see, the different approaches to operating cash flow that exist all measure the same thing. If they are used correctly, they all produce the same answer, and one is not necessarily any better or more useful than another. Unfortunately, the fact that alternative definitions are used does sometimes lead to confusion. For this reason, we examine several of these variations next to see how they are related.

In the discussion that follows, keep in mind that when we speak of cash flow, we literally mean dollars in less dollars out. This is all we are concerned with. Different definitions of operating cash flow amount to different ways of manipulating basic information about sales, costs, depreciation, and taxes to get at cash flow.

For a particular project and year under consideration, suppose we have the following estimates:

$$\begin{aligned}\text{Sales} &= \$1{,}500\\ \text{Costs} &= \$700\\ \text{Depreciation} &= \$600\end{aligned}$$

With these estimates, notice that EBIT is:

$$\begin{aligned}\text{EBIT} &= \text{Sales} - \text{Costs} - \text{Depreciation}\\ &= \$1{,}500 - 700 - 600\\ &= \$200\end{aligned}$$

Once again, we assume that no interest is paid, so the tax bill is:

$$\begin{aligned}\text{Taxes} &= \text{EBIT} \times T_C\\ &= \$200 \times .21 = \$42\end{aligned}$$

where T_C, the corporate tax rate, is 21 percent.

When we put all of this together, we see that project operating cash flow, OCF, is:

$$\begin{aligned}\text{OCF} &= \text{EBIT} + \text{Depreciation} - \text{Taxes}\\ &= \$200 + 600 - 42 = \$758\end{aligned}$$

There are some other ways to determine OCF that could be (and are) used. We consider these next.

THE BOTTOM-UP APPROACH

Because we are ignoring any financing expenses, such as interest, in our calculations of project OCF, we can write project net income as:

$$\begin{aligned}\text{Project net income} &= \text{EBIT} - \text{Taxes}\\ &= \$200 - 42\\ &= \$158\end{aligned}$$

If we add the depreciation to both sides, we arrive at a slightly different and very common expression for OCF:

$$\begin{aligned}\textbf{OCF} &= \textbf{Net income} + \textbf{Depreciation}\\ &= \$158 + 600\\ &= \$758\end{aligned} \tag{10.1}$$

This is the *bottom-up* approach. Here, we start with the accountant's bottom line (net income) and add back any noncash deductions such as depreciation. It is crucial to remember that this definition of operating cash flow as net income plus depreciation is correct only if there is no interest expense subtracted in the calculation of net income.

Applying this approach to the shark attractant project (see Section 10.3), net income was \$21,780 and depreciation was \$30,000, so the bottom-up calculation is:

$$\text{OCF} = \$21{,}780 + 30{,}000 = \$51{,}780$$

This is exactly the same OCF we had previously.

THE TOP-DOWN APPROACH

Perhaps the most obvious way to calculate OCF is:

$$\begin{aligned}\textbf{OCF} &= \textbf{Sales} - \textbf{Costs} - \textbf{Taxes}\\ &= \$1{,}500 - 700 - 42 = \$758\end{aligned} \tag{10.2}$$

This is the *top-down* approach, the second variation on the basic OCF definition. Here, we start at the top of the income statement with sales and work our way down to net cash flow by subtracting costs, taxes, and other expenses. Along the way, we leave out any strictly noncash items such as depreciation.

For the shark attractant project, the operating cash flow can be readily calculated using the top-down approach. With sales of \$200,000, total costs (fixed plus variable) of \$142,430, and a tax bill of \$5,790, the OCF is:

$$\text{OCF} = \$200{,}000 - 142{,}430 - 5{,}790 = \$51{,}780$$

This is as we had before.

THE TAX SHIELD APPROACH

The third variation on our basic definition of OCF is the *tax shield* approach. This approach will be useful for some problems we consider in the next section. The tax shield definition of OCF is:

$$\textbf{OCF} = (\textbf{Sales} - \textbf{Costs}) \times (1 - T_C) + \textbf{Depreciation} \times T_C \tag{10.3}$$

where T_C is again the corporate tax rate. Assuming that $T_C = 21\%$, the OCF works out to be:

$$\begin{aligned}\text{OCF} &= (\$1{,}500 - 700) \times .79 + 600 \times .21\\ &= \$632 + 126\\ &= \$758\end{aligned}$$

This is as we had before.

This approach views OCF as having two components. The first part is what the project's cash flow would be if there were no depreciation expense. In this case, this would-have-been cash flow is \$632.

The second part of OCF in this approach is the depreciation deduction multiplied by the tax rate. This is called the **depreciation tax shield**. We know that depreciation is a noncash expense. The only cash flow effect of deducting depreciation is to reduce our taxes, a benefit to us. At the current 21 percent corporate tax rate, every dollar in depreciation expense saves us 21 cents in taxes. So, in our example, the \$600 depreciation deduction saves us $\$600 \times .21 = \$126$ in taxes.

depreciation tax shield
The tax saving that results from the depreciation deduction, calculated as depreciation multiplied by the corporate tax rate.

For the shark attractant project we considered earlier in the chapter, the depreciation tax shield would be $\$30{,}000 \times .21 = \$6{,}300$. The aftertax value for sales less costs would be $(\$200{,}000 - 142{,}430) \times (1 - .21) = \$45{,}480$. Adding these together yields the value of OCF:

$$\text{OCF} = \$45{,}480 + 6{,}300 = \$51{,}780$$

This calculation verifies that the tax shield approach is completely equivalent to the approach we used before.

CONCLUSION

Now that we've seen that all of these approaches are the same, you're probably wondering why everybody doesn't just agree on one of them. One reason, as we will see in the next section, is that different approaches are useful in different circumstances. The best approach to use is whichever one happens to be the most convenient for the problem at hand.

Concept Questions

10.5a What are the top-down and bottom-up definitions of operating cash flow?

10.5b What is meant by the term *depreciation tax shield*?

10.6 Some Special Cases of Discounted Cash Flow Analysis

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To finish our chapter, we look at three common cases involving discounted cash flow analysis. The first case involves investments that are primarily aimed at improving efficiency and thereby cutting costs. The second case we consider comes up when a firm is involved in submitting competitive bids. The third and final case arises in choosing between equipment options with different economic lives.

We could consider many other special cases, but these three are particularly important because problems similar to these are so common. Also, they illustrate some diverse applications of cash flow analysis and DCF valuation.

EVALUATING COST-CUTTING PROPOSALS

One decision we frequently face is whether to upgrade existing facilities to make them more cost-effective. The issue is whether the cost savings are large enough to justify the necessary capital expenditure.

For example, suppose we are considering automating some part of an existing production process. The necessary equipment costs $80,000 to buy and install. The automation will save $22,000 per year (before taxes) by reducing labor and material costs. For simplicity, assume that the equipment has a five-year life and is depreciated to zero on a straight-line basis over that period. It will actually be worth $20,000 in five years. Should we automate? The tax rate is 21 percent, and the discount rate is 10 percent.

As always, the first step in making such a decision is to identify the relevant incremental cash flows. First, determining the relevant capital spending is easy enough. The initial cost is $80,000. The aftertax salvage value is $20,000 × (1 − .21) = $15,800 because the book value will be zero in five years. Second, there are no working capital consequences here, so we don't need to worry about changes in net working capital.

Operating cash flows are the third component to consider. Buying the new equipment affects our operating cash flows in two ways. First, we save $22,000 before taxes every year. In other words, the firm's operating income increases by $22,000, so this is the relevant incremental project operating income.

Second (and it's easy to overlook this), we have an additional depreciation deduction. In this case, the depreciation is $80,000/5 = $16,000 per year.

Because the project has an operating income of $22,000 (the annual pretax cost saving) and a depreciation deduction of $16,000, taking the project will increase the firm's EBIT by $22,000 − 16,000 = $6,000, so this is the project's EBIT.

Finally, because EBIT is rising for the firm, taxes will increase. This increase in taxes will be $6,000 × .21 = $1,260. With this information, we can compute operating cash flow in the usual way:

EBIT	$ 6,000
+ Depreciation	16,000
− Taxes	1,260
Operating cash flow	$20,740

So, our aftertax operating cash flow is $20,740.

It might be somewhat more enlightening to calculate operating cash flow using a different approach. What is actually going on here is very simple. First, the cost savings increase our pretax income by $22,000. We have to pay taxes on this amount, so our tax bill increases by .21 × $22,000 = $4,620. In other words, the $22,000 pretax saving amounts to $22,000 × (1 − .21) = $17,380 after taxes.

Second, the extra $16,000 in depreciation isn't really a cash outflow, but it does reduce our taxes by $16,000 × .21 = $3,360. The sum of these two components is $17,380 + 3,360 = $20,740, as we had before. Notice that the $3,360 is the depreciation tax shield we discussed earlier, and we have effectively used the tax shield approach here.

We can now finish our analysis. Based on our discussion, here are the relevant cash flows:

	Year					
	0	1	2	3	4	5
Operating cash flow		$20,740	$20,740	$20,740	$20,740	$20,740
Capital spending	−$80,000					15,800
Total cash flow	−$80,000	$20,740	$20,740	$20,740	$20,740	$36,540

At 10 percent, it's straightforward to verify that the NPV here is $8,431, so we should go ahead and automate.

To Buy or Not to Buy

EXAMPLE 10.3

We are considering the purchase of a $200,000 computer-based inventory management system. It will be depreciated straight-line to zero over its four-year life. It will be worth $30,000 at the end of that time. The system will save us $60,000 before taxes in inventory-related costs. The relevant tax rate is 21 percent. Because the new setup is more efficient than our existing one, we will be able to carry less total inventory and thus free up $45,000 in net working capital. What is the NPV at 16 percent? What is the DCF return (the IRR) on this investment?

We can first calculate the operating cash flow. The aftertax cost savings are $60,000 × (1 − .21) = $47,400. The depreciation is $200,000/4 = $50,000 per year, so the depreciation tax shield is $50,000 × .21 = $10,500. Operating cash flow is $47,400 + 10,500 = $57,900 per year.

The capital spending involves $200,000 up front to buy the system. The aftertax salvage is $30,000 × (1 − .21) = $23,700. Finally, and this is the somewhat tricky part, the initial investment in net working capital is a $45,000 *inflow* because the system frees up working capital. Furthermore, we will have to put this back in at the end of the project's life. What this really means is simple: While the system is in operation, we have $45,000 to use elsewhere.

To finish our analysis, we can compute the total cash flows:

	Year				
	0	1	2	3	4
Operating cash flow		$57,900	$57,900	$57,900	$57,900
Change in NWC	$ 45,000				− 45,000
Capital spending	− 200,000				23,700
Total cash flow	−$155,000	$57,900	$57,900	$57,900	$36,600

At 16 percent, the NPV is −$4,749, so the investment is not attractive. After some trial and error, we find that the NPV is zero when the discount rate is 14.36 percent, so the IRR on this investment is about 14.4 percent.

SETTING THE BID PRICE

Early on, we used discounted cash flow analysis to evaluate a proposed new product. A somewhat different (and common) scenario arises when we must submit a competitive bid to win a job. Under such circumstances, the winner is whoever submits the lowest bid.

There is an old joke concerning this process: The low bidder is whoever makes the biggest mistake. This is called the winner's curse. In other words, if you win, there is a good chance you underbid. In this section, we look at how to go about setting the bid price to avoid the winner's curse. The procedure we describe is useful anytime we have to set a price on a product or service.

To illustrate how to go about setting a bid price, imagine we are in the business of buying stripped-down truck platforms and then modifying them to customer specifications for resale. A local distributor has requested bids for five specially modified trucks each year for the next four years, for a total of 20 trucks in all.

We need to decide what price per truck to bid. The goal of our analysis is to determine the lowest price we can profitably charge. This maximizes our chances of being awarded the contract while guarding against the winner's curse.

Suppose we can buy the truck platforms for $10,000 each. The facilities we need can be leased for $24,000 per year. The labor and material cost to do the modification works out to be about $4,000 per truck. Total cost per year will thus be $24,000 + 5 × (10,000 + 4,000) = $94,000.

We will need to invest $60,000 in new equipment. This equipment will be depreciated straight-line to a zero salvage value over the four years. It will be worth about $5,000 at the end of that time. We will also need to invest $40,000 in raw materials inventory and other working capital items. The relevant tax rate is 21 percent. What price per truck should we bid if we require a 20 percent return on our investment?

We start by looking at the capital spending and net working capital investment. We have to spend $60,000 today for new equipment. The aftertax salvage value is $5,000 × (1 − .21) = $3,950. Furthermore, we have to invest $40,000 today in working capital. We will get this back in four years.

We can't determine the operating cash flow just yet because we don't know the sales price. If we draw a time line, here is what we have so far:

	Year				
	0	1	2	3	4
Operating cash flow		+OCF	+OCF	+OCF	+OCF
Change in NWC	−$ 40,000				$40,000
Capital spending	− 60,000				3,950
Total cash flow	−$100,000	+OCF	+OCF	+OCF	+OCF + $43,950

With this in mind, note that the key observation is the following: The lowest possible price we can profitably charge will result in a zero NPV at 20 percent. At that price, we earn exactly 20 percent on our investment.

Given this observation, we first need to determine what the operating cash flow must be for the NPV to equal zero. To do this, we calculate the present value of the $43,050 non-operating cash flow from the last year and subtract it from the $100,000 initial investment:

$$\$100{,}000 - 43{,}950/1.20^4 = \$100{,}000 - 21{,}195 = \$78{,}805$$

Once we have done this, our time line is as follows:

	Year				
	0	1	2	3	4
Total cash flow	−$78,805	+OCF	+OCF	+OCF	+OCF

As the time line suggests, the operating cash flow is now an unknown ordinary annuity amount. The four-year annuity factor for 20 percent is 2.58873, so we have:

$$\text{NPV} = 0 = -\$78{,}805 + \text{OCF} \times 2.58873$$

This implies that:

$$\text{OCF} = \$78{,}805/2.58873 = \$30{,}442$$

So the operating cash flow needs to be $30,442 each year.

We're not quite finished. The final problem is to find out what sales price results in an operating cash flow of \$30,442. The easiest way to do this is to recall that operating cash flow can be written as net income plus depreciation (the bottom-up definition). The depreciation here is \$60,000/4 = \$15,000. Given this, we can determine what net income must be:

$$\begin{aligned}\text{Operating cash flow} &= \text{Net income} + \text{Depreciation}\\ \$30{,}442 &= \text{Net income} + \$15{,}000\\ \text{Net income} &= \$15{,}442\end{aligned}$$

From here, we work our way backward up the income statement. If net income is \$15,442, then our income statement is as follows:

Sales	?
Costs	\$94,000
Depreciation	15,000
Taxes (21%)	?
Net income	\$15,442

We can solve for sales by noting that:

$$\begin{aligned}\text{Net income} &= (\text{Sales} - \text{Costs} - \text{Depreciation}) \times (1 - T_C)\\ \$15{,}442 &= (\text{Sales} - \$94{,}000 - \$15{,}000) \times (1 - .21)\\ \text{Sales} &= \$15{,}442/.79 + 94{,}000 + 15{,}000\\ &= \$128{,}546\end{aligned}$$

Sales per year must be \$128,546. Because the contract calls for five trucks per year, the sales price has to be \$128,546/5 = \$25,709. If we round this up a bit, it looks as though we need to bid about \$26,000 per truck. At this price, were we to get the contract, our return would be just over 20 percent.

EVALUATING EQUIPMENT OPTIONS WITH DIFFERENT LIVES

The final problem we consider involves choosing among different possible systems, equipment setups, or procedures. Our goal is to choose the most cost-effective alternative. The approach we consider here is necessary only when two special circumstances exist. First, the possibilities under evaluation have different economic lives. Second, and just as important, we will need whatever we buy more or less indefinitely. As a result, when it wears out, we will buy another one.

We can illustrate this problem with a simple example. Imagine we are in the business of manufacturing stamped metal subassemblies. Whenever a stamping mechanism wears out, we have to replace it with a new one to stay in business. We are considering which of two stamping mechanisms to buy.

Machine A costs \$100 to buy and \$10 per year to operate. It wears out and must be replaced every two years. Machine B costs \$140 to buy and \$8 per year to operate. It lasts for three years and must then be replaced. Ignoring taxes, which one should we choose if we use a 10 percent discount rate?

In comparing the two machines, we notice that the first is cheaper to buy, but it costs more to operate and it wears out more quickly. How can we evaluate these trade-offs? We can start by computing the present value of the costs for each:

$$\text{Machine A: PV} = -\$100 + -10/1.1 + -10/1.1^2 = -\$117.36$$
$$\text{Machine B: PV} = -\$140 + -8/1.1 + -8/1.1^2 + -8/1.1^3 = -\$159.89$$

Notice that *all* the numbers here are costs, so they all have negative signs. If we stopped here, it might appear that A is more attractive because the PV of the costs is less. However, all we have really discovered so far is that A effectively provides two years' worth of stamping service for \$117.36, whereas B effectively provides three years' worth for \$159.89. These costs are not directly comparable because of the difference in service periods.

We need to somehow work out a cost per year for these two alternatives. To do this, we ask: What amount, paid each year over the life of the machine, has the same PV of costs? This amount is called the **equivalent annual cost (EAC)**.

equivalent annual cost (EAC)
The present value of a project's costs calculated on an annual basis.

Calculating the EAC involves finding an unknown payment amount. For example, for Machine A, we need to find a two-year ordinary annuity with a PV of −\$117.36 at 10 percent. Going back to Chapter 6, we know that the two-year annuity factor is:

$$\text{Annuity factor} = (1 - 1/1.10^2)/.10 = 1.7355$$

For Machine A, then, we have:

$$\begin{aligned}\text{PV of costs} = -\$117.36 &= \text{EAC} \times 1.7355 \\ \text{EAC} &= -\$117.36/1.7355 \\ &= -\$67.62\end{aligned}$$

For Machine B, the life is three years, so we first need the three-year annuity factor:

$$\text{Annuity factor} = (1 - 1/1.10^3)/.10 = 2.4869$$

We calculate the EAC for B just as we did for A:

$$\begin{aligned}\text{PV of costs} = -\$159.89 &= \text{EAC} \times 2.4869 \\ \text{EAC} &= -\$159.89/2.4869 \\ &= -\$64.30\end{aligned}$$

Based on this analysis, we should purchase B because it effectively costs \$64.30 per year versus \$67.62 for A. In other words, all things considered, B is cheaper. In this case, the longer life and lower operating cost are more than enough to offset the higher initial purchase price.

EXAMPLE 10.4 Equivalent Annual Costs

This extended example illustrates what happens to the EAC when we consider taxes. You are evaluating two different pollution control options. A filtration system will cost \$1.1 million to install and \$60,000 annually, before taxes, to operate. It will have to be completely replaced every five years. A precipitation system will cost \$1.9 million to install but only \$10,000 per year to operate. The precipitation equipment has an effective operating life of eight years. Straight-line depreciation is used throughout, and neither system has any salvage value. Which option should we select if we use a 12 percent discount rate? The tax rate is 21 percent.

We need to consider the EACs for the two systems because they have different service lives and will be replaced as they wear out. The relevant information can be summarized as follows:

	Filtration System	Precipitation System
Aftertax operating cost	−\$ 47,400	−\$ 7,900
Depreciation tax shield	46,200	49,875
Operating cash flow	−\$ 1,200	\$ 41,975
Economic life	5 years	8 years
Annuity factor (12%)	3.6048	4.9676
Present value of operating cash flow	−\$ 4,326	\$ 208,517
Capital spending	− 1,100,000	− 1,900,000
Total PV of costs	−\$1,104,326	−\$1,691,483

Notice that the operating cash flow is actually positive in the second case because of the large depreciation tax shield. This can occur whenever the operating cost is small relative to the purchase price.

To decide which system to purchase, we compute the EACs for both using the appropriate annuity factors:

$$\text{Filtration system: } -\$1{,}104{,}326 = \text{EAC} \times 3.6048$$
$$\text{EAC} = -\$306{,}351$$
$$\text{Precipitation system: } -\$1{,}691{,}483 = \text{EAC} \times 4.9676$$
$$\text{EAC} = -\$340{,}500$$

The filtration system is the cheaper of the two, so we select it. In this case, the longer life and smaller operating cost of the precipitation system are insufficient to offset its higher initial cost.

Concept Questions

10.6a In setting a bid price, we used a zero NPV as our benchmark. Explain why this is appropriate.

10.6b Under what circumstances do we have to worry about unequal economic lives? How do you interpret the EAC?

10.7 Summary and Conclusions

This chapter has described how to put together a discounted cash flow analysis. In it, we covered:

1. The identification of relevant project cash flows: We discussed project cash flows and described how to handle some issues that often come up, including sunk costs, opportunity costs, financing costs, net working capital, and erosion.
2. Preparing and using pro forma, or projected, financial statements: We showed how information from such financial statements is useful in coming up with projected cash flows, and we also looked at some alternative definitions of operating cash flow.
3. The role of net working capital and depreciation in determining project cash flows: We saw that including the change in net working capital was important in cash flow analysis because it adjusted for the discrepancy between accounting revenues and costs and cash revenues and costs. We also went over the calculation of depreciation expense under current tax law.
4. Some special cases encountered in using discounted cash flow analysis: Here we looked at three special issues. First, we evaluated cost-cutting investments. Next, we examined how to go about setting a bid price. Finally, we looked at unequal lives problem.

The discounted cash flow analysis we've covered here is a standard tool in the business world. It is a very powerful tool, so care should be taken in its use. The most important thing is to identify the cash flows in a way that makes economic sense. This chapter gives you a good start in learning how to do this.

CONNECT TO FINANCE

Connect Finance offers you plenty of opportunities to practice mastering these concepts. Log on to connect.mheducation.com to learn more. If you like what you see, ask your professor about using *Connect Finance*!

Can you answer the following *Connect* Quiz questions?

Section 10.1 The analysis of a project based on the project's relevant cash flows is referred to as the ______________.

Section 10.2 What should NOT be included as an incremental cash flow for a proposed project?

Section 10.3 A project has projected sales of $62,000, costs of $48,000, depreciation expense of $6,200, and a tax rate of 21 percent. What is the operating cash flow for this project?

Section 10.4 An asset costs $24,000 and is classified as three-year MACRS property. What is the depreciation expense in Year 2?

Section 10.5 A firm has sales for the year of $92,000, costs of $46,000, and taxes of $21,000. What is the operating cash flow for the year?

Section 10.6 What rate of return will a firm earn if it accepts a project with a sales price per unit set equal to the bid price?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

10.1 Capital Budgeting for Project X Based on the following information for Project X, should we undertake the venture? To answer, first prepare a pro forma income statement for each year. Next calculate operating cash flow. Finish the problem by determining total cash flow and then calculating NPV assuming a 28 percent required return. Use a 21 percent tax rate throughout. For help, look back at our shark attractant and power mulcher examples.

Project X involves a new type of graphite composite in-line skate wheel. We think we can sell 6,000 units per year at a price of $1,000 each. Variable costs will run about $400 per unit, and the product should have a four-year life.

Fixed costs for the project will run $450,000 per year. Further, we will need to invest a total of $1,250,000 in manufacturing equipment. This equipment is seven-year MACRS property for tax purposes. In four years, the equipment will be worth about half of what we paid for it. We will have to invest $1,150,000 in net working capital at the start. After that, net working capital requirements will be 25 percent of sales.

10.2 Calculating Operating Cash Flow Mont Blanc Livestock Pens, Inc., has projected a sales volume of $1,650 for the second year of a proposed expansion project. Costs normally run 60 percent of sales, or about $990 in this case. The depreciation expense will be $100, and the tax rate is 21 percent. What is the operating cash flow? Calculate your answer using all of the approaches (including the top-down, bottom-up, and tax shield approaches) described in the chapter.

10.3 Spending Money to Save Money? For help on this one, refer back to the computerized inventory management system in Example 10.3. Here, we're contemplating a new automatic surveillance system to replace our current contract security system. It will cost $450,000 to get the new system. The cost will be depreciated straight-line to zero over the system's four-year expected life. The system is expected to be worth $250,000 at the end of four years after removal costs.

We think the new system will save us $125,000 per year, before taxes, in contract security costs. The tax rate is 21 percent. What are the NPV and IRR for buying the new system? The required return is 17 percent.

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

10.1 To develop the pro forma income statements, we need to calculate the depreciation for each of the four years. The relevant MACRS percentages, depreciation allowances, and book values for the first four years are shown here:

Year	MACRS Percentage	Depreciation	Ending Book Value
1	14.29%	.1429 × $1,250,000 = $178,625	$1,071,375
2	24.49	.2449 × 1,250,000 = 306,125	765,250
3	17.49	.1749 × 1,250,000 = 218,625	546,625
4	12.49	.1249 × 1,250,000 = 156,125	390,500

The projected income statements, therefore, are as follows:

	Year			
	1	2	3	4
Sales	$6,000,000	$6,000,000	$6,000,000	$6,000,000
Variable costs	2,400,000	2,400,000	2,400,000	2,400,000
Fixed costs	450,000	450,000	450,000	450,000
Depreciation	178,625	306,125	218,625	156,125
EBIT	$2,971,375	$2,843,875	$2,931,375	$2,993,875
Taxes (21%)	623,989	597,214	615,589	628,714
Net income	$2,347,386	$2,246,661	$2,315,786	$2,365,161

Based on this information, here are the operating cash flows:

	Year			
	1	2	3	4
EBIT	$2,971,375	$2,843,875	$2,931,375	$2,993,875
Depreciation	178,625	306,125	218,625	156,125
Taxes	623,989	597,214	615,589	628,714
Operating cash flow	$2,526,011	$2,552,786	$2,534,411	$2,521,286

We now have to worry about the nonoperating cash flows. Net working capital starts out at $1,150,000 and then rises to 25 percent of sales, or $1,500,000. This is a $350,000 change in net working capital.

Finally, we have to invest $1,250,000 to get started. In four years, the book value of this investment will be $390,500, compared to an estimated market value of $625,000 (half of the cost). The aftertax salvage is thus $625,000 − .21 × ($625,000 − 390,500) = $575,755.

When we combine all this information, the projected cash flows for Project X are as follows:

	Year				
	0	1	2	3	4
Operating cash flow		$2,526,011	$2,552,786	$2,534,411	$2,521,286
Change in NWC	−$1,150,000	− 350,000			1,500,000
Capital spending	− 1,250,000				575,755
Total cash flow	−$2,400,000	$2,176,011	$2,552,786	$2,534,411	$4,597,041

With these cash flows, the NPV at 28 percent is:

$$\begin{aligned} \text{NPV} &= -\$2{,}400{,}000 + 2{,}176{,}011/1.28 + 2{,}552{,}786/1.28^2 \\ &\quad +2{,}534{,}411/1.28^3 + 4{,}597{,}041/1.28^4 \\ &= \$3{,}779{,}139 \end{aligned}$$

So, this project appears to be quite profitable.

10.2 First, we can calculate the project's EBIT, its tax bill, and its net income:

$$\begin{aligned} \text{EBIT} &= \text{Sales} - \text{Costs} - \text{Depreciation} \\ &= \$1{,}650 - 990 - 100 = \$560 \\ \text{Taxes} &= \$560 \times .21 = \$118 \\ \text{Net income} &= \$560 - 118 = \$442 \end{aligned}$$

With these numbers, operating cash flow is:

$$\begin{aligned} \text{OCF} &= \text{EBIT} + \text{Depreciation} - \text{Taxes} \\ &= \$560 + 100 - 118 \\ &= \$542 \end{aligned}$$

Using the other OCF definitions, we have:

$$\begin{aligned} \text{Bottom-up OCF} &= \text{Net income} + \text{Depreciation} \\ &= \$442 + 100 \\ &= \$542 \end{aligned}$$

$$\begin{aligned} \text{Top-down OCF} &= \text{Sales} - \text{Costs} - \text{Taxes} \\ &= \$1{,}650 - 990 - 118 \\ &= \$542 \end{aligned}$$

$$\begin{aligned} \text{Tax shield OCF} &= (\text{Sales} - \text{Costs}) \times (1 - .21) + \text{Depreciation} \times .21 \\ &= (\$1{,}650 - 990) \times .79 + 100 \times .21 \\ &= \$542 \end{aligned}$$

As expected, all of these definitions produce exactly the same answer.

10.3 The $125,000 pretax saving amounts to (1 − .21) × $125,000 = $98,750 after taxes. The annual depreciation of $450,000/4 = $112,500 generates a tax shield of .21 × $112,500 = $23,625 each year. Putting these together, we calculate that the operating cash flow is $98,750 + 23,625 = $122,375. Because the book value is zero in four years, the aftertax salvage value is (1 − .21) × $250,000 = $197,500. There are no working capital consequences, so here are the cash flows:

	Year				
	0	1	2	3	4
Operating cash flow		$122,375	$122,375	$122,375	$122,375
Capital spending	−$450,000				165,000
Total cash flow	−$450,000	$122,375	$122,375	$122,375	$287,375

You can verify that the NPV at 17 percent is −$26,244, and the return on the new surveillance system is only about 14.40 percent. The project does not appear to be profitable.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Opportunity Cost [LO1]** In the context of capital budgeting, what is an opportunity cost?
2. **Depreciation [LO1]** Given the choice, would a firm prefer to use MACRS depreciation or straight-line depreciation? Why?
3. **Net Working Capital [LO1]** In our capital budgeting examples, we assumed that a firm would recover all of the working capital it invested in a project. Is this a reasonable assumption? When might it not be valid?
4. **Stand-Alone Principle [LO1]** Suppose a financial manager is quoted as saying, “Our firm uses the stand-alone principle. Because we treat projects like minifirms in our evaluation process, we include financing costs because they are relevant at the firm level.” Critically evaluate this statement.
5. **Equivalent Annual Cost [LO4]** When is EAC analysis appropriate for comparing two or more projects? Why is this method used? Are there any implicit assumptions required by this method that you find troubling? Explain.
6. **Cash Flow and Depreciation [LO1]** “When evaluating projects, we’re concerned with only the relevant incremental aftertax cash flows. Therefore, because depreciation is a noncash expense, we should ignore its effects when evaluating projects.” Critically evaluate this statement.
7. **Capital Budgeting Considerations [LO1]** A major college textbook publisher has an existing finance textbook. The publisher is debating whether to produce an “essentialized” version, meaning a shorter (and lower-priced) book. What are some of the considerations that should come into play?

To answer the next three questions, refer to the following example. In 2003, Porsche unveiled its new sports utility vehicle (SUV), the Cayenne. With a price tag of over $40,000, the Cayenne went from zero to 62 mph in 9.7 seconds. Porsche’s decision to enter the SUV market was a response to the runaway success of other high-priced SUVs such as the Mercedes-Benz M-class. Vehicles in this class had generated years of high profits. The Cayenne certainly spiced up the market, and Porsche subsequently introduced the Cayenne Turbo S, which goes from zero to 60 mph in 3.8 seconds and has a top speed of 176 mph. The price tag for the Cayenne Turbo S in 2018? About $130,000!

Some analysts questioned Porsche’s entry into the luxury SUV market. The analysts were concerned not only that Porsche was a late entry into the market, but also that the introduction of the Cayenne would damage Porsche’s reputation as a maker of high-performance automobiles.

8. **Erosion** [LO1] In evaluating the Cayenne, would you use the term *erosion* to describe the possible damage to Porsche's reputation?
9. **Capital Budgeting** [LO1] Porsche was one of the last manufacturers to enter the sports utility vehicle market. Why would one company decide to proceed with a product when other companies, at least initially, decide not to enter the market?
10. **Capital Budgeting** [LO1] In evaluating the Cayenne, what do you think Porsche needs to assume regarding the substantial profit margins that exist in this market? Is it likely they will be maintained as the market becomes more competitive, or will Porsche be able to maintain the profit margin because of its image and the performance of the Cayenne?

QUESTIONS AND PROBLEMS

connect

BASIC
(Questions 1–20)

1. **Relevant Cash Flows** [LO1] Parker & Stone, Inc., is looking at setting up a new manufacturing plant in South Park to produce garden tools. The company bought some land six years ago for $3.6 million in anticipation of using it as a warehouse and distribution site, but the company has since decided to rent these facilities from a competitor instead. If the land were sold today, the company would net $4.1 million. The company wants to build its new manufacturing plant on this land; the plant will cost $18.1 million to build, and the site requires $950,000 worth of grading before it is suitable for construction. What is the proper cash flow amount to use as the initial investment in fixed assets when evaluating this project? Why?
2. **Relevant Cash Flows** [LO1] Winnebagel Corp. currently sells 20,000 motor homes per year at $97,000 each and 14,000 luxury motor coaches per year at $145,000 each. The company wants to introduce a new portable camper to fill out its product line; it hopes to sell 30,000 of these campers per year at $21,000 each. An independent consultant has determined that if the company introduces the new campers, it should boost the sales of its existing motor homes by 2,700 units per year and reduce the sales of its motor coaches by 1,300 units per year. What is the amount to use as the annual sales figure when evaluating this project? Why?
3. **Calculating Projected Net Income** [LO1] A proposed new investment has projected sales of $585,000. Variable costs are 44 percent of sales, and fixed costs are $187,000; depreciation is $51,000. Prepare a pro forma income statement assuming a tax rate of 21 percent. What is the projected net income?
4. **Calculating OCF** [LO1] Consider the following income statement:

Sales	$747,300
Costs	582,600
Depreciation	89,300
EBIT	?
Taxes (22%)	?
Net income	?

Fill in the missing numbers and then calculate the OCF. What is the depreciation tax shield?

5. **OCF from Several Approaches** [LO1] A proposed new project has projected sales of $175,000, costs of $93,000, and depreciation of $24,800. The tax rate is 23 percent. Calculate operating cash flow using the four different approaches described in the chapter and verify that the answer is the same in each case.

6. **Calculating Depreciation** [LO1] A piece of newly purchased industrial equipment costs $1,375,000 and is classified as seven-year property under MACRS. Calculate the annual depreciation allowances and end-of-the-year book values for this equipment.

7. **Calculating Salvage Value** [LO1] Consider an asset that costs $680,000 and is depreciated straight-line to zero over its eight-year tax life. The asset is to be used in a five-year project; at the end of the project, the asset can be sold for $143,000. If the relevant tax rate is 21 percent, what is the aftertax cash flow from the sale of this asset?

8. **Calculating Salvage Value** [LO1] An asset used in a four-year project falls in the five-year MACRS class for tax purposes. The asset has an acquisition cost of $5,100,000 and will be sold for $1,600,000 at the end of the project. If the tax rate is 21 percent, what is the aftertax salvage value of the asset?

9. **Calculating Project OCF** [LO1] Quad Enterprises is considering a new three-year expansion project that requires an initial fixed asset investment of $2.32 million. The fixed asset will be depreciated straight-line to zero over its three-year tax life, after which time it will be worthless. The project is estimated to generate $1.735 million in annual sales, with costs of $650,000. If the tax rate is 21 percent, what is the OCF for this project?

10. **Calculating Project NPV** [LO1] In the previous problem, suppose the required return on the project is 12 percent. What is the project's NPV?

11. **Calculating Project Cash Flow from Assets** [LO1] In the previous problem, suppose the project requires an initial investment in net working capital of $250,000, and the fixed asset will have a market value of $180,000 at the end of the project. What is the project's Year 0 net cash flow? Year 1? Year 2? Year 3? What is the new NPV?

12. **NPV and MACRS** [LO1] In the previous problem, suppose the fixed asset actually falls into the three-year MACRS class. All the other facts are the same. What is the project's Year 1 net cash flow now? Year 2? Year 3? What is the new NPV?

13. **NPV and Bonus Depreciation** [LO1] In the previous problem, suppose the fixed asset actually qualifies for 100 percent bonus depreciation in the first year. All the other facts are the same. What is the project's Year 1 net cash flow now? Year 2? Year 3? What is the new NPV?

14. **Project Evaluation** [LO1] Dog Up! Franks is looking at a new sausage system with an installed cost of $460,000. This cost will be depreciated straight-line to zero over the project's five-year life, at the end of which the sausage system can be scrapped for $55,000. The sausage system will save the firm $155,000 per year in pretax operating costs, and the system requires an initial investment in net working capital of $29,000. If the tax rate is 21 percent and the discount rate is 10 percent, what is the NPV of this project?

15. **NPV and Bonus Depreciation** [LO1] In the previous problem, suppose the fixed asset actually qualifies for 100 percent bonus depreciation in the first year. What is the new NPV?

16. **Project Evaluation** [LO1] Your firm is contemplating the purchase of a new $485,000 computer-based order entry system. The system will be depreciated straight-line to zero over its five-year life. It will be worth $35,000 at the end of that time. You will save $140,000 before taxes per year in order processing costs, and you will be able to reduce working capital by $60,000 (this is a one-time reduction). If the tax rate is 24 percent, what is the IRR for this project?

17. **Project Evaluation** [LO2] In the previous problem, suppose your required return on the project is 11 percent and your pretax cost savings are $150,000 per year. Will you accept the project? What if the pretax cost savings are $100,000 per year? At

what level of pretax cost savings would you be indifferent between accepting the project and not accepting it?

18. **Calculating EAC** [LO4] A five-year project has an initial fixed asset investment of \$315,000, an initial NWC investment of \$25,000, and an annual OCF of −\$35,000. The fixed asset is fully depreciated over the life of the project and has no salvage value. If the required return is 11 percent, what is this project's equivalent annual cost, or EAC?

19. **Calculating EAC** [LO4] You are evaluating two different silicon wafer milling machines. The Techron I costs \$245,000, has a three-year life, and has pretax operating costs of \$63,000 per year. The Techron II costs \$420,000, has a five-year life, and has pretax operating costs of \$35,000 per year. For both milling machines, use straight-line depreciation to zero over the project's life and assume a salvage value of \$40,000. If your tax rate is 22 percent and your discount rate is 10 percent, compute the EAC for both machines. Which do you prefer? Why?

20. **Calculating a Bid Price** [LO3] Martin Enterprises needs someone to supply it with 125,000 cartons of machine screws per year to support its manufacturing needs over the next five years, and you've decided to bid on the contract. It will cost you \$910,000 to install the equipment necessary to start production; you'll depreciate this cost straight-line to zero over the project's life. You estimate that, in five years, this equipment can be salvaged for \$85,000. Your fixed production costs will be \$485,000 per year, and your variable production costs should be \$17.35 per carton. You also need an initial investment in net working capital of \$90,000. If your tax rate is 21 percent and you require a return of 12 percent on your investment, what bid price should you submit?

INTERMEDIATE
(Questions 21–33)

21. **Cost-Cutting Proposals** [LO2] Masters Machine Shop is considering a four-year project to improve its production efficiency. Buying a new machine press for \$385,000 is estimated to result in \$145,000 in annual pretax cost savings. The press falls in the MACRS five-year class, and it will have a salvage value at the end of the project of \$45,000. The press also requires an initial investment in spare parts inventory of \$20,000, along with an additional \$3,100 in inventory for each succeeding year of the project. If the shop's tax rate is 22 percent and its discount rate is 9 percent, should the company buy and install the machine press?

22. **NPV and Bonus Depreciation** [LO1] Eggz, Inc., is considering the purchase of new equipment that will allow the company to collect loose hen feathers for sale. The equipment will cost \$425,000 and will be eligible for 100 percent bonus depreciation. The equipment can be sold for \$25,000 at the end of the project in 5 years. Sales would be \$275,000 per year, with annual fixed costs of \$47,000 and variable costs equal to 35 percent of sales. The project would require an investment of \$25,000 in NWC that would be returned at the end of the project. The tax rate is 22 percent and the required return is 9 percent. What is the project's NPV?

23. **Comparing Mutually Exclusive Projects** [LO1] Letang Industrial Systems Company (LISC) is trying to decide between two different conveyor belt systems. System A costs \$265,000, has a four-year life, and requires \$73,000 in pretax annual operating costs. System B costs \$345,000, has a six-year life, and requires \$67,000 in pretax annual operating costs. Both systems are to be depreciated straight-line to zero over their lives and will have zero salvage value. Whichever project is chosen, it will *not* be replaced when it wears out. If the tax rate is 21 percent and the discount rate is 8 percent, which project should the firm choose?

24. **Comparing Mutually Exclusive Projects** [LO4] Suppose in the previous problem that the company always needs a conveyor belt system; when one wears out, it must be replaced. Which project should the firm choose now?

25. Calculating a Bid Price [LO3] Consider a project to supply 100 million postage stamps per year to the U.S. Postal Service for the next five years. You have an idle parcel of land available that cost $750,000 five years ago; if the land were sold today, it would net you $1,125,000 aftertax. The land can be sold for $1,295,000 after taxes in five years. You will need to install $5.1 million in new manufacturing plant and equipment to actually produce the stamps; this plant and equipment will be depreciated straight-line to zero over the project's five-year life. The equipment can be sold for $450,000 at the end of the project. You will also need $425,000 in initial net working capital for the project, and an additional investment of $50,000 in every year thereafter. Your production costs are .38 cents per stamp, and you have fixed costs of $1.1 million per year. If your tax rate is 23 percent and your required return on this project is 10 percent, what bid price should you submit on the contract?

26. Interpreting a Bid Price [LO3] In the previous problem, suppose you were going to use a three-year MACRS depreciation schedule for your manufacturing equipment and you could keep working capital investments down to only $25,000 per year. How would this new information affect your calculated bid price? What if you used 100 bonus depreciation?

27. Comparing Mutually Exclusive Projects [LO4] Vandelay Industries is considering the purchase of a new machine for the production of latex. Machine A costs $2,900,000 and will last for six years. Variable costs are 35 percent of sales, and fixed costs are $210,000 per year. Machine B costs $5,800,000 and will last for nine years. Variable costs for this machine are 30 percent of sales and fixed costs are $245,000 per year. The sales for each machine will be $13 million per year. The required return is 10 percent, and the tax rate is 24 percent. Both machines will be depreciated on a straight-line basis. If the company plans to replace the machine when it wears out on a perpetual basis, which machine should it choose?

28. Equivalent Annual Cost [LO4] Light-emitting diode (LED) light bulbs have become required in recent years, but do they make financial sense? Suppose a typical 60-watt incandescent light bulb costs $.45 and lasts for 1,000 hours. A 7-watt LED, which provides the same light, costs $2.25 and lasts for 40,000 hours. A kilowatt-hour of electricity costs $.121, which is about the national average. A kilowatt-hour is 1,000 watts for 1 hour. If you require a 10 percent return and use a light fixture 500 hours per year, what is the equivalent annual cost of each lightbulb?

29. Break-Even Cost [LO2] The previous problem suggests that using LEDs instead of incandescent bulbs is a no-brainer. However, electricity costs actually vary quite a bit depending on location and user type (you can get information on your rates from your local power company). An industrial user in West Virginia might pay $.04 per kilowatt-hour whereas a residential user in Hawaii might pay $.25. What's the break-even cost per kilowatt-hour in Problem 25?

30. Break-Even Replacement [LO2] The previous two problems suggest that using LEDs is a good idea from a purely financial perspective unless you live in an area where power is relatively inexpensive, but there is another wrinkle. Suppose you have a residence with a lot of incandescent bulbs that are used on average 500 hours a year. The average bulb will be about halfway through its life, so it will have 500 hours remaining (and you can't tell which bulbs are older or newer). At what cost per kilowatt-hour does it make sense to replace your incandescent bulbs today?

31. Issues in Capital Budgeting [LO1] Before LEDs became a popular replacement for incandescent light bulbs, compact fluorescent lamps (CFLs) were hailed as the new generation of lighting. However, CFLs had even more wrinkles. In no particular order:

1. Incandescent bulbs generate a lot more heat than CFLs.

2. CFL prices will probably decline relative to incandescent bulbs.
3. CFLs unavoidably contain small amounts of mercury, a significant environmental hazard, and special precautions must be taken in disposing of burned-out units (and also in cleaning up a broken lamp). Currently, there is no agreed-upon way to recycle a CFL. Incandescent bulbs pose no disposal/breakage hazards.
4. Depending on a light's location (or the number of lights), there can be a nontrivial cost to change bulbs (i.e., labor cost in a business).
5. Coal-fired power generation accounts for a substantial portion of the mercury emissions in the U.S., though the emissions will drop sharply in the relatively near future.
6. Power generation accounts for a substantial portion of CO_2 emissions in the U.S.
7. CFLs are more energy and material intensive to manufacture. On-site mercury contamination and worker safety are issues.
8. If you install a CFL in a permanent lighting fixture in a building, you will probably move long before the CFL burns out.
9. Even as CFLs began to replace incandescent light bulbs, LEDs were in the latter stages of development. At the time, LEDs were much more expensive than CFLs, but costs were coming down. LEDs last much longer than CFLs and use even less power. Plus, LEDs don't contain mercury.

Qualitatively, how would these issues affect your position in the CFL versus incandescent light bulb debate? Some countries banned incandescent bulbs. Does your analysis suggest such a move was wise? Are there other regulations short of an outright ban that make sense to you?

32. **Replacement Decisions** [LO2] Your small remodeling business has two work vehicles. One is a small passenger car used for job site visits and for other general business purposes. The other is a heavy truck used to haul equipment. The car gets 25 miles per gallon (mpg). The truck gets 10 mpg. You want to improve gas mileage to save money, and you have enough money to upgrade one vehicle. The upgrade cost will be the same for both vehicles. An upgraded car will get 40 mpg; an upgraded truck will get 12.5 mpg. The cost of gasoline is $2.65 per gallon. Assuming an upgrade is a good idea in the first place, which one should you upgrade? Both vehicles are driven 12,000 miles per year.

33. **Replacement Decisions** [LO2] In the previous problem, suppose you drive the truck x miles per year. How many miles would you have to drive the car before upgrading the car would be the better choice? *Hint*: Look at the relative gas savings.

CHALLENGE (Questions 34–40)

34. **Calculating Project NPV** [LO1] You have been hired as a consultant for Pristine Urban-Tech Zither, Inc. (PUTZ), manufacturers of fine zithers. The market for zithers is growing quickly. The company bought some land three years ago for $1.9 million in anticipation of using it as a toxic waste dump site but has recently hired another company to handle all toxic materials. Based on a recent appraisal, the company believes it could sell the land for $2.1 million on an aftertax basis. In four years, the land could be sold for $2.3 million after taxes. The company also hired a marketing firm to analyze the zither market, at a cost of $175,000. An excerpt of the marketing report is as follows:

> The zither industry will have a rapid expansion in the next four years. With the brand name recognition that PUTZ brings to bear, we feel that the company will be able to sell 5,100, 5,800, 6,400, and 4,700 units each year for the next four years, respectively.

> Again, capitalizing on the name recognition of PUTZ, we feel that a premium price of $425 can be charged for each zither. Because zithers appear to be a fad, we feel at the end of the four-year period, sales should be discontinued.

PUTZ believes that fixed costs for the project will be $345,000 per year, and variable costs are 15 percent of sales. The equipment necessary for production will cost $2.65 million and will be depreciated according to a three-year MACRS schedule. At the end of the project, the equipment can be scrapped for $395,000. Net working capital of $125,000 will be required immediately. PUTZ has a tax rate of 22 percent, and the required return on the project is 13 percent. What is the NPV of the project?

35. **NPV and Bonus Depreciation [LO1]** In the previous problem, suppose the fixed asset actually qualifies for 100 percent bonus depreciation in the first year. What is the new NPV?

36. **Project Evaluation [LO1]** Aria Acoustics, Inc. (AAI), projects unit sales for a new seven-octave voice emulation implant as follows:

Year	Unit Sales
1	73,000
2	86,000
3	105,000
4	97,000
5	67,000

Production of the implants will require $1,500,000 in net working capital to start and additional net working capital investments each year equal to 15 percent of the projected sales increase for the following year. Total fixed costs are $3,200,000 per year, variable production costs are $255 per unit, and the units are priced at $375 each. The equipment needed to begin production has an installed cost of $16,500,000. Because the implants are intended for professional singers, this equipment is considered industrial machinery and thus qualifies as seven-year MACRS property. In five years, this equipment can be sold for about 20 percent of its acquisition cost. The tax rate is 21 percent and the required return is 18 percent. Based on these preliminary project estimates, what is the NPV of the project? What is the IRR?

37. **Calculating Required Savings [LO2]** A proposed cost-saving device has an installed cost of $735,000. The device will be used in a five-year project but is classified as three-year MACRS property for tax purposes. The required initial net working capital investment is $55,000, the tax rate is 22 percent, and the project discount rate is 9 percent. The device has an estimated Year 5 salvage value of $85,000. What level of pretax cost savings do we require for this project to be profitable?

38. **Financial Break-Even Analysis [LO2]** To solve the bid price problem presented in the text, we set the project NPV equal to zero and found the required price using the definition of OCF. Thus the bid price represents a financial break-even level for the project. This type of analysis can be extended to many other types of problems.

a. In Problem 20, assume that the price per carton is $26 and find the project NPV. What does your answer tell you about your bid price? What do you know about the number of cartons you can sell and still break even? How about your level of costs?

b. Solve Problem 20 again with the price still at $26, but find the quantity of cartons per year that you can supply and still break even. *Hint*: It's less than 125,000.

c. Repeat (b) with a price of $26 and a quantity of 125,000 cartons per year, and find the highest level of fixed costs you could afford and still break even. *Hint*: It's more than $485,000.

39. **Calculating a Bid Price [LO3]** Your company has been approached to bid on a contract to sell 4,800 voice recognition (VR) computer keyboards per year for four years. Due to technological improvements, beyond that time they will be outdated and no sales will be possible. The equipment necessary for the production will cost $3.1 million and will be depreciated on a straight-line basis to a zero salvage value. Production will require an investment in net working capital of $395,000 to be returned at the end of the project, and the equipment can be sold for $305,000 at the end of production. Fixed costs are $570,000 per year, and variable costs are $75 per unit. In addition to the contract, you feel your company can sell 11,400, 13,500, 17,900, and 10,400 additional units to companies in other countries over the next four years, respectively, at a price of $170. This price is fixed. The tax rate is 23 percent, and the required return is 10 percent. Additionally, the president of the company will undertake the project only if it has an NPV of $100,000. What bid price should you set for the contract?

40. **Replacement Decisions [LO2]** Suppose we are thinking about replacing an old computer with a new one. The old one cost us $1,560,000; the new one will cost $1,872,000. The new machine will be depreciated straight-line to zero over its five-year life. It will probably be worth about $360,000 after five years.

The old computer is being depreciated at a rate of $312,000 per year. It will be completely written off in three years. If we don't replace it now, we will have to replace it in two years. We can sell it now for $504,000; in two years, it will probably be worth $144,000. The new machine will save us $348,000 per year in operating costs. The tax rate is 22 percent, and the discount rate is 12 percent.

a. Suppose we recognize that if we don't replace the computer now, we will be replacing it in two years. Should we replace it now or should we wait? *Hint*: What we effectively have here is a decision either to "invest" in the old computer (by not selling it) or to invest in the new one. Notice that the two investments have unequal lives.

b. Suppose we consider only whether we should replace the old computer now without worrying about what's going to happen in two years. What are the relevant cash flows? Should we replace it or not? *Hint*: Consider the net change in the firm's aftertax cash flows if we do the replacement.

EXCEL MASTER IT! PROBLEM

xlsx

For this Master It! assignment, refer to the Conch Republic Electronics minicase below. For your convenience, we have entered the relevant values in the case such as the price and variable cost. For this project, answer the following questions:

a. What is the profitability index of the project?

b. What is the IRR of the project?

c. What is the NPV of the project?

d. At what price would Conch Republic Electronics be indifferent to accepting the project?

e. At what level of variable costs per unit would Conch Republic Electronics be indifferent to accepting the project?

MINICASE

Conch Republic Electronics, Part 1

Conch Republic Electronics is a midsized electronics manufacturer located in Key West, Florida. The company president is Shelley Couts, who inherited the company. When it was founded over 70 years ago, the company originally repaired radios and other household appliances. Over the years, the company expanded into manufacturing and is now a reputable manufacturer of various electronic items. Jay McCanless, a recent MBA graduate, has been hired by the company's finance department.

One of the major revenue-producing items manufactured by Conch Republic is a smartphone. Conch Republic currently has one smartphone model on the market, and sales have been excellent. The smartphone is a unique item in that it comes in a variety of tropical colors and is preprogrammed to play Jimmy Buffett music. However, as with any electronic item, technology changes rapidly, and the current smartphone has limited features in comparison with newer models. Conch Republic spent $750,000 to develop a prototype for a new smartphone that has all the features of the existing smartphone but adds new features such as WiFi tethering. The company has spent a further $200,000 for a marketing study to determine the expected sales figures for the new smartphone.

Conch Republic can manufacture the new smartphones for $220 each in variable costs. Fixed costs for the operation are estimated to run $6.4 million per year. The estimated sales volume is 155,000, 165,000, 125,000, 95,000, and 75,000 per year for the next five years, respectively. The unit price of the new smartphone will be $535. The necessary equipment can be purchased for $43.5 million and will be depreciated on a seven-year MACRS schedule. It is believed the value of the equipment in five years will be $6.5 million.

As previously stated, Conch Republic currently manufactures a smartphone. Production of the existing model is expected to be terminated in two years. If Conch Republic does not introduce the new smartphone, sales will be 95,000 units and 65,000 units for the next two years, respectively. The price of the existing smartphone is $385 per unit, with variable costs of $145 each and fixed costs of $4.3 million per year. If Conch Republic does introduce the new smartphone, sales of the existing smartphone will fall by 30,000 units per year, and the price of the existing units will have to be lowered to $215 each. Net working capital for the smartphones will be 20 percent of sales and will occur with the timing of the cash flows for the year; for example, there is no initial outlay for NWC, but changes in NWC will first occur in Year 1 with the first year's sales. Conch Republic has a 21 percent corporate tax rate and a required return of 12 percent.

Shelley has asked Jay to prepare a report that answers the following questions.

QUESTIONS

1. What is the payback period of the project?
2. What is the profitability index of the project?
3. What is the IRR of the project?
4. What is the NPV of the project?

Chapter 11

Project Analysis and Evaluation

IN THE SUMMER OF 2016, the movie *Ben-Hur*, starring Jack Huston and Morgan Freeman, thundered into theaters with the slogan, "First to finish. Last to die." But what died was the film's box office. One critic called it "a dull, clunking return to one of cinema's great warhorses." Others were even more harsh, saying the movie was "a digitalized eyesore hobbled in every department by staggering incompetence."

Looking at the numbers, *Ben-Hur*'s losses were epic. After production, distribution, and marketing costs, movie maker MGM and its partners were estimated to have lost as much as $120 million on the film. In fact, about 4 out of 10 movies lose money at the box office, though DVD sales often help the final tally. Of course, there are movies that do quite well. Also in 2016, the Twentieth Century Fox production *Deadpool* raked in about $782 million worldwide at a production cost of $58 million.

Obviously, MGM didn't *plan* to lose $120 million on *Ben-Hur*, but it happened. As this particular box office bomb shows, projects don't always go as companies think they will. This chapter explores how this can happen and what companies can do to analyze and possibly avoid these situations.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Perform and interpret a sensitivity analysis for a proposed investment.

LO2 Perform and interpret a scenario analysis for a proposed investment.

LO3 Determine and interpret cash, accounting, and financial break-even points.

LO4 Explain how the degree of operating leverage can affect the cash flows of a project.

LO5 Discuss how capital rationing affects the ability of a company to accept projects.

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In the previous chapter, we discussed how to identify and organize the relevant cash flows for capital investment decisions. Our primary interest there was in coming up with a preliminary estimate of the net present value for a proposed project. In this chapter, we focus on assessing the reliability of such an estimate and on some additional considerations in project analysis.

We begin by discussing the need for an evaluation of cash flow and NPV estimates. We go on to develop some useful tools for such an evaluation. We also examine additional complications and concerns that can arise in project evaluation.

Evaluating NPV Estimates 11.1

As we discussed in Chapter 9, an investment has a positive net present value if its market value exceeds its cost. Such an investment is desirable because it creates value for its owner. The primary problem in identifying such opportunities is that most of the time we can't actually observe the relevant market value. Instead, we estimate it. Having done so, it is only natural to wonder whether our estimates are at least close to the true values. We consider this question next.

THE BASIC PROBLEM

Suppose we are working on a preliminary discounted cash flow analysis along the lines we described in the previous chapter. We carefully identify the relevant cash flows, avoiding such things as sunk costs, and we remember to consider working capital requirements. We add back any depreciation; we account for possible erosion; and we pay attention to opportunity costs. Finally, we double-check our calculations; when all is said and done, the bottom line is that the estimated NPV is positive.

Now what? Do we stop here and move on to the next proposal? Probably not. The fact that the estimated NPV is positive is definitely a good sign; but, more than anything, this tells us that we need to take a closer look.

If you think about it, there are two circumstances under which a DCF analysis could lead us to conclude that a project has a positive NPV. The first possibility is that the project really does have a positive NPV. That's the good news. The bad news is the second possibility: A project may appear to have a positive NPV because our estimate is inaccurate.

Notice that we could also err in the opposite way. If we conclude that a project has a negative NPV when the true NPV is positive, we lose a valuable opportunity.

PROJECTED VERSUS ACTUAL CASH FLOWS

There is a somewhat subtle point we need to make here. When we say something like, "The projected cash flow in Year 4 is $700," what exactly do we mean? Does this mean that we think the cash flow will actually be $700? Not really. It could happen, of course, but we would be surprised to see it turn out exactly that way. The reason is that the $700 projection is based on only what we know today. Almost anything could happen between now and then to change that cash flow.

Loosely speaking, we really mean that if we took all the possible cash flows that could occur in four years and averaged them, the result would be $700. So, we don't really expect a projected cash flow to be exactly right in any one case. What we do expect is that if we evaluate a large number of projects, our projections will be right on average.

FORECASTING RISK

The key inputs into a discounted cash flow (DCF) analysis are projected future cash flows. If the projections are seriously in error, then we have a classic GIGO (garbage in, garbage out) system. In such a case, no matter how carefully we arrange the numbers and manipulate them, the resulting answer can still be grossly misleading. This is the danger in using a relatively sophisticated technique like DCF. It is sometimes easy to get caught up in number crunching and forget the underlying nuts-and-bolts economic reality.

forecasting risk
The possibility that errors in projected cash flows will lead to incorrect decisions. Also known as *estimation risk*.

The possibility that we will make a bad decision because of errors in the projected cash flows is called **forecasting risk** (or *estimation risk*). Because of forecasting risk, there is the danger that we will think a project has a positive NPV when it really does not. How is this possible? It happens if we are overly optimistic about the future, and, as a result, our projected cash flows don't realistically reflect the possible future cash flows.

Forecasting risk can take many forms. For example, Microsoft spent several billion dollars developing and bringing the Xbox One game console to market. Technologically more sophisticated than its competition, the Xbox One was the best way to play against competitors over the Internet and included other features, such as the Kinect motion detector. However, Microsoft sold only four million Xboxes in the first four months of sales, which was at the low end of Microsoft's expected range and noticeably fewer than the 6.6 million Sony PS4s sold. Since the Xbox was arguably the best available game console at the time, why didn't it sell better? A major reason given by analysts was that the Xbox cost $100 more than the PS4.

So far, we have not explicitly considered what to do about the possibility of errors in our forecasts; so one of our goals in this chapter is to develop some tools that are useful in identifying areas where potential errors exist and where they might be especially damaging. In one form or another, we will be trying to assess the economic "reasonableness" of our estimates. We will also be wondering how much damage will be done by errors in those estimates.

SOURCES OF VALUE

The first line of defense against forecasting risk is to ask, "What is it about this investment that leads to a positive NPV?" We should be able to point to something specific as the source of value. For example, if the proposal under consideration involves a new product, then we might ask questions such as the following: Are we certain that our new product is significantly better than that of the competition? Can we truly manufacture at lower cost, or distribute more effectively, or identify undeveloped market niches, or gain control of a market?

These are just a few of the potential sources of value. There are many others. For example, in 2004, Google announced a new, free email service: Gmail. Why? Free email service is widely available from big hitters like Microsoft and Yahoo! and, obviously, it's free! The answer is that Google's email service is integrated with its acclaimed search engine, thereby giving it an edge. Also, offering email lets Google expand its lucrative keyword-based advertising delivery. So, Google's source of value is leveraging its proprietary web search and ad delivery technologies.

A key factor to keep in mind is the degree of competition in the market. A basic principle of economics is that positive NPV investments will be rare in a highly competitive environment. Therefore, proposals that appear to show significant value in the face of stiff competition are particularly troublesome, and the likely reaction of the competition to any innovations must be closely examined.

To give an example, in 2008, demand for flat-screen LCD televisions was high, prices were high, and profit margins were fat for retailers. But, also in 2008, manufacturers of the screens, such as Samsung and Sony, were projected to pour several billion dollars into new production facilities. Anyone thinking of entering this highly profitable market would have done well to reflect on what the supply (and profit margin) situation would look like in just a few years. And, in fact, the high prices did not last. By 2017, television sets that had been selling for well over $1,000 only a few years before were selling for around $300–$400. And, it is likely that the new 4K television sets will experience a similar price drop in the next few years.

It is also necessary to think about *potential* competition. For example, suppose home improvement retailer Lowe's identifies an area that is underserved and is thinking about opening a store. If the store is successful, what will happen? The answer is that Home Depot (or another competitor) will likely also build a store, thereby driving down volume and profits. So, we always need to keep in mind that success attracts imitators and competitors.

The point to remember is that positive NPV investments are probably not all that common, and the number of positive NPV projects is almost certainly limited for any given firm. If we can't articulate some sound economic basis for thinking ahead of time that we have found something special, then the conclusion that our project has a positive NPV should be viewed with some suspicion.

Concept Questions

11.1a What is forecasting risk? Why is it a concern for the financial manager?

11.1b What are some potential sources of value in a new project?

Scenario and Other What-If Analyses

11.2

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Our basic approach to evaluating cash flow and NPV estimates involves asking what-if questions. Accordingly, we discuss some organized ways of going about a what-if analysis. Our goal in performing such an analysis is to assess the degree of forecasting risk and to identify the most critical components of the success or failure of an investment.

GETTING STARTED

We are investigating a new project. Naturally, the first thing we do is estimate NPV based on our projected cash flows. We will call this initial set of projections the *base case*. Now, we recognize the possibility of error in these cash flow projections. After completing the base case, we wish to investigate how different assumptions about the future will impact our estimates.

One way to organize this investigation is to put upper and lower bounds on the various components of the project. For example, suppose we forecast sales at 100 units per year. We know this estimate may be high or low, but we are relatively certain it is not off by more than 10 units in either direction. In this situation, we would pick a lower bound of 90 and an upper bound of 110. We go on to assign such bounds to any other cash flow components we are unsure about.

When we pick these upper and lower bounds, we are not ruling out the possibility that the actual values could be outside this range. What we are saying, again loosely speaking, is that it is unlikely that the true average (as opposed to our estimated average) of the possible values is outside this range.

An example is useful to illustrate the idea here. The project under consideration costs $200,000, has a five-year life, and has no salvage value. Depreciation is straight-line to zero. The required return is 12 percent, and the tax rate is 21 percent. In addition, we have compiled the following information:

	Base Case	Lower Bound	Upper Bound
Unit sales	6,000	5,500	6,500
Price per unit	$ 80	$ 75	$ 85
Variable costs per unit	$ 60	$ 58	$ 62
Fixed costs per year	$50,000	$45,000	$55,000

With this information, we can calculate the base-case NPV by first calculating net income:

Sales	$480,000
Variable costs	360,000
Fixed costs	50,000
Depreciation	40,000
EBIT	$ 30,000
Taxes (21%)	6,300
Net income	$ 23,700

Operating cash flow is $30,000 + 40,000 − 6,300 = $63,700 per year. At 12 percent, the five-year annuity factor is 3.6048, so the base-case NPV is:

$$\text{Base-case NPV} = -\$200{,}000 + 63{,}700 \times 3.6048$$
$$= \$29{,}624$$

The project looks good so far.

SCENARIO ANALYSIS

scenario analysis
The determination of what happens to NPV estimates when we ask what-if questions.

The basic form of what-if analysis is called **scenario analysis**. What we do is investigate the changes in our NPV estimates that result from asking questions like: What if unit sales realistically should be projected at 5,500 units instead of 6,000?

Once we start looking at alternative scenarios, we might find that most of the plausible ones result in positive NPVs. In this case, we have some confidence in proceeding with the project. If a substantial percentage of the scenarios look bad, the degree of forecasting risk is high and further investigation is in order.

We can consider a number of possible scenarios. A good place to start is with the worst-case scenario. This will tell us the minimum NPV of the project. If this turns out to be positive, we will be in good shape. While we are at it, we will go ahead and determine the other extreme, the best case. This puts an upper bound on our NPV.

To get the worst case, we assign the least favorable value to each item. This means *low* values for items like units sold and price per unit and *high* values for costs. We do the reverse for the best case. For our project, these values would be the following:

	Worst Case	Best Case
Unit sales	5,500	6,500
Price per unit	$ 75	$ 85
Variable costs per unit	$ 62	$ 58
Fixed costs per year	$55,000	$45,000

With this information, we can calculate the net income and cash flows under each scenario (check these for yourself):

Scenario	Net Income	Cash Flow	Net Present Value	IRR
Base case	$23,700	$63,700	$ 29,624	17.8%
Worst case*	−18,565	21,435	−122,732	−17.7
Best case	71,495	111,495	201,915	47.9

*We assume a tax credit is created in our worst-case scenario.

What we learn is that under the worst scenario, the cash flow is still positive at $21,435. That's good news. The bad news is that the return is −17.7 percent in this case, and the NPV is −$122,732. Because the project costs $200,000, we stand to lose more than half of the original investment under the worst possible scenario. The best case offers an attractive 47.9 percent return.

The terms *best case* and *worst case* are commonly used, and we will stick with them; but they are somewhat misleading. The absolutely best thing that could happen would be something absurdly unlikely, such as launching a new diet soda and subsequently learning that our (patented) formulation also just happens to cure the common cold. Similarly, the true worst case would involve some incredibly remote possibility of total disaster. We're not claiming that these things don't happen; once in a while they do. Some products, such as personal computers, succeed beyond the wildest expectations; and some turn out to be absolute catastrophes. For example, in April 2010, BP's Gulf of Mexico oil rig *Deepwater Horizon* caught fire and sank following an explosion, leading to a massive oil spill. The leak was finally stopped in July after releasing over 200 million gallons of crude oil into the Gulf. When everything was included, BP's costs associated with the disaster were about $62 billion, not including opportunity costs such as lost government contracts. Nonetheless, our point is that in assessing the reasonableness of an NPV estimate, we need to stick to cases that are reasonably likely to occur.

Instead of *best* and *worst*, then, it is probably more accurate to use the words *optimistic* and *pessimistic*. In broad terms, if we were thinking about a reasonable range for, say, unit sales, then what we call the best case would correspond to something near the upper end of that range. The worst case would correspond to the lower end.

Not all companies complete (or at least publish) all three estimates. For example, Almaden Minerals, Ltd., made a press release with information concerning its Elk Gold Project in British Columbia. Here is a table of the possible outcomes given by the company:

Project Summary	Base Case	$1,200 Case	Unit
Assumed gold price	1,000	1,200	$US/tr.oz
Tonnes per day treated	500	1,000	tpd
Life	7	9	years
Total tonnes treated	1.1	2.6	MT
Grade	4.14	3.89	g/t
Waste: Ore ratio	16.4	30.1	
Plant recovery	92	92	%
Ounces Au produced	139,198	297,239	tr.oz
Initial capital expense	9.91	17.50	$CADM
Working and preproduction capital	2.27	9.60	$CADM
Waste mining	2.42	1.90	$CAD/tonne waste
Ore mining	8.38	5.87	$CAD/tonne ore
Processing	20.68	14.74	$CAD/tonne ore
Administration and overheads	2.07	1.27	$CAD/tonne ore
Total operating cost	70.30	78.91	$CAD/tonne ore
Pretax NPV @ 8%	28.7	67.9	$CADM
Pretax IRR	51%	39%	
Max exposure	13.66	33.53	$CADM
Payback, years from start production	1.85	3.30	years
Ratio, gross earnings: max exposure	5.02	6.00	
Ratio, NPV: max exposure	2.10	2.03	

As you can see, the NPV is projected at C$28.7 million in the base case and C$67.9 million in the best ($1,200 price) case. Unfortunately, Almaden did not release a worst-case analysis, but we hope the company also examined this possibility.

As we have mentioned, there are an unlimited number of different scenarios that we could examine. At a minimum, we might want to investigate two intermediate cases by going halfway between the base amounts and the extreme amounts. This would give us five scenarios in all, including the base case.

Beyond this point, it is hard to know when to stop. As we generate more and more possibilities, we run the risk of experiencing "paralysis of analysis." The difficulty is that no matter how many scenarios we run, all we can learn are possibilities—some good and some bad. Beyond that, we don't get any guidance as to what to do. Scenario analysis is useful in telling us what can happen and in helping us gauge the potential for disaster, but it does not tell us whether to take a project.

Unfortunately, in practice, even the worst-case scenarios may not be low enough. Two recent examples show what we mean. The Eurotunnel, or Chunnel, may be one of the new wonders of the world. The tunnel under the English Channel connects England to France and covers 24 miles. It took 8,000 workers eight years to remove 9.8 million cubic yards of rock. When the tunnel was finally built, it cost $17.9 billion, or slightly more than twice the original estimate of $8.8 billion. And things got worse. Forecasts called for 16.8 million passengers in the first year, but only 4 million actually used it. Revenue estimates for 2003 were $2.88 billion, but actual revenue was only about one-third of that. The major problems faced by the Eurotunnel were increased competition from ferry services, which dropped their prices, and the rise of low-cost airlines. In 2006, things got so bad that the company operating the Eurotunnel was forced into negotiations with creditors to chop its $11.1 billion debt in half to avoid bankruptcy. The debt reduction appeared to help. In 2007, the Eurotunnel reported its first profit of €1 million ($1.6 million). By 2013, the Chunnel had a profit of €101 million ($138 million). Sales for the year were €1.09 billion ($1.49 billion), the first year its sales exceeded €1 billion, and for the first time it transported more than 10 million passengers in a year. And, by 2016, the Chunnel's profit reached €535 million ($700 million).

Another example is the Samsung Note 7 cell phone, which caught fire with consumers when it was introduced in August 2016. Unfortunately, the phones subsequently began to actually catch fire, causing the Federal Aviation Administration to ban them from flights, even in a checked bag. In early September, Samsung recalled 2.5 million Note 7s. The company halted all further production and sales in early October, which caused Samsung's market capitalization to drop about $17 billion. The company was expected to eventually write off about $5 billion, a "Note-able" loss.

SENSITIVITY ANALYSIS

sensitivity analysis
Investigation of what happens to NPV when only one variable is changed.

Sensitivity analysis is a variation on scenario analysis that is useful in pinpointing the areas where forecasting risk is especially severe. The basic idea with a sensitivity analysis is to freeze all of the variables except one and then see how sensitive our estimate of NPV is to changes in that one variable. If our NPV estimate turns out to be very sensitive to relatively small changes in the projected value of some component of project cash flow, then the forecasting risk associated with that variable is high.

To illustrate how sensitivity analysis works, we go back to our base case for every item except unit sales. We can then calculate cash flow and NPV using the largest and smallest unit sales figures.

Scenario	Unit Sales	Cash Flow	Net Present Value	IRR
Base case	6,000	$63,700	$29,624	17.8%
Worst case	5,500	55,800	1,147	12.2
Best case	6,500	71,600	58,102	23.2

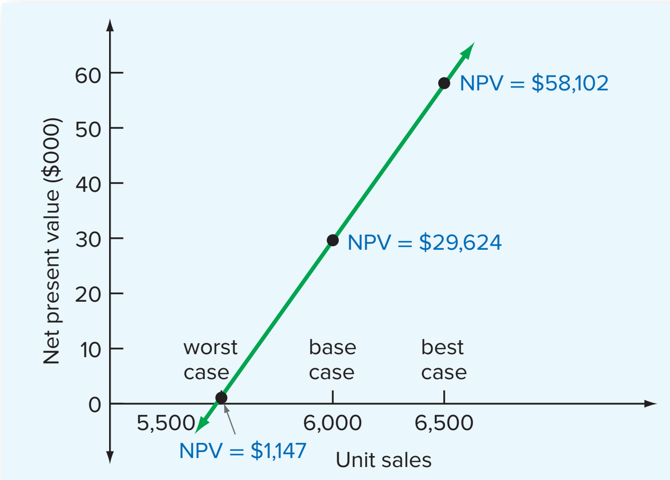


FIGURE 11.1

Sensitivity Analysis for Unit Sales

For comparison, we now freeze everything except fixed costs and repeat the analysis:

Scenario	Fixed Costs	Cash Flow	Net Present Value	IRR
Base case	$50,000	$63,700	$29,624	17.8%
Worst case	55,000	59,750	15,385	15.1
Best case	45,000	67,650	43,863	20.5

What we see here is that given our ranges, the estimated NPV of this project is more sensitive to changes in projected unit sales than it is to changes in projected fixed costs. In fact, under the worst case for fixed costs, the NPV is still positive.

The results of our sensitivity analysis for unit sales can be illustrated graphically as in Figure 11.1. Here we place NPV on the vertical axis and unit sales on the horizontal axis. When we plot the combinations of unit sales versus NPV, we see that all possible combinations fall on a straight line. The steeper the resulting line is, the greater the sensitivity of the estimated NPV to changes in the projected value of the variable being investigated.

Sensitivity analysis can produce results that vary dramatically depending on the assumptions. For example, Bard Ventures Ltd. announced its projections for a molybdenum mine in British Columbia. At a cost of capital of 10 percent and an average molybdenum price of $19 per ton, the NPV of the new mine would be $112 million with an IRR of 12.4 percent. At a high price of $30 per ton, the NPV would be $1.152 billion, and the IRR would be 32.0 percent.

As we have illustrated, sensitivity analysis is useful in pinpointing which variables deserve the most attention. If we find that our estimated NPV is especially sensitive to changes in a variable that is difficult to forecast (such as unit sales), then the degree of forecasting risk is high. We might decide that further market research would be a good idea in this case.

Because sensitivity analysis is a form of scenario analysis, it suffers from the same drawbacks. Sensitivity analysis is useful for pointing out where forecasting errors will do the most damage, but it does not tell us what to do about possible errors.

SIMULATION ANALYSIS

Scenario analysis and sensitivity analysis are widely used. With scenario analysis, we let all the different variables change, but we let them take on only a few values. With sensitivity analysis, we let only one variable change, but we let it take on many values. If we combine the two approaches, the result is a crude form of **simulation analysis**.

simulation analysis
A combination of scenario and sensitivity analysis.

If we want to let all the items vary at the same time, we have to consider a very large number of scenarios, and computer assistance is almost certainly needed. In the simplest case, we start with unit sales and assume that any value in our 5,500 to 6,500 range is equally likely. We start by randomly picking one value (or by instructing a computer to do so). We then randomly pick a price, a variable cost, and so on.

Once we have values for all the relevant components, we calculate an NPV. We repeat this sequence as many times as we desire, probably several thousand times. The result is many NPV estimates that we summarize by calculating the average value and some measure of how spread out the different possibilities are. For example, it would be of some interest to know what percentage of the possible scenarios result in negative estimated NPVs.

Because simulation analysis (or simulation) is an extended form of scenario analysis, it has the same problems. Once we have the results, no simple decision rule tells us what to do. Also, we have described a relatively simple form of simulation. To really do it right, we would have to consider the interrelationships between the different cash flow components. Furthermore, we assumed that the possible values were equally likely to occur. It is probably more realistic to assume that values near the base case are more likely than extreme values, but coming up with the probabilities is difficult, to say the least.

For these reasons, the use of simulation is somewhat limited in practice. However, recent advances in computer software and hardware (and user sophistication) lead us to believe it may become more common in the future, particularly for large-scale projects.

Concept Questions

11.2a What are scenario, sensitivity, and simulation analysis?

11.2b What are the drawbacks to the various types of what-if analysis?

11.3 Break-Even Analysis

It will frequently turn out that the crucial variable for a project is sales volume. If we are thinking of creating a new product or entering a new market, for example, the hardest thing to forecast accurately is how much we can sell. For this reason, sales volume is usually analyzed more closely than other variables.

Break-even analysis is a popular and commonly used tool for analyzing the relationship between sales volume and profitability. There are a variety of different break-even measures, and we have already seen several types. For example, we discussed (in Chapter 9) how the payback period can be interpreted as the length of time until a project breaks even, ignoring time value.

All break-even measures have a similar goal. Loosely speaking, we will always be asking, "How bad do sales have to get before we actually begin to lose money?" Implicitly, we will also be asking, "Is it likely that things will get that bad?" To get started on this subject, we first discuss fixed and variable costs.

FIXED AND VARIABLE COSTS

In discussing break-even, the difference between fixed and variable costs becomes very important. As a result, we need to be a little more explicit about the difference than we have been so far.

variable costs
Costs that change when the quantity of output changes.

Variable Costs By definition, **variable costs** change as the quantity of output changes, and they are zero when production is zero. For example, direct labor costs and raw

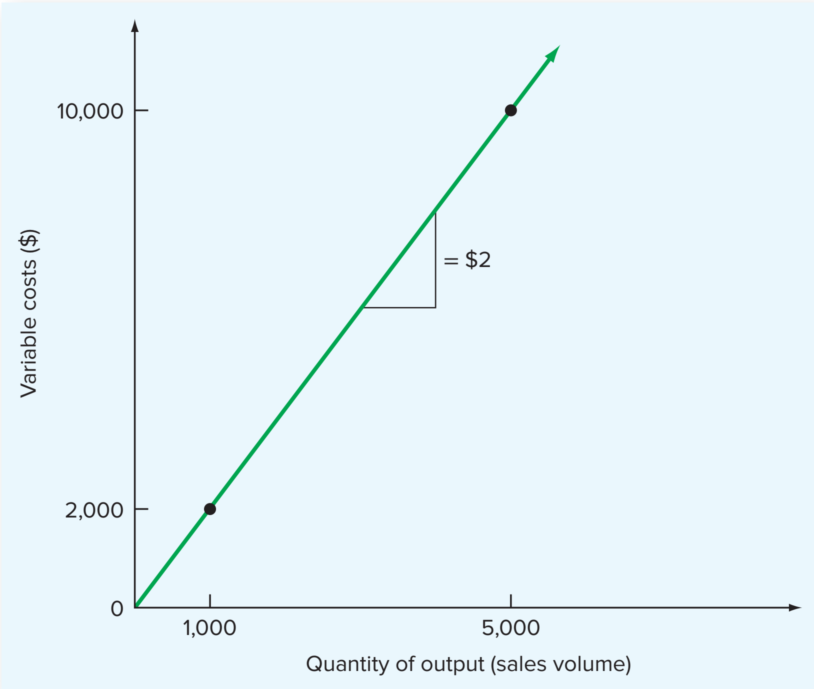


FIGURE 11.2
Output Level and Variable Costs

material costs are usually considered variable. This makes sense because if we shut down operations tomorrow, there will be no future costs for labor or raw materials.

We will assume that variable costs are a constant amount per unit of output. This means that total variable cost is equal to the cost per unit multiplied by the number of units. In other words, the relationship between total variable cost (VC), cost per unit of output (v), and total quantity of output (Q) can be written as:

$$\text{Total variable cost} = \text{Total quantity of output} \times \text{Cost per unit of output}$$
$$\text{VC} = Q \times v$$

For example, suppose variable costs (v) are \$2 per unit. If total output (Q) is 1,000 units, what will total variable costs (VC) be?

$$\begin{aligned}\text{VC} &= Q \times v \\ &= 1{,}000 \times \$2 \\ &= \$2{,}000\end{aligned}$$

Similarly, if Q is 5,000 units, then VC will be $5{,}000 \times \$2 = \$10{,}000$. Figure 11.2 illustrates the relationship between output level and variable costs in this case. In Figure 11.2, notice that increasing output by one unit results in variable costs rising by \$2, so "the rise over the run" (the slope of the line) is given by $\$2/1 = \$2$.

Variable Costs — EXAMPLE 11.1

The Blume Corporation is a manufacturer of pencils. It has received an order for 5,000 pencils, and the company has to decide whether to accept the order. From recent experience, the company knows that each pencil requires 5 cents in raw materials and 50 cents in direct labor costs. These variable costs are expected to continue to apply in the future. What will Blume's total variable costs be if it accepts the order?

In this case, the cost per unit is 50 cents in labor plus 5 cents in material for a total of 55 cents per unit. At 5,000 units of output, we have:

$$\begin{aligned} VC &= Q \times v \\ &= 5{,}000 \times \$.55 \\ &= \$2{,}750 \end{aligned}$$

Therefore, total variable costs will be $2,750.

fixed costs
Costs that do not change when the quantity of output changes during a particular time period.

Fixed Costs

Fixed costs, by definition, do not change during a specified time period. So, unlike variable costs, they do not depend on the amount of goods or services produced during a period (at least within some range of production). For example, the lease payment on a production facility and the company president's salary are fixed costs, at least over some period.

Naturally, fixed costs are not fixed forever. They are fixed only during some particular time, say, a quarter or a year. Beyond that time, leases can be terminated and executives "retired." More to the point, any fixed cost can be modified or eliminated given enough time; so, in the long run, all costs are variable.

Notice that when a cost is fixed, that cost is effectively a sunk cost because we are going to have to pay it no matter what.

Total Costs

Total costs (TC) for a given level of output are the sum of variable costs (VC) and fixed costs (FC):

$$\begin{aligned} TC &= VC + FC \\ &= v \times Q + FC \end{aligned}$$

So, for example, if we have variable costs of $3 per unit and fixed costs of $8,000 per year, our total cost is:

$$TC = \$3 \times Q + \$8{,}000$$

If we produce 6,000 units, our total production cost will be $3 × 6,000 + $8,000 = $26,000. At other production levels, we have the following:

Quantity Produced	Total Variable Costs	Fixed Costs	Total Costs
0	$ 0	$8,000	$ 8,000
1,000	3,000	8,000	11,000
5,000	15,000	8,000	23,000
10,000	30,000	8,000	38,000

marginal cost
The change in costs that occurs when there is a small change in output. Also called *incremental cost.*

By plotting these points in Figure 11.3, we see that the relationship between quantity produced and total costs is given by a straight line. In Figure 11.3, notice that total costs equal fixed costs when sales are zero. Beyond that point, every one-unit increase in production leads to a $3 increase in total costs, so the slope of the line is 3. In other words, the **marginal**, or **incremental**, **cost** of producing one more unit is $3.

EXAMPLE 11.2 Average Cost versus Marginal Cost

Suppose the Blume Corporation has a variable cost per pencil of 55 cents. The lease payment on the production facility runs $5,000 per month. If Blume produces 100,000 pencils per year, what are the total costs of production? What is the average cost per pencil?

The fixed costs are $5,000 per month, or $60,000 per year. The variable cost is $.55 per pencil. So the total cost for the year, assuming that Blume produces 100,000 pencils, is:

$$\begin{aligned}\text{Total cost} &= v \times Q + \text{FC} \\ &= \$.55 \times 100{,}000 + \$60{,}000 \\ &= \$115{,}000\end{aligned}$$

The average cost per pencil is $115,000/100,000 = $1.15.

Now suppose that Blume has received a special, one-shot order for 5,000 pencils. Blume has sufficient capacity to manufacture the 5,000 pencils on top of the 100,000 already produced, so no additional fixed costs will be incurred. Also, there will be no effect on existing orders. If Blume can get 75 cents per pencil for this order, should the order be accepted?

What this boils down to is a simple proposition. It costs 55 cents to make another pencil. Anything Blume can get for this pencil in excess of the 55-cent incremental cost contributes in a positive way toward covering fixed costs. The 75-cent **marginal**, or **incremental**, **revenue** exceeds the 55-cent marginal cost, so Blume should take the order.

marginal revenue
The change in revenue that occurs when there is a small change in output. Also called *incremental revenue*.

The fixed cost of $60,000 is irrelevant to this decision because it is effectively sunk, at least for the current period. In the same way, the fact that the average cost is $1.15 is irrelevant because this average reflects the fixed cost. As long as producing the extra 5,000 pencils truly does not cost anything beyond the 55 cents per pencil, then Blume should accept any price above 55 cents.

ACCOUNTING BREAK-EVEN

The most widely used measure of break-even is **accounting break-even**. The accounting break-even point is the sales level that results in a zero project net income.

accounting break-even
The sales level that results in zero project net income.

To determine a project's accounting break-even, we start off with some common sense. Suppose we retail one-petabyte computer disks for $5 apiece. We can buy disks from a wholesale supplier for $3 apiece. We have accounting expenses of $600 in fixed costs and $300 in depreciation. How many disks do we have to sell to break even—that is, for net income to be zero?

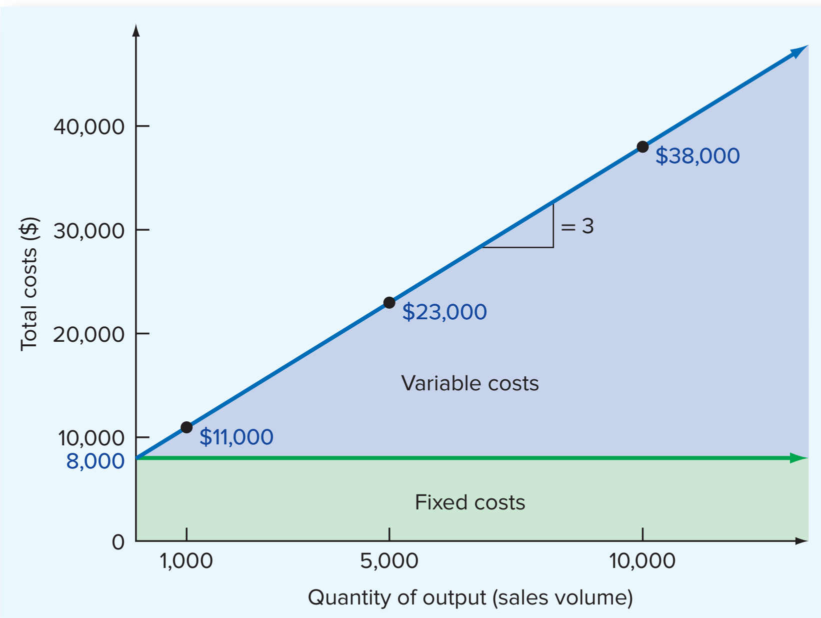


FIGURE 11.3
Output Level and Total Costs

For every disk we sell, we pick up $\$5 - 3 = \$2$ toward covering our other expenses (this \$2 difference between the selling price and the variable cost is often called the *contribution margin per unit*). We have to cover a total of $\$600 + 300 = \$900$ in accounting expenses, so we obviously need to sell $\$900/\$2 = 450$ disks. We can check this by noting that at a sales level of 450 units, our revenues are $\$5 \times 450 = \$2{,}250$ and our variable costs are $\$3 \times 450 = \$1{,}350$. Here is the income statement:

Sales	\$2,250
Variable costs	1,350
Fixed costs	600
Depreciation	300
EBIT	\$ 0
Taxes (21%)	0
Net income	\$ 0

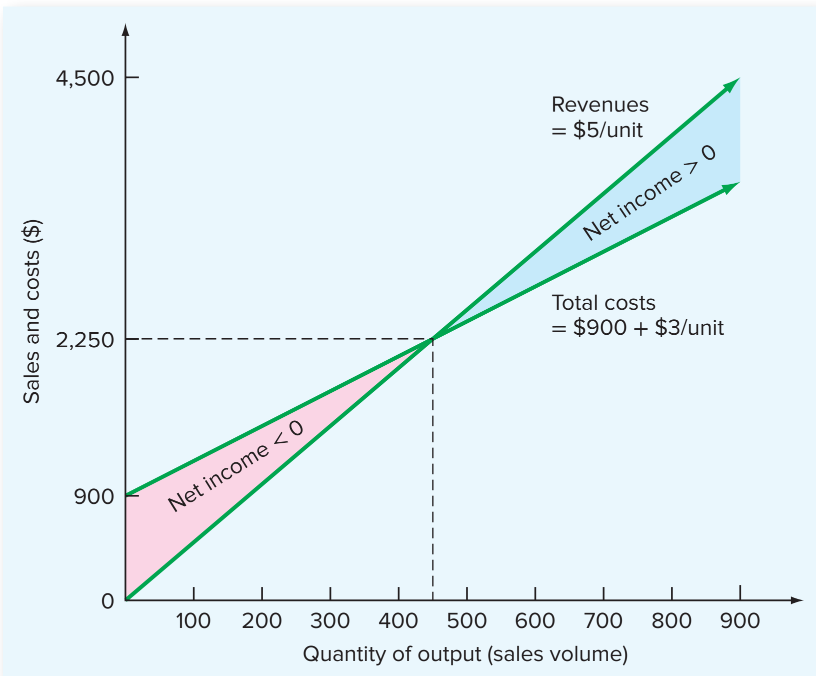
Remember, because we are discussing a proposed new project, we do not consider any interest expense in calculating net income or cash flow from the project. Also, notice that we include depreciation in calculating expenses here, even though depreciation is not a cash outflow. That is why we call it an accounting break-even. Finally, notice that when net income is zero, so are pretax income and, of course, taxes. In accounting terms, our revenues are equal to our costs, so there is no profit to tax.

Figure 11.4 presents another way to see what is happening. This figure looks a lot like Figure 11.3 except that we add a line for revenues. As indicated, total revenues are zero when output is zero. Beyond that, each unit sold brings in another \$5, so the slope of the revenue line is 5.

From our preceding discussion, we know that we break even when revenues are equal to total costs. The line for revenues and the line for total costs cross right where output is at

FIGURE 11.4

Accounting Break-Even



450 units. As illustrated, at any level of output below 450, our accounting profit is negative, and at any level above 450, we have a positive net income.

ACCOUNTING BREAK-EVEN: A CLOSER LOOK

In our numerical example, notice that the break-even level is equal to the sum of fixed costs and depreciation, divided by price per unit less variable costs per unit. This is always true. To see why, we recall all of the following variables:

P = Selling price per unit
v = Variable cost per unit
Q = Total units sold
S = Total sales = $P \times Q$
VC = Total variable costs = $v \times Q$
FC = Fixed costs
D = Depreciation
T_C = Tax rate

Project net income is given by:

$$\begin{aligned}\text{Net income} &= (\text{Sales} - \text{Variable costs} - \text{Fixed costs} - \text{Depreciation}) \times (1 - T_C)\\ &= (S - \text{VC} - \text{FC} - D) \times (1 - T_C)\end{aligned}$$

From here, it is not difficult to calculate the break-even point. If we set this net income equal to zero, we get:

$$\text{Net income} \overset{\text{SET}}{=} 0 = (S - \text{VC} - \text{FC} - D) \times \left(1 - T_C\right)$$

Divide both sides by $(1 - T_C)$ to get:

$$S - \text{VC} - \text{FC} - D = 0$$

As we have seen, this says that when net income is zero, so is pretax income. If we recall that $S = P \times Q$ and $\text{VC} = v \times Q$, then we can rearrange the equation to solve for the break-even level:

$$\begin{aligned}S - \text{VC} &= \text{FC} + D\\ P \times Q - v \times Q &= \text{FC} + D\\ (P - v) \times Q &= \text{FC} + D\\ \boldsymbol{Q} &= \boldsymbol{(\text{FC} + D)/(P - v)}\end{aligned} \quad \textbf{11.1}$$

This is the same result we described earlier.

USES FOR THE ACCOUNTING BREAK-EVEN

Why would anyone be interested in knowing the accounting break-even point? To illustrate how it can be useful, suppose we are a small specialty ice cream manufacturer with a strictly local distribution. We are thinking about expanding into new markets. Based on the estimated cash flows, we find that the expansion has a positive NPV.

Going back to our discussion of forecasting risk, we know that it is likely that what will make or break our expansion is sales volume. The reason is that, in this case at least, we probably have a fairly good idea of what we can charge for the ice cream. Further, we know relevant production and distribution costs reasonably well because we are already in the business. What we do not know with any real precision is how much ice cream we can sell.

Given the costs and selling price, we can immediately calculate the break-even point. Once we have done so, we might find that we need to get 30 percent of the market just to break even. If we think that this is unlikely to occur, because, for example, we have only 10 percent of our current market, then we know our forecast is questionable and there is a real possibility that the true NPV is negative. On the other hand, we might find that we already have firm commitments from buyers for about the break-even amount, so we are almost certain we can sell more. In this case, the forecasting risk is much lower, and we have greater confidence in our estimates.

There are several other reasons why knowing the accounting break-even can be useful. First, as we will discuss in more detail later, accounting break-even and payback period are similar measures. Like payback period, accounting break-even is relatively easy to calculate and explain.

Second, managers are often concerned with the contribution a project will make to the firm's total accounting earnings. A project that does not break even in an accounting sense actually reduces total earnings.

Third, a project that just breaks even on an accounting basis loses money in a financial or opportunity cost sense. This is true because we could have earned more by investing elsewhere. Such a project does not lose money in an out-of-pocket sense. As described in the following sections, we get back exactly what we put in. For noneconomic reasons, opportunity losses may be easier to live with than out-of-pocket losses.

Concept Questions

11.3a How are fixed costs similar to sunk costs?

11.3b What is net income at the accounting break-even point? What about taxes?

11.3c Why might a financial manager be interested in the accounting break-even point?

11.4 Operating Cash Flow, Sales Volume, and Break-Even

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Accounting break-even is one tool that is useful for project analysis. Ultimately, we are more interested in cash flow than accounting income. So, for example, if sales volume is the critical variable, then we need to know more about the relationship between sales volume and cash flow than just the accounting break-even.

Our goal in this section is to illustrate the relationship between operating cash flow and sales volume. We also discuss some other break-even measures. To simplify matters somewhat, we will ignore the effect of taxes. We start off by looking at the relationship between accounting break-even and cash flow.

ACCOUNTING BREAK-EVEN AND CASH FLOW

Now that we know how to find the accounting break-even, it is natural to wonder what happens with cash flow. To illustrate, suppose the Wettway Sailboat Corporation is considering whether to launch its new Margo-class sailboat. The selling price will be $40,000 per boat. The variable costs will be about half that, or $20,000 per boat, and fixed costs will be $500,000 per year.

The Base Case The total investment needed to undertake the project is $3,500,000. This amount will be depreciated straight-line to zero over the five-year life of the equipment.

The salvage value is zero, and there are no working capital consequences. Wettway has a 20 percent required return on new projects.

Based on market surveys and historical experience, Wettway projects total sales for the five years at 425 boats, or about 85 boats per year. Ignoring taxes, should this project be launched?

To begin, ignoring taxes, the operating cash flow at 85 boats per year is:

$$\begin{aligned}\text{Operating cash flow} &= \text{EBIT} + \text{Depreciation} - \text{Taxes}\\ &= (S - \text{VC} - \text{FC} - D) + D - 0\\ &= 85 \times (\$40{,}000 - 20{,}000) - \$500{,}000\\ &= \$1{,}200{,}000 \text{ per year}\end{aligned}$$

At 20 percent, the five-year annuity factor is 2.9906, so the NPV is:

$$\begin{aligned}\text{NPV} &= -\$3{,}500{,}000 + \$1{,}200{,}000 \times 2.9906\\ &= -\$3{,}500{,}000 + 3{,}588{,}735\\ &= \$88{,}735\end{aligned}$$

In the absence of additional information, the project should be launched.

Calculating the Break-Even Level To begin looking a little closer at this project, you might ask a series of questions. For example, how many new boats does Wettway need to sell for the project to break even on an accounting basis? If Wettway does break even, what will be the annual cash flow from the project? What will be the return on the investment in this case?

Before fixed costs and depreciation are considered, Wettway generates $40,000 − 20,000 = $20,000 per boat (this is revenue less variable cost). Depreciation is $3,500,000/5 = $700,000 per year. Fixed costs and depreciation together total $1.2 million, so Wettway needs to sell $(\text{FC} + D)/(P - v)$ = $1.2 million/$20,000 = 60 boats per year to break even on an accounting basis. This is 25 boats less than projected sales; so, assuming that Wettway is confident its projection is accurate to within, say, 15 boats, it appears unlikely that the new investment will fail to at least break even on an accounting basis.

To calculate Wettway's cash flow in this case, we note that if 60 boats are sold, net income will be exactly zero. Recalling from the previous chapter that operating cash flow for a project can be written as net income plus depreciation (the bottom-up definition), we can see that the operating cash flow is equal to the depreciation, or $700,000 in this case. The internal rate of return is exactly zero (why?).

Payback and Break-Even As our example illustrates, whenever a project breaks even on an accounting basis, the cash flow for that period will equal the depreciation. This result makes perfect accounting sense. For example, suppose we invest $100,000 in a five-year project. The depreciation is straight-line to a zero salvage, or $20,000 per year. If the project exactly breaks even every period, then the cash flow will be $20,000 per period.

The sum of the cash flows for the life of this project is 5 × $20,000 = $100,000, the original investment. What this shows is that a project's payback period is exactly equal to its life if the project breaks even every period. Similarly, a project that does better than break even has a payback that is shorter than the life of the project and has a positive rate of return.

The bad news is that a project that just breaks even on an accounting basis has a negative NPV and a zero return. For our sailboat project, the fact that Wettway will almost surely break even on an accounting basis is partially comforting because it means that the firm's "downside" risk (its potential loss) is limited, but we still don't know if the project is truly profitable. More work is needed.

SALES VOLUME AND OPERATING CASH FLOW

At this point, we can generalize our example and introduce some other break-even measures. From our discussion in the previous section, we know that, ignoring taxes, a project's operating cash flow, OCF, can be written as EBIT plus depreciation:

$$\textbf{OCF} = [(P - v) \times Q - \text{FC} - D] + D$$
$$= \boldsymbol{(P - v) \times Q - \text{FC}} \quad \textbf{11.2}$$

For the Wettway sailboat project, the general relationship (in thousands of dollars) between operating cash flow and sales volume is:

$$\begin{aligned}\text{OCF} &= (P - v) \times Q - \text{FC} \\ &= (\$40 - 20) \times Q - 500 \\ &= -\$500 + \$20 \times Q\end{aligned}$$

What this tells us is that the relationship between operating cash flow and sales volume is given by a straight line with a slope of \$20 and a *y*-intercept of −\$500. If we calculate some different values, we get:

Quantity Sold	Operating Cash Flow
0	−\$ 500
15	− 200
30	100
50	500
75	1,000

These points are plotted in Figure 11.5, where we have indicated three different break-even points. We discuss these next.

CASH FLOW, ACCOUNTING, AND FINANCIAL BREAK-EVEN POINTS

We know from the preceding discussion that the relationship between operating cash flow and sales volume (ignoring taxes) is:

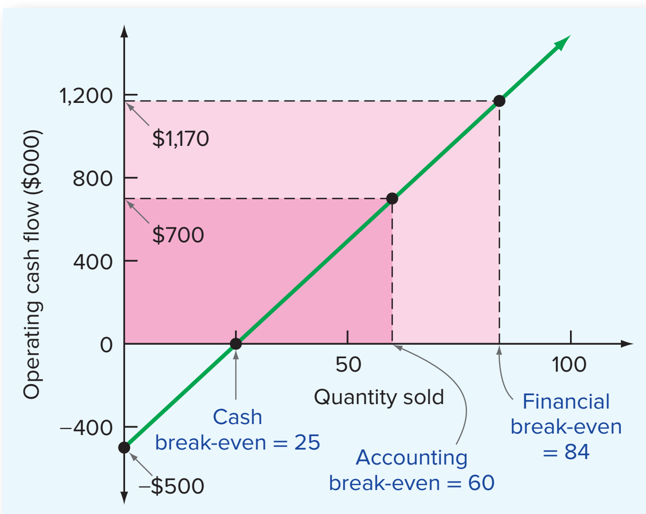
$$\text{OCF} = (P - v) \times Q - \text{FC}$$

If we rearrange this and solve for Q, we get:

$$\boldsymbol{Q = (\text{FC} + \text{OCF})/(P - v)} \quad \textbf{11.3}$$

FIGURE 11.5

Operating Cash Flow and Sales Volume



This tells us what sales volume (Q) is necessary to achieve any given OCF, so this result is more general than the accounting break-even. We use it to find the various break-even points in Figure 11.5.

Accounting Break-Even Revisited Looking at Figure 11.5, suppose operating cash flow is equal to depreciation (D). Recall that this situation corresponds to our break-even point on an accounting basis. To find the sales volume, we substitute the $700 depreciation amount for OCF in our general expression:

$$\begin{aligned} Q &= (\text{FC} + \text{OCF})/(P - v) \\ &= (\$500 + 700)/\$20 \\ &= 60 \end{aligned}$$

This is the same quantity we had before.

Cash Break-Even We have seen that a project that breaks even on an accounting basis has a net income of zero, but it still has a positive cash flow. At some sales level below the accounting break-even, the operating cash flow actually goes negative. This is a particularly unpleasant occurrence. If it happens, we actually have to supply additional cash to the project to keep it afloat.

To calculate the **cash break-even** (the point where operating cash flow is equal to zero), we put in a zero for OCF:

cash break-even
The sales level that results in a zero operating cash flow.

$$\begin{aligned} Q &= (\text{FC} + 0)/(P - v) \\ &= \$500/\$20 \\ &= 25 \end{aligned}$$

Wettway must therefore sell 25 boats to cover the $500 in fixed costs. As we show in Figure 11.5, this point occurs right where the operating cash flow line crosses the horizontal axis.

Notice that a project that just breaks even on a cash flow basis can cover its own fixed operating costs, but that is all. It never pays back anything, so the original investment is a complete loss (the IRR is −100 percent).

Financial Break-Even The last case we consider is that of **financial break-even**, the sales level that results in a zero NPV. To the financial manager, this is the most interesting case. What we do is first determine what operating cash flow has to be for the NPV to be zero. We then use this amount to determine the sales volume.

financial break-even
The sales level that results in a zero NPV.

To illustrate, recall that Wettway requires a 20 percent return on its $3,500 (in thousands) investment. How many sailboats does Wettway have to sell to break even once we account for the 20 percent per year opportunity cost?

The sailboat project has a five-year life. The project has a zero NPV when the present value of the operating cash flows equals the $3,500 investment. Because the cash flow is the same each year, we can solve for the unknown amount by viewing it as an ordinary annuity. The five-year annuity factor at 20 percent is 2.9906, and the OCF can be determined as follows:

$$\begin{aligned} \$3{,}500 &= \text{OCF} \times 2.9906 \\ \text{OCF} &= \$3{,}500/2.9906 \\ &= \$1{,}170 \end{aligned}$$

Wettway needs an operating cash flow of $1,170 each year to break even. We can now plug this OCF into the equation for sales volume:

$$\begin{aligned} Q &= (\$500 + 1{,}170)/\$20 \\ &= 83.5 \end{aligned}$$

So, Wettway needs to sell about 84 boats per year. This is not good news.

As indicated in Figure 11.5, the financial break-even is substantially higher than the accounting break-even. This will often be the case. Moreover, what we have discovered is that the sailboat project has a substantial degree of forecasting risk. We project sales of 85 boats per year, but it takes 84 just to earn the required return.

Conclusion Overall, it seems unlikely that the Wettway sailboat project would fail to break even on an accounting basis. However, there appears to be a very good chance that the true NPV is negative. This illustrates the danger in looking at just the accounting break-even.

What should Wettway do? Is the new project all wet? The decision at this point is essentially a managerial issue—a judgment call. The crucial questions are these:

1. How much confidence do we have in our projections?
2. How important is the project to the future of the company?
3. How badly will the company be hurt if sales turn out to be low? What options are available to the company in this case?

We will consider questions such as these in a later section. For future reference, our discussion of the different break-even measures is summarized in Table 11.1.

TABLE 11.1

Summary of Break-Even Measures

I. The General Break-Even Expression

Ignoring taxes, the relation between operating cash flow (OCF) and quantity of output or sales volume (Q) is:

$$Q = \frac{\text{FC} + \text{OCF}}{P - v}$$

where

FC = Total fixed costs
P = Price per unit
v = Variable cost per unit

As shown next, this relation can be used to determine the accounting, cash, and financial break-even points.

II. The Accounting Break-Even Point

Accounting break-even occurs when net income is zero. Operating cash flow is equal to depreciation when net income is zero, so the accounting break-even point is:

$$Q = \frac{\text{FC} + D}{P - v}$$

A project that always just breaks even on an accounting basis has a payback exactly equal to its life, a negative NPV, and an IRR of zero.

III. The Cash Break-Even Point

Cash break-even occurs when operating cash flow is zero. The cash break-even point is:

$$Q = \frac{\text{FC}}{P - v}$$

A project that always just breaks even on a cash basis never pays back, has an NPV that is negative and equal to the initial outlay, and has an IRR of −100 percent.

IV. The Financial Break-Even Point

Financial break-even occurs when the NPV of the project is zero. The financial break-even point is:

$$Q = \frac{\text{FC} + \text{OCF}^*}{P - v}$$

where OCF* is the level of OCF that results in a zero NPV. A project that breaks even on a financial basis has a discounted payback equal to its life, a zero NPV, and an IRR just equal to the required return.

Concept Questions

11.4a If a project breaks even on an accounting basis, what is its operating cash flow?

11.4b If a project breaks even on a cash basis, what is its operating cash flow?

11.4c If a project breaks even on a financial basis, what do you know about its *discounted* payback?

11.5 Operating Leverage

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We have discussed how to calculate and interpret various measures of break-even for a proposed project. What we have not explicitly discussed is what determines these points and how they might be changed. We now turn to this subject.[1]

THE BASIC IDEA

operating leverage The degree to which a firm or project relies on fixed costs.

Operating leverage is the degree to which a project or firm is committed to fixed production costs. A firm with low operating leverage will have low fixed costs compared to a firm with high operating leverage. Generally speaking, projects with a relatively heavy investment in plant and equipment will have a relatively high degree of operating leverage. Such projects are said to be *capital intensive*.

Anytime we are thinking about a new venture, there will normally be alternative ways of producing and delivering the product. For example, Wettway Sailboat Corporation can purchase the necessary equipment and build all of the components for its sailboats in-house. Alternatively, some of the work could be farmed out to other firms. The first option involves a greater investment in plant and equipment, greater fixed costs and depreciation, and, as a result, a higher degree of operating leverage.

IMPLICATIONS OF OPERATING LEVERAGE

Regardless of how it is measured, operating leverage has important implications for project evaluation. Fixed costs act like a lever in the sense that a small percentage change in operating revenue can be magnified into a large percentage change in operating cash flow and NPV. This explains why we call it operating "leverage."

The higher the degree of operating leverage, the greater is the potential danger from forecasting risk. The reason is that relatively small errors in forecasting sales volume can get magnified, or "levered up," into large errors in cash flow projections.

From a managerial perspective, one way of coping with highly uncertain projects is to keep the degree of operating leverage as low as possible. This will generally have the effect of keeping the break-even point (however measured) at its minimum level. We will illustrate this point in a bit, but first we need to discuss how to measure operating leverage.

MEASURING OPERATING LEVERAGE

degree of operating leverage (DOL) The percentage change in operating cash flow relative to the percentage change in quantity sold.

One way of measuring operating leverage is to ask: If quantity sold rises by 5 percent, what will be the percentage change in operating cash flow? In other words, the **degree of operating leverage (DOL)** is defined such that:

$$\text{Percentage change in OCF} = \text{DOL} \times \text{Percentage change in } Q$$

[1]The assumption of no taxes still holds. To see the effect of taxes on break-even and DOL, see Problems 25 and 26.

Based on the relationship between OCF and Q, DOL can be written as:[2]

DOL = 1 + FC/OCF 11.4

The ratio FC/OCF measures fixed costs as a percentage of total operating cash flow. Notice that zero fixed costs would result in a DOL of 1, implying that percentage changes in quantity sold would show up one for one in operating cash flow. In other words, no magnification, or leverage, effect would exist.

To illustrate this measure of operating leverage, we go back to the Wettway sailboat project. Fixed costs were \$500 and $(P - v)$ was \$20, so OCF was:

$$\text{OCF} = -\$500 + \$20 \times Q$$

Suppose Q is currently 50 boats. At this level of output, OCF is −\$500 + 1,000 = \$500.

If Q rises by 1 unit to 51, then the percentage change in Q is (51 − 50)/50 = .02, or 2%. OCF rises to \$520, a change of $P - v = \$20$. The percentage change in OCF is (\$520 − 500)/\$500 = .04, or 4%. So a 2 percent increase in the number of boats sold leads to a 4 percent increase in operating cash flow. The degree of operating leverage must be exactly 2.00. We can check this by noting that:

$$\begin{aligned}\text{DOL} &= 1 + \text{FC/OCF} \\ &= 1 + \$500/\$500 \\ &= 2\end{aligned}$$

This verifies our previous calculations.

Our formulation of DOL depends on the current output level, Q. However, it can handle changes from the current level of any size, not just one unit. For example, suppose Q rises from 50 to 75, a 50 percent increase. With DOL equal to 2, operating cash flow should increase by 100 percent, or exactly double. Does it? The answer is yes, because, at a Q of 75, OCF is:

$$\text{OCF} = -\$500 + \$20 \times 75 = \$1{,}000$$

Notice that operating leverage declines as output (Q) rises. For example, at an output level of 75, we have:

$$\begin{aligned}\text{DOL} &= 1 + \$500/\$1{,}000 \\ &= 1.50\end{aligned}$$

The reason DOL declines is that fixed costs, considered as a percentage of operating cash flow, get smaller and smaller, so the leverage effect diminishes.

---

[2]To see this, note that if Q goes up by one unit, OCF will go up by $(P - v)$. In this case, the percentage change in Q is $1/Q$, and the percentage change in OCF is $(P - v)/\text{OCF}$. Given this, we have:

$$\begin{aligned}\text{Percentage change in OCF} &= \text{DOL} \times \text{Percentage change in } Q \\ (P - v)/\text{OCF} &= \text{DOL} \times 1/Q \\ \text{DOL} &= (P - v) \times Q/\text{OCF}\end{aligned}$$

Also, based on our definitions of OCF:

$$\text{OCF} + \text{FC} = (P - v) \times Q$$

Thus, DOL can be written as:

$$\begin{aligned}\text{DOL} &= (\text{OCF} + \text{FC})/\text{OCF} \\ &= 1 + \text{FC/OCF}\end{aligned}$$

Operating Leverage — EXAMPLE 11.3

The Sasha Corp. currently sells gourmet dog food for \$1.20 per can. The variable cost is 80 cents per can, and the packaging and marketing operations have fixed costs of \$360,000 per year. Depreciation is \$60,000 per year. What is the accounting break-even? Ignoring taxes, what will be the increase in operating cash flow if the quantity sold rises to 10 percent above the break-even point?

The accounting break-even is \$420,000/\$.40 = 1,050,000 cans. As we know, the operating cash flow is equal to the \$60,000 depreciation at this level of production, so the degree of operating leverage is:

$$\begin{aligned} \text{DOL} &= 1 + \text{FC/OCF} \\ &= 1 + \$360{,}000/\$60{,}000 \\ &= 7 \end{aligned}$$

Given this, a 10 percent increase in the number of cans of dog food sold will increase operating cash flow by a substantial 70 percent.

To check this answer, we note that if sales rise by 10 percent, then the quantity sold will rise to 1,050,000 × 1.1 = 1,155,000. Ignoring taxes, the operating cash flow will be 1,155,000 × \$.40 − \$360,000 = \$102,000. Compared to the \$60,000 cash flow we had, this is exactly 70 percent more: \$102,000/\$60,000 = 1.70.

OPERATING LEVERAGE AND BREAK-EVEN

We illustrate why operating leverage is an important consideration by examining the Wettway sailboat project under an alternative scenario. At a Q of 85 boats, the degree of operating leverage for the sailboat project under the original scenario is:

$$\begin{aligned} \text{DOL} &= 1 + \text{FC/OCF} \\ &= 1 + \$500/\$1{,}200 \\ &= 1.42 \end{aligned}$$

Also, recall that the NPV at a sales level of 85 boats was \$88,735, and the accounting break-even was 60 boats.

An option available to Wettway is to subcontract production of the boat hull assemblies. If the company does this, the necessary investment falls to \$3,200,000 and the fixed operating costs fall to \$180,000. Variable costs will rise to \$25,000 per boat because subcontracting is more expensive than producing in-house. Ignoring taxes, evaluate this option.

For practice, see if you don't agree with the following:

$$\begin{aligned} \text{NPV at 20\% (85 units)} &= \$74{,}720 \\ \text{Accounting break-even} &= 55 \text{ boats} \\ \text{Degree of operating leverage} &= 1.16 \end{aligned}$$

What has happened? This option results in a slightly lower estimated net present value, and the accounting break-even point falls to 55 boats from 60 boats.

Given that this alternative has the lower NPV, is there any reason to consider it further? Maybe there is. The degree of operating leverage is substantially lower in the second case. If Wettway is worried about the possibility of an overly optimistic projection, then it might prefer to subcontract.

There is another reason why Wettway might consider the second arrangement. If sales turn out to be better than expected, the company still has the option of starting to produce in-house at a later date. As a practical matter, it is much easier to increase operating leverage (by purchasing equipment) than to decrease it (by selling off equipment). As we discuss in a later chapter, one of the drawbacks to discounted cash flow analysis is that it is difficult to explicitly include options of this sort in the analysis, even though they may be quite important.

Concept Questions

11.5a What is operating leverage?
11.5b How is operating leverage measured?
11.5c What are the implications of operating leverage for the financial manager?

11.6 Capital Rationing

capital rationing
The situation that exists if a firm has positive NPV projects but cannot find the necessary financing.

Capital rationing is said to exist when we have profitable (positive NPV) investments available but we can't get the funds needed to undertake them. For example, as division managers for a large corporation, we might identify $5 million in excellent projects but find that, for whatever reason, we can spend only $2 million. Now what? Unfortunately, for reasons we will discuss, there may be no truly satisfactory answer.

SOFT RATIONING

soft rationing
The situation that occurs when units in a business are allocated a certain amount of financing for capital budgeting.

The situation we have just described is called **soft rationing**. This occurs when, for example, different units in a business are allocated some fixed amount of money each year for capital spending. Such an allocation is primarily a means of controlling and keeping track of overall spending. The important thing to note about soft rationing is that the corporation as a whole isn't short of capital; more can be raised on ordinary terms if management so desires.

If we face soft rationing, the first thing to do is to try to get a larger allocation. Failing that, one common suggestion is to generate as large a net present value as possible within the existing budget. This amounts to choosing projects with the largest benefit-cost ratio (profitability index).

Strictly speaking, this is the correct thing to do only if the soft rationing is a one-time event—that is, it won't exist next year. If the soft rationing is a chronic problem, then something is amiss. The reason goes all the way back to Chapter 1. Ongoing soft rationing means we are constantly bypassing positive NPV investments. This contradicts the goal of our firm. If we are not trying to maximize value, then the question of which projects to take becomes ambiguous because we no longer have an objective goal in the first place.

HARD RATIONING

hard rationing
The situation that occurs when a business cannot raise financing for a project under any circumstances.

With **hard rationing**, a business cannot raise capital for a project under any circumstances. For large, healthy corporations, this situation probably does not occur very often. This is fortunate because, with hard rationing, our DCF analysis breaks down, and the best course of action is ambiguous.

The reason DCF analysis breaks down has to do with the required return. Suppose we say our required return is 20 percent. Implicitly, we are saying we will take a project with a return that exceeds this. However, if we face hard rationing, then we are not going to take a new project no matter what the return on that project is, so the whole concept of a required return is ambiguous. About the only interpretation we can give this situation is that the required return is so large that no project has a positive NPV in the first place.

Hard rationing can occur when a company experiences financial distress, meaning that bankruptcy is a possibility. Also, a firm may not be able to raise capital without violating a preexisting contractual agreement. We discuss these situations in greater detail in a later chapter.

Concept Questions

11.6a What is capital rationing? What types are there?

11.6b What problems does capital rationing create for discounted cash flow analysis?

Summary and Conclusions 11.7

In this chapter, we looked at some ways of evaluating the results of a discounted cash flow analysis; we also touched on some of the problems that can come up in practice:

1. Net present value estimates depend on projected future cash flows. If there are errors in those projections, then our estimated NPVs can be misleading. We called this possibility *forecasting risk*.
2. Scenario and sensitivity analysis are useful tools for identifying which variables are critical to the success of a project and where forecasting problems can do the most damage.
3. Break-even analysis in its various forms is a particularly common type of scenario analysis that is useful for identifying critical levels of sales.
4. Operating leverage is a key determinant of break-even levels. It reflects the degree to which a project or a firm is committed to fixed costs. The degree of operating leverage tells us the sensitivity of operating cash flow to changes in sales volume.
5. Projects usually have future managerial options associated with them. These options may be important, but standard discounted cash flow analysis tends to ignore them.
6. Capital rationing occurs when apparently profitable projects cannot be funded. Standard discounted cash flow analysis is troublesome in this case because NPV is not necessarily the appropriate criterion.

The most important thing to carry away from reading this chapter is that estimated NPVs or returns should not be taken at face value. They depend critically on projected cash flows. If there is room for significant disagreement about those projected cash flows, the results from the analysis have to be taken with a grain of salt.

Despite the problems we have discussed, discounted cash flow analysis is still *the* way of attacking problems because it forces us to ask the right questions. What we have learned in this chapter is that knowing the questions to ask does not guarantee we will get all the answers.

CONNECT TO FINANCE

Can you answer the following *Connect* Quiz questions?

Section 11.1 The potential for believing that a project has a positive net present value when it does not is referred to as ___________.

Section 11.2 Marcos Entertainment expects to sell 84,000 theater tickets at $12 each during the coming year. What is the worst-case sales revenue if all estimates are accurate to within a ±3 percent range?

Section 11.3 Delta Tool has projected sales of 8,500 units at a sales price per unit of $9,400. Fixed costs are estimated at $5.2 million, and estimated variable costs per unit are $8,300. What is the amount of the total costs if the firm temporarily stops production?

Section 11.4 What is true for a project if that project is operating at its financial break-even point?

Section 11.5 A capital-intensive project is one that has a ___________.

Section 11.6 Pavloki, Inc., has three proposed projects with positive net present values. These projects and their net present values are: Project A—NPV $46,300; Project B—NPV $31,900; Project C—NPV $6,400. If the firm is faced with hard rationing, which of the projects will it accept?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

Use the following base-case information to work the self-test problems:

A project under consideration costs $750,000, has a five-year life, and has no salvage value. Depreciation is straight-line to zero. The required return is 17 percent, and the tax rate is 21 percent. Sales are projected at 500 units per year. Price per unit is $2,500, variable cost per unit is $1,500, and fixed costs are $200,000 per year.

11.1 **Scenario Analysis** Suppose you think that the unit sales, price, variable cost, and fixed cost projections given here are accurate to within 5 percent. What are the upper and lower bounds for these projections? What is the base-case NPV? What are the best- and worst-case scenario NPVs?

11.2 **Break-Even Analysis** Given the base-case projections in the previous problem, what are the cash, accounting, and financial break-even sales levels for this project? Ignore taxes in answering.

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

11.1 We can summarize the relevant information as follows:

	Base Case	Lower Bound	Upper Bound
Unit sales	500	475	525
Price per unit	$ 2,500	$ 2,375	$ 2,625
Variable cost per unit	$ 1,500	$ 1,425	$ 1,575
Fixed cost per year	$200,000	$190,000	$210,000

Depreciation is $150,000 per year; knowing this, we can calculate the cash flows under each scenario. Remember that we assign high costs and low prices and volume for the worst case and just the opposite for the best case:

Scenario	Unit Sales	Unit Price	Unit Variable Cost	Fixed Costs	Cash Flow
Base case	500	$2,500	$1,500	$200,000	$268,500
Best case	525	2,625	1,425	190,000	379,100
Worst case	475	2,375	1,575	210,000	165,800

At 17 percent, the five-year annuity factor is 3.19935, so the NPVs are:

$$\begin{aligned}\text{Base-case NPV} &= -\$750{,}000 + 3.19935 \times \$268{,}500\\ &= \$109{,}024\\ \text{Best-case NPV} &= -\$750{,}000 + 3.19935 \times \$379{,}100\\ &= \$462{,}872\\ \text{Worst-case NPV} &= -\$750{,}000 + 3.19935 \times \$165{,}800\\ &= -\$219{,}548\end{aligned}$$

11.2 In this case, we have $200,000 in cash fixed costs to cover. Each unit contributes $2,500 − 1,500 = $1,000 toward covering fixed costs. The cash break-even is thus $200,000/$1,000 = 200 units. We have another $150,000 in depreciation, so the accounting break-even is ($200,000 + 150,000)/$1,000 = 350 units.

To get the financial break-even, we need to find the OCF such that the project has a zero NPV. As we have seen, the five-year annuity factor is 3.19935 and the project costs $750,000, so the OCF must be such that:

$$\$750{,}000 = \text{OCF} \times 3.19935$$

So, for the project to break even on a financial basis, the project's cash flow must be $750,000/3.19935, or $234,423 per year. If we add this to the $200,000 in cash fixed costs, we get a total of $434,423 that we have to cover. At $1,000 per unit, we need to sell $434,423/$1,000 = 435 units.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Forecasting Risk** **[LO1]** What is forecasting risk? In general, would the degree of forecasting risk be greater for a new product or a cost-cutting proposal? Why?
2. **Sensitivity Analysis and Scenario Analysis** **[LO1, 2]** What is the essential difference between sensitivity analysis and scenario analysis?
3. **Marginal Cash Flows** **[LO3]** A co-worker claims that looking at all this marginal this and incremental that is just a bunch of nonsense, saying, "Listen, if our average revenue doesn't exceed our average cost, then we will have a negative cash flow, and we will go broke!" How do you respond?
4. **Operating Leverage** **[LO4]** At one time at least, many Japanese companies had a "no-layoff" policy (for that matter, so did IBM). What are the implications of such a policy for the degree of operating leverage a company faces?
5. **Operating Leverage** **[LO4]** Airlines offer an example of an industry in which the degree of operating leverage is fairly high. Why?
6. **Break-Even** **[LO3]** As a shareholder of a firm that is contemplating a new project, would you be more concerned with the accounting break-even point, the cash break-even point, or the financial break-even point? Why?
7. **Break-Even** **[LO3]** Assume a firm is considering a new project that requires an initial investment and has equal sales and costs over its life. Will the project reach the accounting, cash, or financial break-even point first? Which will it reach next? Last? Will this ordering always apply?

8. **Capital Rationing** [LO5] How do soft rationing and hard rationing differ? What are the implications if a firm is experiencing soft rationing? Hard rationing?
9. **Capital Rationing** [LO5] Going all the way back to Chapter 1, recall that we saw that partnerships and proprietorships can face difficulties when it comes to raising capital. In the context of this chapter, the implication is that small businesses will generally face what problem?
10. **Scenario Analysis** [LO2] You are at work when a co-worker excitedly comes to your desk and shows you the scenario analysis that he has just completed for a potential new project. All three scenarios show a positive NPV. He states, "We have to take this project!" What is your initial reaction regarding this new project. Do you believe the results of the scenario analysis?

QUESTIONS AND PROBLEMS

connect

BASIC

(Questions 1–15)

1. **Calculating Costs and Break-Even** [LO3] Night Shades, Inc. (NSI), manufactures biotech sunglasses. The variable materials cost is \$11.13 per unit, and the variable labor cost is \$7.29 per unit.
   a. What is the variable cost per unit?
   b. Suppose the company incurs fixed costs of \$875,000 during a year in which total production is 190,000 units. What are the total costs for the year?
   c. If the selling price is \$44.99 per unit, does the company break even on a cash basis? If depreciation is \$435,000 per year, what is the accounting break-even point?
2. **Computing Average Cost** [LO3] K-Too Everwear Corporation can manufacture mountain climbing shoes for \$33.18 per pair in variable raw material costs and \$24.36 per pair in variable labor expense. The shoes sell for \$170 per pair. Last year, production was 145,000 pairs. Fixed costs were \$1,750,000. What were total production costs? What is the marginal cost per pair? What is the average cost? If the company is considering a one-time order for an extra 5,000 pairs, what is the minimum acceptable total revenue from the order? Explain.
3. **Scenario Analysis** [LO2] Sloan Transmissions, Inc., has the following estimates for its new gear assembly project: Price = \$1,440 per unit; variable costs = \$460 per unit; fixed costs = \$3.9 million; quantity = 85,000 units. Suppose the company believes all of its estimates are accurate only to within ±15 percent. What values should the company use for the four variables given here when it performs its best-case scenario analysis? What about the worst-case scenario?
4. **Sensitivity Analysis** [LO1] For the company in the previous problem, suppose management is most concerned about the impact of its price estimate on the project's profitability. How could you address this concern? Describe how you would calculate your answer. What values would you use for the other forecast variables?
5. **Sensitivity Analysis and Break-Even** [LO1, 3] We are evaluating a project that costs \$786,000, has an eight-year life, and has no salvage value. Assume that depreciation is straight-line to zero over the life of the project. Sales are projected at 65,000 units per year. Price per unit is \$48, variable cost per unit is \$25, and fixed costs are \$725,000 per year. The tax rate is 22 percent, and we require a return of 10 percent on this project.
   a. Calculate the accounting break-even point. What is the degree of operating leverage at the accounting break-even point?

b. Calculate the base-case cash flow and NPV. What is the sensitivity of NPV to changes in the quantity sold? Explain what your answer tells you about a 500-unit decrease in the quantity sold.

c. What is the sensitivity of OCF to changes in the variable cost figure? Explain what your answer tells you about a $1 decrease in estimated variable costs.

6. Scenario Analysis [LO2] In the previous problem, suppose the projections given for price, quantity, variable costs, and fixed costs are all accurate to within ±10 percent. Calculate the best-case and worst-case NPV figures.

7. Calculating Break-Even [LO3] In each of the following cases, calculate the accounting break-even and the cash break-even points. Ignore any tax effects in calculating the cash break-even.

Unit Price	Unit Variable Cost	Fixed Costs	Depreciation
$2,980	$2,135	$8,100,000	$3,100,000
46	41	185,000	183,000
9	3	2,770	1,050

8. Calculating Break-Even [LO3] In each of the following cases, find the unknown variable:

Accounting Break-Even	Unit Price	Unit Variable Cost	Fixed Costs	Depreciation
125,736	$39	$30	$ 820,000	?
165,000	?	27	2,320,000	$975,000
21,430	92	?	237,000	128,700

9. Calculating Break-Even [LO3] A project has the following estimated data: Price = $62 per unit; variable costs = $28 per unit; fixed costs = $27,300; required return = 12 percent; initial investment = $34,800; life = four years. Ignoring the effect of taxes, what is the accounting break-even quantity? The cash break-even quantity? The financial break-even quantity? What is the degree of operating leverage at the financial break-even level of output?

10. Using Break-Even Analysis [LO3] Consider a project with the following data: Accounting break-even quantity = 13,700 units; cash break-even quantity = 9,600 units; life = five years; fixed costs = $185,000; variable costs = $23 per unit; required return = 12 percent. Ignoring the effect of taxes, find the financial break-even quantity.

11. Calculating Operating Leverage [LO4] At an output level of 45,000 units, you calculate that the degree of operating leverage is 2.79. If output rises to 48,000 units, what will the percentage change in operating cash flow be? Will the new level of operating leverage be higher or lower? Explain.

12. Leverage [LO4] In the previous problem, suppose fixed costs are $175,000. What is the operating cash flow at 43,000 units? The degree of operating leverage?

13. Operating Cash Flow and Leverage [LO4] A proposed project has fixed costs of $89,000 per year. The operating cash flow at 10,400 units is $127,400. Ignoring the effect of taxes, what is the degree of operating leverage? If units sold rise from 10,400 to 11,100, what will be the increase in operating cash flow? What is the new degree of operating leverage?

14. **Cash Flow and Leverage [LO4]** At an output level of 17,500 units, you have calculated that the degree of operating leverage is 3.26. The operating cash flow is \$78,000 in this case. Ignoring the effect of taxes, what are fixed costs? What will the operating cash flow be if output rises to 18,500 units? If output falls to 16,500 units?

15. **Leverage [LO4]** In the previous problem, what will be the new degree of operating leverage in each case?

INTERMEDIATE
(Questions 16–24)

16. **Break-Even Intuition [LO3]** Consider a project with a required return of R percent that costs \$$I$ and will last for N years. The project uses straight-line depreciation to zero over the N-year life; there is no salvage value or net working capital requirements.
    a. At the accounting break-even level of output, what is the IRR of this project? The payback period? The NPV?
    b. At the cash break-even level of output, what is the IRR of this project? The payback period? The NPV?
    c. At the financial break-even level of output, what is the IRR of this project? The payback period? The NPV?

17. **Sensitivity Analysis [LO1]** Consider a four-year project with the following information: Initial fixed asset investment = \$575,000; straight-line depreciation to zero over the four-year life; zero salvage value; price = \$29; variable costs = \$19; fixed costs = \$235,000; quantity sold = 76,000 units; tax rate = 21 percent. How sensitive is OCF to changes in quantity sold?

18. **Operating Leverage [LO4]** In the previous problem, what is the degree of operating leverage at the given level of output? What is the degree of operating leverage at the accounting break-even level of output?

19. **Project Analysis [LO1, 2, 3, 4]** You are considering a new product launch. The project will cost \$1,950,000, have a four-year life, and have no salvage value; depreciation is straight-line to zero. Sales are projected at 210 units per year; price per unit will be \$17,500, variable cost per unit will be \$10,600, and fixed costs will be \$560,000 per year. The required return on the project is 12 percent, and the relevant tax rate is 21 percent.
    a. Based on your experience, you think the unit sales, variable cost, and fixed cost projections given here are probably accurate to within ±10 percent. What are the upper and lower bounds for these projections? What is the base-case NPV? What are the best-case and worst-case scenarios?
    b. Evaluate the sensitivity of your base-case NPV to changes in fixed costs.
    c. What is the cash break-even level of output for this project (ignoring taxes)?
    d. What is the accounting break-even level of output for this project? What is the degree of operating leverage at the accounting break-even point? How do you interpret this number?

20. **Project Analysis [LO1, 2]** McGilla Golf has decided to sell a new line of golf clubs. The clubs will sell for \$845 per set and have a variable cost of \$405 per set. The company has spent \$150,000 for a marketing study that determined the company will sell 60,000 sets per year for seven years. The marketing study also determined that the company will lose sales of 10,000 sets of its high-priced clubs. The high-priced clubs sell at \$1,175 and have variable costs of \$620. The company will also increase sales of its cheap clubs by 12,000 sets. The cheap clubs sell for \$435 and have variable costs of \$200 per set. The fixed costs each year will be \$9.75 million. The company has also spent \$1 million on research and development for the new clubs. The plant and equipment required will cost \$37.1 million and will be depreciated on a straight-line basis. The new clubs will also require an increase in net working

capital of $1.7 million that will be returned at the end of the project. The tax rate is 25 percent, and the cost of capital is 10 percent. Calculate the payback period, the NPV, and the IRR.

21. **Scenario Analysis** [LO2] In the previous problem, you feel that the values are accurate to within only ±10 percent. What are the best-case and worst-case NPVs? *Hint*: The price and variable costs for the two existing sets of clubs are known with certainty; only the sales gained or lost are uncertain.

22. **Sensitivity Analysis** [LO1] In Problem 20, McGilla Golf would like to know the sensitivity of NPV to changes in the price of the new clubs and the quantity of new clubs sold. What is the sensitivity of the NPV to each of these variables?

23. **Break-Even Analysis** [LO3] Hybrid cars are touted as a "green" alternative; however, the financial aspects of hybrid ownership are not as clear. Consider the 2016 Toyota Camry Hybrid LE, which had a list price of $5,500 (including tax consequences) more than the comparable Volkswagen Touareg VR6. Additionally, the annual ownership costs (other than fuel) for the hybrid were expected to be $350 more than the traditional sedan. The EPA mileage estimate was 39 mpg for the hybrid and 30 mpg for the traditional sedan.

a. Assume that gasoline costs $2.85 per gallon and you plan to keep either car for six years. How many miles per year would you need to drive to make the decision to buy the hybrid worthwhile, ignoring the time value of money?

b. If you drive 15,000 miles per year and keep either car for six years, what price per gallon would make the decision to buy the hybrid worthwhile, ignoring the time value of money?

c. Rework parts (a) and (b) assuming the appropriate interest rate is 10 percent and all cash flows occur at the end of the year.

d. What assumption did the analysis in the previous parts make about the resale value of each car?

24. **Break-Even Analysis** [LO3] In an effort to capture the large jet market, Airbus invested $13 billion developing its A380, which is capable of carrying 800 passengers. The plane had a list price of $280 million. In discussing the plane, Airbus stated that the company would break even when 249 A380s were sold.

a. Assuming the break-even sales figure given is the accounting break-even, what is the cash flow per plane?

b. Airbus promised its shareholders a 20 percent rate of return on the investment. If sales of the plane continue in perpetuity, how many planes must the company sell per year to deliver on this promise?

c. Suppose instead that the sales of the A380 last for only 10 years. How many planes must Airbus sell per year to deliver the same rate of return?

CHALLENGE (Questions 25–30)

25. **Break-Even and Taxes** [LO3] This problem concerns the effect of taxes on the various break-even measures.

a. Show that, when we consider taxes, the general relationship between operating cash flow, OCF, and sales volume, Q, can be written as:

$$Q = \frac{\text{FC} + \dfrac{\text{OCF} - T_C \times D}{1 - T_C}}{P - v}$$

b. Use the expression in part (a) to find the cash, accounting, and financial break-even points for the Wettway sailboat example in the chapter. Assume a 21 percent tax rate.

c. In part (b), the accounting break-even should be the same as before. Why? Verify this algebraically.

26. Operating Leverage and Taxes [LO4] Show that if we consider the effect of taxes, the degree of operating leverage can be written as:

$$\text{DOL} = 1 + [\text{FC} \times (1 - T_C) - T_C \times D]/\text{OCF}$$

Notice that this reduces to our previous result if $T_C = 0$. Can you interpret this in words?

27. Scenario Analysis [LO2] Consider a project to supply Detroit with 30,000 tons of machine screws annually for automobile production. You will need an initial $4.3 million investment in threading equipment to get the project started; the project will last for five years. The accounting department estimates that annual fixed costs will be $1.025 million and that variable costs should be $190 per ton; accounting will depreciate the initial fixed asset investment straight-line to zero over the five-year project life. It also estimates a salvage value of $400,000 after dismantling costs. The marketing department estimates that the automakers will let the contract at a selling price of $290 per ton. The engineering department estimates you will need an initial net working capital investment of $410,000. You require a return of 13 percent and face a tax rate of 22 percent on this project.

a. What is the estimated OCF for this project? The NPV? Should you pursue this project?

b. Suppose you believe that the accounting department's initial cost and salvage value projections are accurate only to within ±15 percent; the marketing department's price estimate is accurate only to within ±10 percent; and the engineering department's net working capital estimate is accurate only to within ±5 percent. What is your worst-case scenario for this project? Your best-case scenario? Do you still want to pursue the project?

28. Sensitivity Analysis [LO1] In Problem 27, suppose you're confident about your own projections, but you're a little unsure about Detroit's actual machine screw requirement. What is the sensitivity of the project OCF to changes in the quantity supplied? What about the sensitivity of NPV to changes in quantity supplied? Given the sensitivity number you calculated, is there some minimum level of output below which you wouldn't want to operate? Why?

29. Break-Even Analysis [LO3] Use the results of Problem 25 to find the accounting, cash, and financial break-even quantities for the company in Problem 27.

30. Operating Leverage [LO4] Use the results of Problem 26 to find the degree of operating leverage for the company in Problem 27 at the base-case output level of 30,000 tons. How does this number compare to the sensitivity figure you found in Problem 28? Verify that either approach will give you the same OCF figure at any new quantity level.

EXCEL MASTER IT! PROBLEM

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Harper Industries is examining a new project to manufacture cell phones. The company has examined several alternatives for the manufacturing process. With Process I, the company would manufacture the cell phone entirely in-house. This would require the highest initial cost and fixed costs. Process II would involve subcontracting the manufacture of the electronics. While this choice would reduce the initial cost and fixed costs, it would result in higher variable costs. Finally, Process III would subcontract all production, with Harper Industries only completing the final assembly and testing. Below you are given the information for each of the options available to the company.

	Process I	Process II	Process III
Initial cost:	$75,000,000	$55,000,000	$36,000,000
Life (years):	7		
Units:	450,000		
Price per unit:	$ 345		
VC per unit:	$ 85	$ 137	$ 182
Fixed costs:	$81,000,000	$63,000,000	$48,000,000
Required return:	13%		
Tax rate:	21%		

a. Calculate the NPV for each of the three manufacturing processes available to the company.

b. What are the accounting break-even, cash break-even, and financial break-even points for each manufacturing process?

c. What is the DOL for each manufacturing process? Graph the DOL for each manufacturing process on the same graph for different unit sales.

MINICASE

Conch Republic Electronics, Part 2

Shelley Couts, the owner of Conch Republic Electronics, has received the capital budgeting analysis from Jay McCanless for the new smartphone the company is considering. Shelley is pleased with the results, but she still has concerns about the new smartphone. Conch Republic has used a small market research firm for the past 20 years, but recently the founder of that firm has retired. Because of this, Shelley is not convinced the sales projections presented by the market research firm are entirely accurate. Additionally, because of rapid changes in technology, she is concerned that a competitor may enter the market. This would likely force Conch Republic to lower the sales price of its new smartphone. For these reasons, she has asked Jay to analyze how changes in the price of the new smartphone and changes in the quantity sold will affect the NPV of the project.

Shelley has asked Jay to prepare a memo answering the following questions.

QUESTIONS

1. How sensitive is the NPV to changes in the price of the new smartphone?
2. How sensitive is the NPV to changes in the quantity sold of the new smartphone?

Chapter 12 Some Lessons from Capital Market History

WITH THE S&P 500 UP about 12 percent and the NASDAQ index up about 9 percent in 2016, stock market performance overall was mixed for the year. The S&P 500 return was about average, while the NASDAQ return was below average. However, investors in AK Steel had to be thrilled with the 359 percent gain in that stock, and investors in United States Steel had to feel pleased with its 332 percent gain. Of course, not all stocks increased during the year. Stock in pharmaceutical company Endo International fell 73 percent during the year, and stock in First Solar fell 51 percent.

These examples show that there were tremendous potential profits to be made during 2016, but there was also the risk of losing money—lots of it. So what should you, as a stock market investor, expect when you invest your own money? In this chapter, we study almost nine decades of market history to find out.

Learning Objectives

After studying this chapter, you should be able to:

- **LO1** Calculate the return on an investment.
- **LO2** Discuss the historical returns on various important types of investments.
- **LO3** Discuss the historical risks on various important types of investments.
- **LO4** Explain the implications of market efficiency.

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Thus far, we haven't had much to say about what determines the required return on an investment. In one sense, the answer is simple: The required return depends on the risk of the investment. The greater the risk, the greater is the required return.

Having said this, we are left with a somewhat more difficult problem. How can we measure the amount of risk present in an investment? Put another way, what does it mean to say that one investment is riskier than another? Obviously, we need to define what we mean by *risk* if we are going to answer these questions. This is our task in this chapter and the next.

From the last several chapters, we know that one of the responsibilities of the financial manager is to assess the value of proposed real asset investments. In doing this, it is important that we first look at what financial investments have to offer. At a minimum, the return we require from a proposed nonfinancial investment must be greater than what we can get by buying financial assets of similar risk.

Our goal in this chapter is to provide a perspective on what capital market history can tell us about risk and return. The most important thing to get out of this chapter is a feel for the numbers. What is a high return? What is a low return? More generally, what returns should we expect from financial assets, and what are the risks of such investments? This perspective is essential for understanding how to analyze and value risky investment projects.

We start our discussion of risk and return by describing the historical experience of investors in U.S. financial markets. In 1931, for example, the stock market lost 44 percent of its value. Just two years later, the stock market gained 54 percent. In more recent memory, the market lost about 25 percent of its value on October 19, 1987, alone. What lessons, if any, can financial managers learn from such shifts in the stock market? We will explore almost a century of market history to find out.

Not everyone agrees on the value of studying history. On the one hand, there is philosopher George Santayana's famous comment: "Those who do not remember the past are condemned to repeat it."* On the other hand, there is industrialist Henry Ford's equally famous comment: "History is more or less bunk."† Nonetheless, perhaps everyone would agree with Mark Twain's observation: "October. This is one of the peculiarly dangerous months to speculate in stocks. The others are July, January, September, April, November, May, March, June, December, August, and February."‡

Two central lessons emerge from our study of market history. First, there is a reward for bearing risk. Second, the greater is the potential reward, the greater is the risk. To illustrate these facts about market returns, we devote much of this chapter to reporting the statistics and numbers that make up the modern capital market history of the United States. In the next chapter, these facts provide the foundation for our study of how financial markets put a price on risk.

Returns

12.1

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We wish to discuss historical returns on different types of financial assets. The first thing we need to do, then, is to briefly discuss how to calculate the return from investing.

DOLLAR RETURNS

If you buy an asset of any sort, your gain (or loss) from that investment is called the *return on your investment*. This return will usually have two components. First, you may receive some cash directly while you own the investment. This is called the *income component* of your return. Second, the value of the asset you purchase will often change. In this case, you have a capital gain or capital loss on your investment.[1]

How did the market do today? Find out at **finance.yahoo.com**.

To illustrate, suppose the Video Concept Company has several thousand shares of stock outstanding. You purchased some of these shares of stock in the company at the beginning of the year. It is now year-end, and you want to determine how well you have done on your investment.

First, over the year, a company may pay cash dividends to its shareholders. As a stockholder in Video Concept Company, you are a part owner of the company. If the company is profitable, it may choose to distribute some of its profits to shareholders (we discuss the details of dividend policy in a later chapter). So, as the owner of some stock, you will receive some cash. This cash is the income component from owning the stock.

In addition to the dividend, the other part of your return is the capital gain or capital loss on the stock. This part arises from changes in the value of your investment. For example, consider the cash flows illustrated in Figure 12.1. At the beginning of the year, the stock was selling for $37 per share. If you had bought 100 shares, you would have had a total outlay of $3,700. Suppose that, over the year, the stock paid a dividend of $1.85 per share. By the end of the year, then, you would have received income of:

$$\text{Dividend} = \$1.85 \times 100 = \$185$$

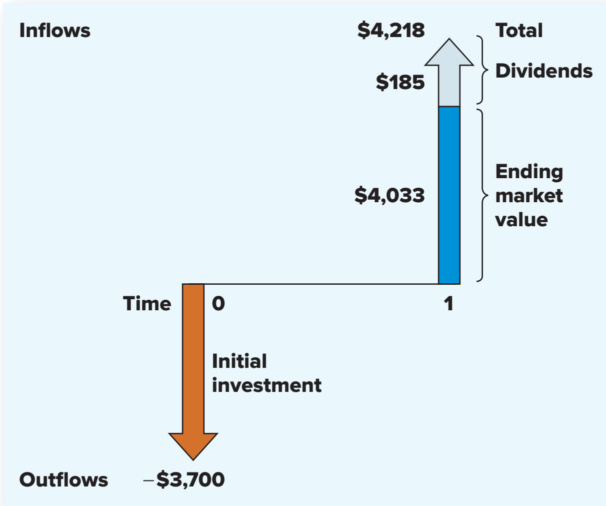
*Source: George Santayana, Philosopher (1863–1952)

†Source: Henry Ford, Industrialist (1863–1947)

‡Source: Mark Twain (1835–1910)

[1]As we mentioned in an earlier chapter, strictly speaking, what is and what is not a capital gain (or loss) is determined by the IRS. We use the terms loosely.

FIGURE 12.1
Dollar Returns



Also, the value of the stock has risen to \$40.33 per share by the end of the year. Your 100 shares are now worth \$4,033, so you have a capital gain of:

$$\text{Capital gain} = (\$40.33 - 37) \times 100 = \$333$$

On the other hand, if the price had dropped to, say, \$34.78, you would have a capital loss of:

$$\text{Capital loss} = (\$34.78 - 37) \times 100 = -\$222$$

Notice that a capital loss is the same thing as a negative capital gain.

The total dollar return on your investment is the sum of the dividend and the capital gain:

$$\textbf{Total dollar return} = \textbf{Dividend income} + \textbf{Capital gain (or loss)} \tag{12.1}$$

In our first example, the total dollar return is given by:

$$\text{Total dollar return} = \$185 + 333 = \$518$$

Notice that if you sold the stock at the end of the year, the total amount of cash you would have would equal your initial investment plus the total return. In the preceding example, then:

$$\begin{aligned} \textbf{Total cash if stock is sold} &= \textbf{Initial investment} + \textbf{Total return} \\ &= \$3{,}700 + 518 \\ &= \$4{,}218 \end{aligned} \tag{12.2}$$

As a check, notice that this is the same as the proceeds from the sale of the stock plus the dividends:

$$\begin{aligned} \text{Proceeds from stock sale} + \text{Dividends} &= \$40.33 \times 100 + 185 \\ &= \$4{,}033 + 185 \\ &= \$4{,}218 \end{aligned}$$

Suppose you hold on to your Video Concept stock and don't sell it at the end of the year. Should you still consider the capital gain as part of your return? Isn't this only a "paper" gain and not really a cash flow if you don't sell the stock?

The answer to the first question is a strong yes, and the answer to the second is an equally strong no. The capital gain is every bit as much a part of your return as the dividend, and you should certainly count it as part of your return. That you actually decided to keep the stock and not sell (you don't "realize" the gain) is irrelevant because you could have converted it to cash if you had wanted to. Whether you choose to do so or not is up to you.

After all, if you insisted on converting your gain to cash, you could always sell the stock at year-end and immediately reinvest by buying the stock back. There is no net difference between doing this and just not selling (assuming, of course, that there are no tax consequences from selling the stock). Again, the point is that your decision to actually cash out and buy sodas (or whatever) or to reinvest by not selling doesn't affect the return you earn.

PERCENTAGE RETURNS

It is usually more convenient to summarize information about returns in percentage terms, rather than dollar terms, because that way your return doesn't depend on how much you actually invest. The question we want to answer is this: How much do we get for each dollar we invest?

To answer this question, let P_t be the price of the stock at the beginning of the year and let D_{t+1} be the dividend paid on the stock during the year. Consider the cash flows in Figure 12.2. These are the same as those in Figure 12.1, except that we have now expressed everything on a per-share basis.

In our example, the price at the beginning of the year was \$37 per share and the dividend paid during the year on each share was \$1.85. As we discussed in Chapter 8, expressing the dividend as a percentage of the beginning stock price results in the dividend yield:

$$\begin{aligned} \text{Dividend yield} &= D_{t+1}/P_t \\ &= \$1.85/\$37 = .05, \text{ or } 5\% \end{aligned}$$

This says that for each dollar we invest, we get five cents in dividends.

The second component of our percentage return is the capital gains yield. Recall (from Chapter 8) that this is calculated as the change in the price during the year (the capital gain) divided by the beginning price:

$$\begin{aligned} \text{Capital gains yield} &= (P_{t+1} - P_t)/P_t \\ &= (\$40.33 - 37)/\$37 \\ &= \$3.33/\$37 \\ &= .09, \text{ or } 9\% \end{aligned}$$

So, per dollar invested, we get nine cents in capital gains.

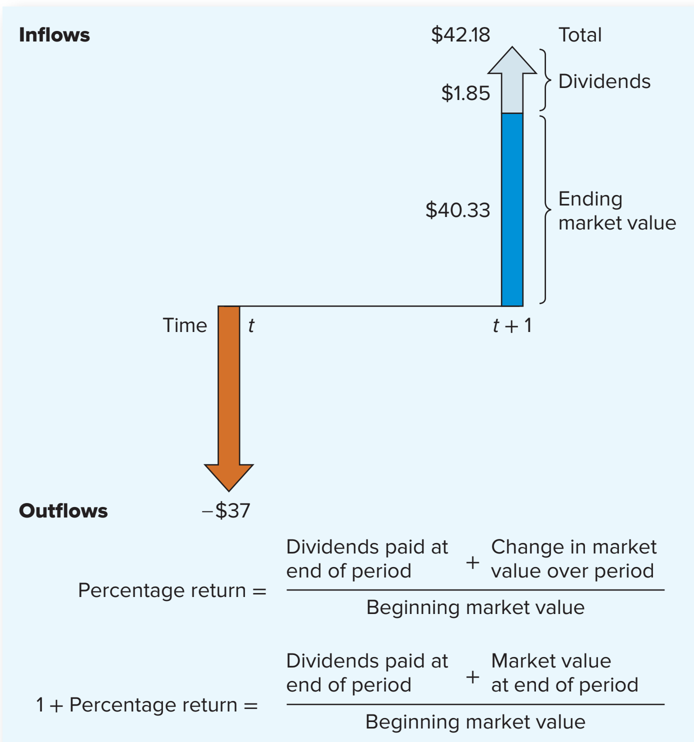


FIGURE 12.2
Percentage Returns

Putting it together, per dollar invested, we get 5 cents in dividends and 9 cents in capital gains; so we get a total of 14 cents. Our percentage return is 14 cents on the dollar, or 14 percent.

To check this, notice that we invested \$3,700 and ended up with \$4,218. By what percentage did our \$3,700 increase? As we saw, we picked up \$4,218 − 3,700 = \$518. This is a \$518/\$3,700 = 14% increase.

EXAMPLE 12.1 Calculating Returns

Suppose you buy some stock at the beginning of the year for \$25 per share. At the end of the year, the price is \$35 per share. During the year, you receive a \$2 dividend per share. This is the situation illustrated in Figure 12.3. What is the dividend yield? The capital gains yield? The percentage return? If your total investment was \$1,000, how much do you have at the end of the year?

Your \$2 dividend per share works out to a dividend yield of:

$$\begin{aligned}\text{Dividend yield} &= D_{t+1}/P_t \\ &= \$2/\$25 = .08, \text{ or } 8\%\end{aligned}$$

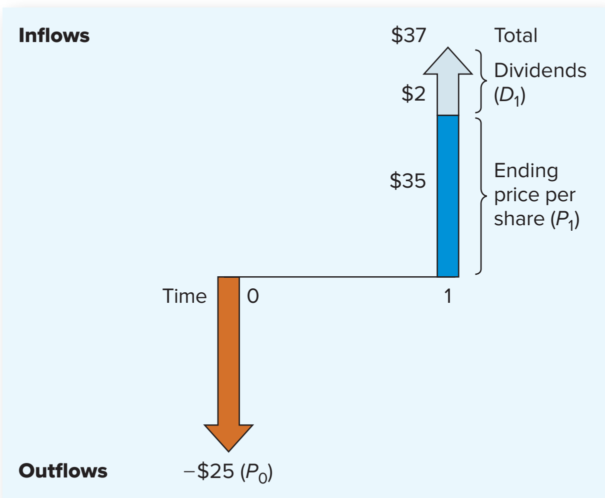
The per-share capital gain is \$10, so the capital gains yield is:

$$\begin{aligned}\text{Capital gains yield} &= (P_{t+1} - P_t)/P_t \\ &= (\$35 - 25)/\$25 \\ &= \$10/\$25 \\ &= .40, \text{ or } 40\%\end{aligned}$$

The total percentage return is 48 percent.

If you had invested \$1,000, you would have \$1,480 at the end of the year, representing a 48 percent increase. To check this, note that your \$1,000 would have bought you \$1,000/\$25 = 40 shares. Your 40 shares would then have paid you a total of 40 × \$2 = \$80 in cash dividends. Your \$10 per-share gain would give you a total capital gain of \$10 × 40 = \$400. Add these together, and you get the \$480 increase.

FIGURE 12.3 Cash Flow—An Investment Example



To give another example, stock in entertainment company Time Warner began 2016 at \$70.65 per share. Time Warner paid dividends of \$1.61 during 2016, and the stock price at the end of the year was \$93.85. What was the return on Time Warner for the year? For practice, see if you agree that the answer is 35.12 percent. Of course, negative returns occur as well. For example, again in 2016, the stock price of shoe giant Nike was \$62.50 per share at the beginning of the year and dividends of \$.66 were paid. The stock ended the year at \$50.83 per share. Verify that the loss was 17.62 percent for the year.

Concept Questions

12.1a What are the two parts of total return?

12.1b Why are unrealized capital gains or losses included in the calculation of returns?

12.1c What is the difference between a dollar return and a percentage return? Why are percentage returns more convenient?

12.2 The Historical Record

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Roger Ibbotson and Rex Sinquefield conducted a famous set of studies dealing with rates of return in U.S. financial markets.[2] They presented year-to-year historical rates of return on five important types of financial investments. The returns can be interpreted as what you would have earned if you had held portfolios of the following:

1. *Large-company stocks:* This common stock portfolio is based on the Standard & Poor's (S&P) 500 index, which contains 500 of the largest companies (in terms of total market value of outstanding stock) in the United States.
2. *Small-company stocks:* This is a portfolio composed of the stock corresponding to the smallest 20 percent of the companies listed on the New York Stock Exchange, again as measured by market value of outstanding stock.
3. *Long-term corporate bonds:* This is based on high-quality bonds with 20 years to maturity.
4. *Long-term U.S. government bonds:* This is based on U.S. government bonds with 20 years to maturity.
5. *U.S. Treasury bills:* This is based on Treasury bills (T-bills for short) with a one-month maturity.

These returns are not adjusted for inflation or taxes; they are nominal, pretax returns.

In addition to the year-to-year returns on these financial instruments, the year-to-year percentage change in the consumer price index (CPI) is also computed. This is a commonly used measure of inflation, so we can calculate real returns using this as the inflation rate.

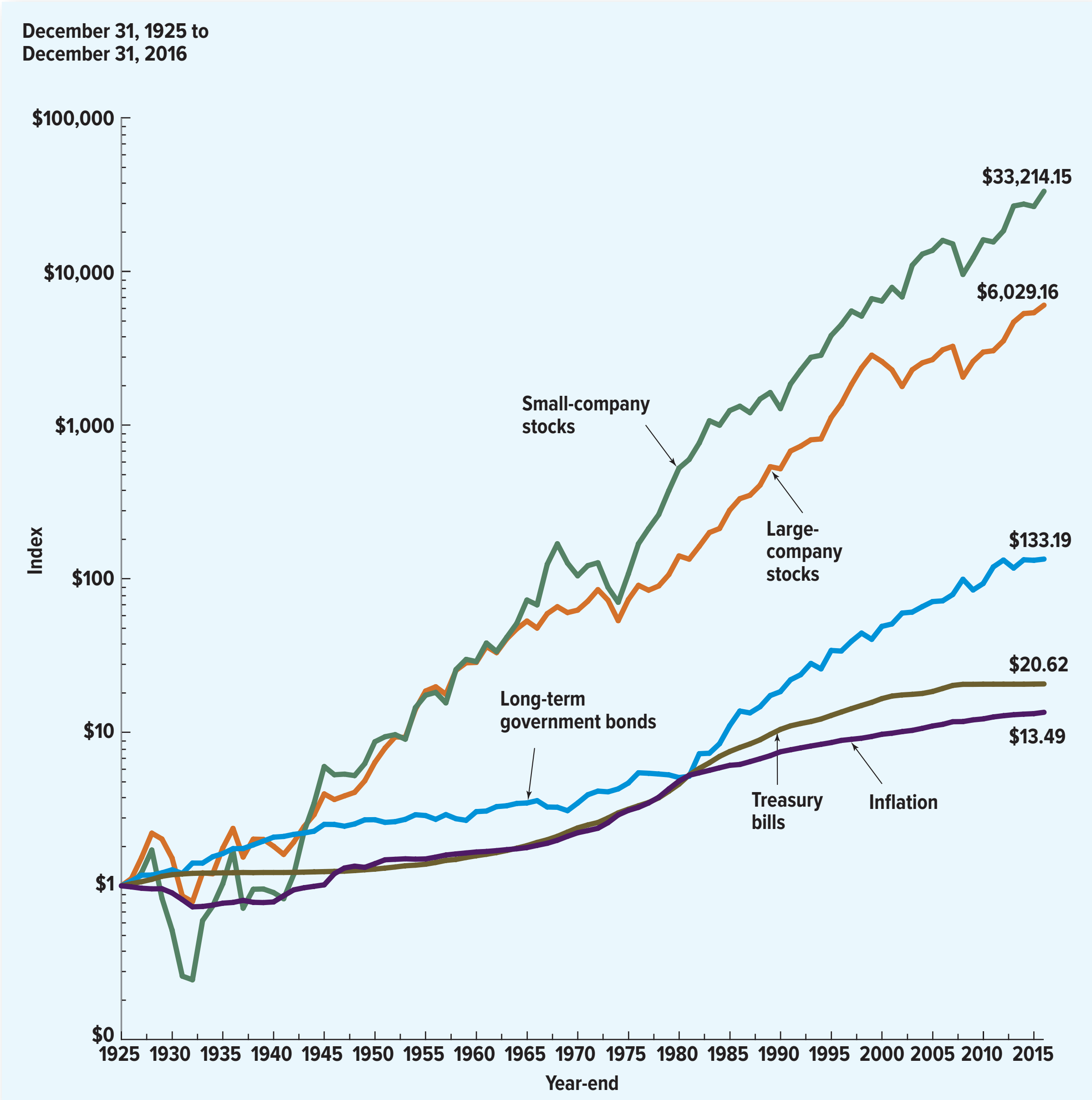
For more about market history, visit **www.globalfinancialdata.com**.

A FIRST LOOK

Before looking closely at the different portfolio returns, we take a look at the big picture. Figure 12.4 shows what happened to \$1 invested in these different portfolios at the end of 1925. The growth in value for each of the different portfolios over the 91-year period ending in 2016 is given separately (the long-term corporate bonds are omitted). Notice that to get everything on a single graph, some modification in scaling is used. As is commonly

[2] R. G. Ibbotson and R. A. Sinquefield, *Stocks, Bonds, Bills, and Inflation* [SBBI] (Charlottesville, VA: Financial Analysis Research Foundation, 1982).

FIGURE 12.4 A $1 Investment in Different Types of Portfolios: 1926–2016 (Year-End 1925 = $1)



SOURCE: Morningstar, 2017, author calculations.

Go to **bigcharts.marketwatch.com** to see both intraday and long-term charts.

done with financial series, the vertical axis is scaled so that equal distances measure equal percentage (as opposed to dollar) changes in values.[3]

Looking at Figure 12.4, we see that the "small-cap" (short for small-capitalization) investment did the best overall. Every dollar invested grew to a remarkable $33,214.15 over the 91 years. The large-company common stock portfolio did less well; a dollar invested in it grew to $6,029.16.

[3]In other words, the scale is logarithmic.

At the other end, the T-bill portfolio grew to only $20.62. This is even less impressive when we consider the inflation over the period in question. As illustrated, the increase in the price level was such that $13.49 was needed at the end of the period just to replace the original $1.

Given the historical record, why would anybody buy anything other than small-cap stocks? If you look closely at Figure 12.4, you will probably see the answer. The T-bill and long-term government bond portfolios grew more slowly than did the stock portfolios, but they also grew much more steadily. The small stocks ended up on top; but as you can see, they grew quite erratically at times. For example, the small stocks were the worst performers for about the first 10 years and had a smaller return than long-term government bonds for over 15 years.

A CLOSER LOOK

To illustrate the variability of the different investments, Figures 12.5 through 12.8 plot the year-to-year percentage returns in the form of vertical bars drawn from the horizontal

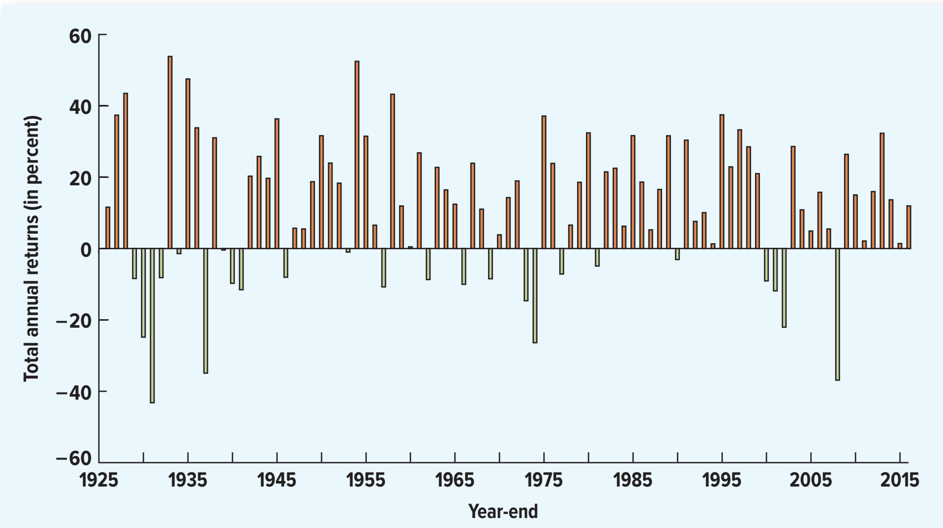


FIGURE 12.5

Year-by-Year Total Returns on Large-Company Common Stocks

SOURCE: Morningstar, 2017

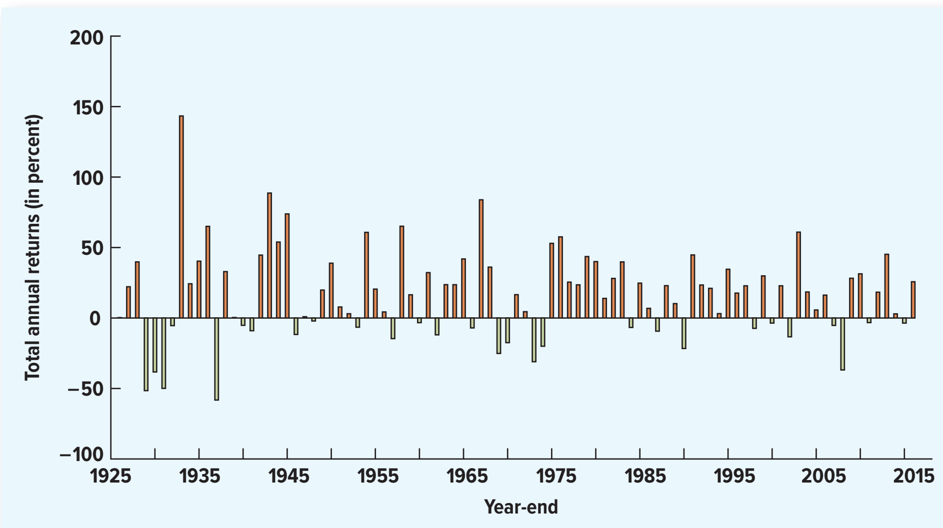


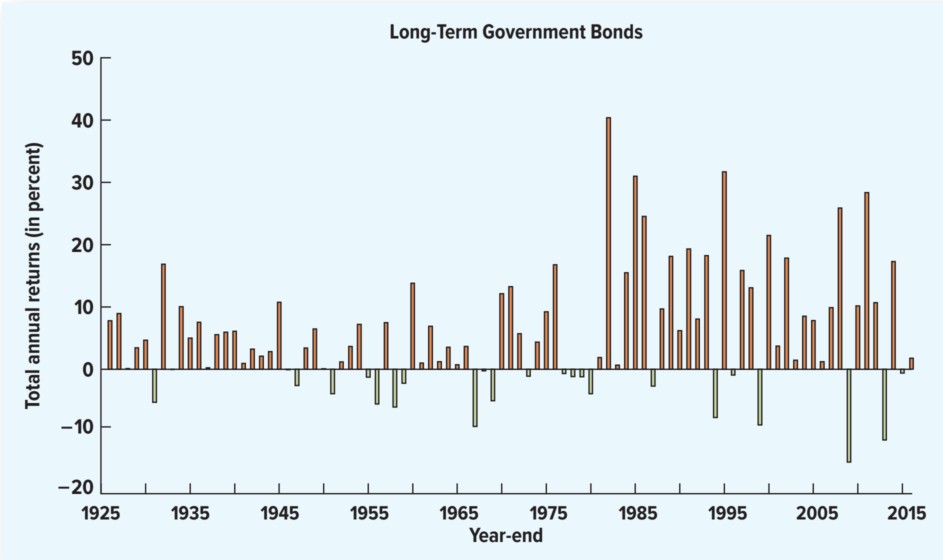
FIGURE 12.6

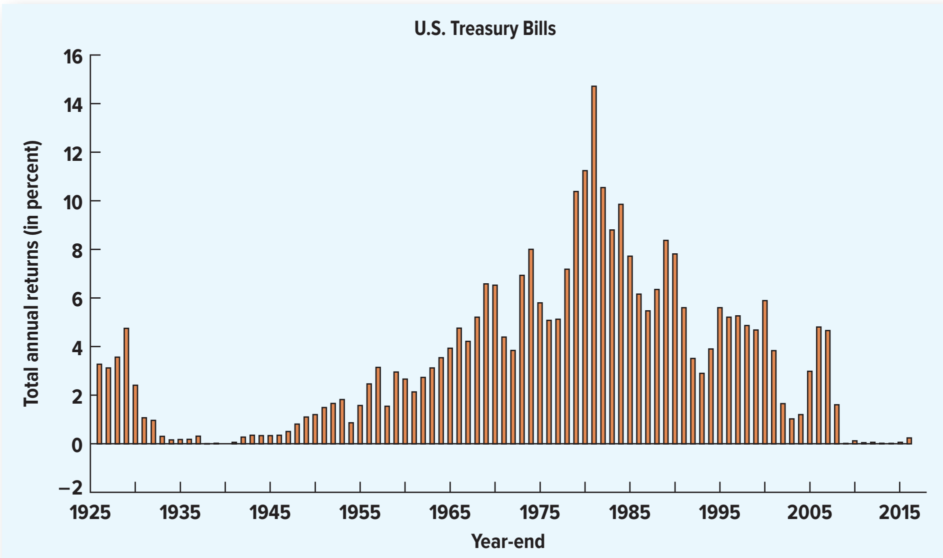
Year-by-Year Total Returns on Small-Company Stocks

SOURCE: Morningstar, 2017

FIGURE 12.7

Year-by-Year Total Returns on Bonds and Bills





SOURCE: Morningstar, 2017

axis. The height of the bar tells us the return for the particular year. For example, looking at the long-term government bonds (Figure 12.7), we see that the largest historical return (44.28 percent) occurred in 1982. This was a good year for bonds. In comparing these charts, notice the differences in the vertical axis scales. With these differences in mind, you can see how predictably the Treasury bills (Figure 12.7) behaved compared to the small-company stocks (Figure 12.6).

The returns shown in these bar graphs are sometimes very large. Looking at the graphs, for example, we see that the largest single-year return is a remarkable 142.87 percent for the small-cap stocks in 1933. In the same year, the large-company stocks returned "only" 52.95 percent. In contrast, the largest Treasury bill return was 14.60 percent in 1981. For future reference, the actual year-to-year returns for the large-company stocks, long-term government bonds, Treasury bills, and the CPI are shown in Table 12.1.

IN THEIR OWN WORDS ...

Roger Ibbotson on Capital Market History

The financial markets are the most carefully documented human phenomena in history. Every day, almost 2,000 NYSE stocks are traded, and at least 8,000 more stocks are listed on other U.S. exchanges and trading venues. Bonds, commodities, futures, and options also provide a wealth of data. These data are available across a wide spectrum of electronic media, including newswires, websites, and market data platforms like Bloomberg. A record actually exists of almost every transaction, providing not only a real-time database but also a historical record extending back, in many cases, more than a century.

The global market adds another dimension to this wealth of data. Over 2,500 stocks trade on Japanese stock markets while the London Exchange reports on over 2,000 domestic and foreign issues a day. Altogether, more than 20 billion shares trade globally on a typical day.

The data generated by these transactions are quantifiable, quickly analyzed and disseminated, and are easily accessible. Because of this, finance has increasingly come to resemble one of the exact sciences. The use of financial market data ranges from the simple, such as using the S&P 500 index to compare the performance of a portfolio, to the incredibly complex. For example, only a few decades ago, the bond market was the most staid province on Wall Street. Today, it attracts swarms of traders seeking to exploit arbitrage opportunities—small temporary mispricings—using real-time data and computers to analyze them.

Financial market data are the foundation for the extensive empirical understanding we now have of the financial markets. The following is a list of some of the principal findings of such research:

- Trading is more automated and its cost is lower than ever.
- Risky securities, such as stocks, have higher average returns than riskless securities, such as Treasury bills.
- Stocks of small companies have higher average returns than those of larger companies.
- More liquid stocks have higher valuations, but lower returns than less liquid stocks.
- The cost of capital for a company, project, or division can be estimated using data from the markets.

Because phenomena in the financial markets are so well measured, finance is the most readily quantifiable branch of economics. Researchers are able to do more extensive empirical research than in any other economic field, and the research can be quickly translated into action in the marketplace.

Roger Ibbotson is Professor in the Practice of Management at the Yale School of Management. He is also chairman of Zebra Capital, an equity investment manager. He is the founder of Ibbotson Associates, now part of Morningstar, Inc., a major supplier of financial data and analysis. An outstanding scholar, he is best known for his original estimates of the historical rates of return realized by investors in different markets.

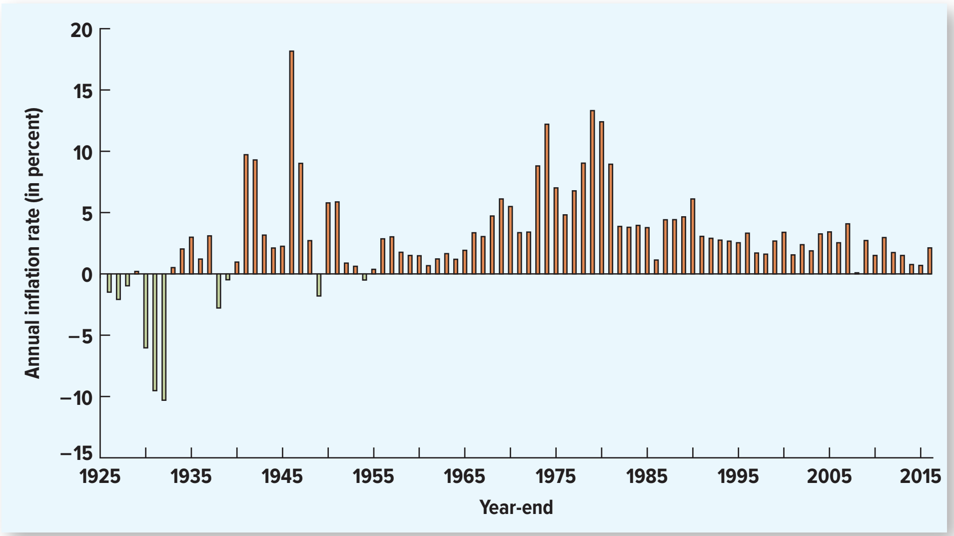


FIGURE 12.8

Year-by-Year Inflation

SOURCE: Morningstar, 2017

TABLE 12.1 Year-to-Year Total Returns: 1926–2016

Year	Large-Company Stocks	Long-Term Government Bonds	U.S. Treasury Bills	Consumer Price Index	Year	Large-Company Stocks	Long-Term Government Bonds	U.S. Treasury Bills	Consumer Price Index
1926	13.75%	5.69%	3.30%	−1.12%	1972	18.99%	2.39%	4.23%	3.41%
1927	35.70	6.58	3.15	−2.26	1973	−14.69	3.30	7.29	8.71
1928	45.08	1.15	4.05	−1.16	1974	−26.47	4.00	7.99	12.34
1929	−8.80	4.39	4.47	.58	1975	37.23	5.52	5.87	6.94
1930	−25.13	4.47	2.27	−6.40	1976	23.93	15.56	5.07	4.86
1931	−43.60	−2.15	1.15	−9.32	1977	−7.16	.38	5.45	6.70
1932	−8.75	8.51	.88	−10.27	1978	6.57	−1.26	7.64	9.02
1933	52.95	1.92	.52	.76	1979	18.61	−2.76	10.56	13.29
1934	−2.31	7.59	.27	1.52	1980	32.50	−2.48	12.10	12.52
1935	46.79	4.20	.17	2.99	1981	−4.92	4.04	14.60	8.92
1936	32.49	5.13	.17	1.45	1982	21.55	44.28	10.94	3.83
1937	−35.45	1.44	.27	2.86	1983	22.56	1.29	8.99	3.79
1938	31.63	4.21	.06	−2.78	1984	6.27	15.29	9.90	3.95
1939	−1.43	3.84	.04	.00	1985	31.73	32.27	7.71	3.80
1940	−10.36	5.70	.04	.71	1986	18.67	22.39	6.09	1.10
1941	−12.02	.47	.14	9.93	1987	5.25	−3.03	5.88	4.43
1942	20.75	1.80	.34	9.03	1988	16.61	6.84	6.94	4.42
1943	25.38	2.01	.38	2.96	1989	31.69	18.54	8.44	4.65
1944	19.49	2.27	.38	2.30	1990	−3.10	7.74	7.69	6.11
1945	36.21	5.29	.38	2.25	1991	30.46	19.36	5.43	3.06
1946	−8.42	.54	.38	18.13	1992	7.62	7.34	3.48	2.90
1947	5.05	−1.02	.62	8.84	1993	10.08	13.06	3.03	2.75
1948	4.99	2.66	1.06	2.99	1994	1.32	−7.32	4.39	2.67
1949	17.81	4.58	1.12	−2.07	1995	37.58	25.94	5.61	2.54
1950	30.05	−.98	1.22	5.93	1996	22.96	.13	5.14	3.32
1951	23.79	−.20	1.56	6.00	1997	33.36	12.02	5.19	1.70
1952	18.39	2.43	1.75	.75	1998	28.58	14.45	4.86	1.61
1953	−1.07	2.28	1.87	.75	1999	21.04	−7.51	4.80	2.68
1954	52.23	3.08	.93	−.74	2000	−9.10	17.22	5.98	3.39
1955	31.62	−.73	1.80	.37	2001	−11.89	5.51	3.33	1.55
1956	6.91	−1.72	2.66	2.99	2002	−22.10	15.15	1.61	2.38
1957	−10.50	6.82	3.28	2.90	2003	28.89	2.01	.94	1.88
1958	43.57	−1.72	1.71	1.76	2004	10.88	8.12	1.14	3.26
1959	12.01	−2.02	3.48	1.73	2005	4.91	6.89	2.79	3.42
1960	.47	11.21	2.81	1.36	2006	15.79	.28	4.97	2.54
1961	26.84	2.20	2.40	.67	2007	5.49	10.85	4.52	4.08
1962	−8.75	5.72	2.82	1.33	2008	−37.00	41.78	1.24	.09
1963	22.70	1.79	3.23	1.64	2009	26.46	−25.61	.15	2.72
1964	16.43	3.71	3.62	.97	2010	15.06	7.73	.14	1.50
1965	12.38	.93	4.06	1.92	2011	2.11	35.75	.06	2.96
1966	−10.06	5.12	4.94	3.46	2012	16.00	1.80	.08	1.74
1967	23.98	−2.86	4.39	3.04	2013	32.39	−14.69	.05	1.50
1968	11.03	2.25	5.49	4.72	2014	13.69	24.74	.03	.75
1969	−8.43	−5.63	6.90	6.20	2015	1.41	−.64	.04	.74
1970	3.94	18.92	6.50	5.57	2016	11.98	1.76	.21	2.11
1971	14.30	11.24	4.36	3.27					

SOURCE: Authors' calculation based on data obtained from *Global Financial Data* and other sources.

Concept Questions

12.2a With 20/20 hindsight, what do you say was the best investment for the period from 1926 through 1935?

12.2b Why doesn't everyone just buy small stocks as investments?

12.2c What was the smallest return observed over the 91 years for each of these investments? Approximately when did it occur?

12.2d About how many times did large-company stocks return more than 30 percent? How many times did they return less than −20 percent?

12.2e What was the longest "winning streak" (years without a negative return) for large-company stocks? For long-term government bonds?

12.2f How often did the T-bill portfolio have a negative return?

Average Returns: The First Lesson

12.3

Excel Master It!

Excel Master coverage online

As you've probably begun to notice, the history of capital market returns is too complicated to be of much use in its undigested form. We need to begin summarizing all these numbers. Accordingly, we discuss how to go about condensing the detailed data. We start out by calculating average returns.

CALCULATING AVERAGE RETURNS

The obvious way to calculate the average returns on the different investments in Table 12.1 is to add up the yearly returns and divide by 91. The result is the historical average of the individual values.

For example, if you add up the returns for the large-company stocks in Figure 12.5 for the 91 years, you will get about 10.88. The average annual return is 10.88/91 = .120, or 12.0%. You interpret this 12.0 percent just like any other average. If you were to pick a year at random from the 91-year history and you had to guess what the return in that year was, the best guess would be 12.0 percent.

AVERAGE RETURNS: THE HISTORICAL RECORD

Table 12.2 shows the average returns for the investments we have discussed. As shown, in a typical year, the small-company stocks increased in value by 16.6 percent. Notice also how much larger the returns are for stocks, compared to the returns on bonds.

These averages are, of course, nominal because we haven't worried about inflation. Notice that the average inflation rate was 3.0 percent per year over this 91-year span. The nominal return on U.S. Treasury bills was 3.4 percent per year. The average real return on

TABLE 12.2

Average Annual Returns: 1926–2016

Investment	Average Return
Large-company stocks	12.0%
Small-company stocks	16.6
Long-term corporate bonds	6.3
Long-term government bonds	6.0
U.S. Treasury bills	3.4
Inflation	3.0

SOURCE: Morningstar, 2017, author calculations.

Treasury bills was approximately .4 percent per year; so the real return on T-bills has been quite low historically.

At the other extreme, small stocks had an average real return of about 16.6% − 3.0 = 13.6%, which is relatively large. If you remember the Rule of 72 (Chapter 5), then you know that a quick back-of-the-envelope calculation tells us that 13.6 percent real growth doubles your buying power about every five years. Notice also that the real value of the large-company stock portfolio increased by about 9 percent in a typical year.

RISK PREMIUMS

Now that we have computed some average returns, it seems logical to see how they compare with each other. One such comparison involves government-issued securities. These are free of much of the variability we see in, for example, the stock market.

The government borrows money by issuing bonds in different forms. The ones we will focus on are the Treasury bills. These have the shortest time to maturity of the different government bonds. Because the government can always raise taxes to pay its bills, the debt represented by T-bills is virtually free of any default risk over its short life. We will call the rate of return on such debt the *risk-free return*, and we will use it as a kind of benchmark.

A particularly interesting comparison involves the virtually risk-free return on T-bills and the very risky return on common stocks. The difference between these two returns can be interpreted as a measure of the *excess return* on the average risky asset (assuming that the stock of a large U.S. corporation has about average risk compared to all risky assets).

We call this the "excess" return because it is the additional return we earn by moving from a relatively risk-free investment to a risky one. Because it can be interpreted as a reward for bearing risk, we will call it a **risk premium**.

risk premium
The excess return required from an investment in a risky asset over that required from a risk-free investment.

Using Table 12.2, we can calculate the risk premiums for the different investments; these are shown in Table 12.3. We report only the nominal risk premiums because there is only a slight difference between the historical nominal and real risk premiums.

The risk premium on T-bills is shown as zero in the table because we have assumed that they are riskless.

THE FIRST LESSON

Looking at Table 12.3, we see that the average risk premium earned by a typical large-company stock is 12.0% − 3.4 = 8.6%. This is a significant reward. The fact that it exists historically is an important observation, and it is the basis for our first lesson: Risky assets, on average, earn a risk premium. Put another way, there is a reward for bearing risk.

Why is this so? Why, for example, is the risk premium for small stocks so much larger than the risk premium for large stocks? More generally, what determines the relative sizes of the risk premiums for the different assets? The answers to these questions are at the heart of modern finance, and the next chapter is devoted to them. For now, we can find part of the answer by looking at the historical variability of the returns on these different investments. So, to get started, we now turn our attention to measuring variability in returns.

TABLE 12.3

Average Annual Returns and Risk Premiums: 1926–2016

Investment	Average Return	Risk Premium
Large-company stocks	12.0%	8.6%
Small-company stocks	16.6	13.2
Long-term corporate bonds	6.3	2.9
Long-term government bonds	6.0	2.6
U.S. Treasury bills	3.4	0.0

SOURCE: Morningstar, 2017, author calculations.

Concept Questions

12.3a What do we mean by *excess return* and *risk premium*?

12.3b What was the real (as opposed to nominal) risk premium on the common stock portfolio?

12.3c What was the nominal risk premium on corporate bonds? The real risk premium?

12.3d What is the first lesson from capital market history?

The Variability of Returns: The Second Lesson 12.4

Excel Master It!
xlsx
Excel Master coverage online

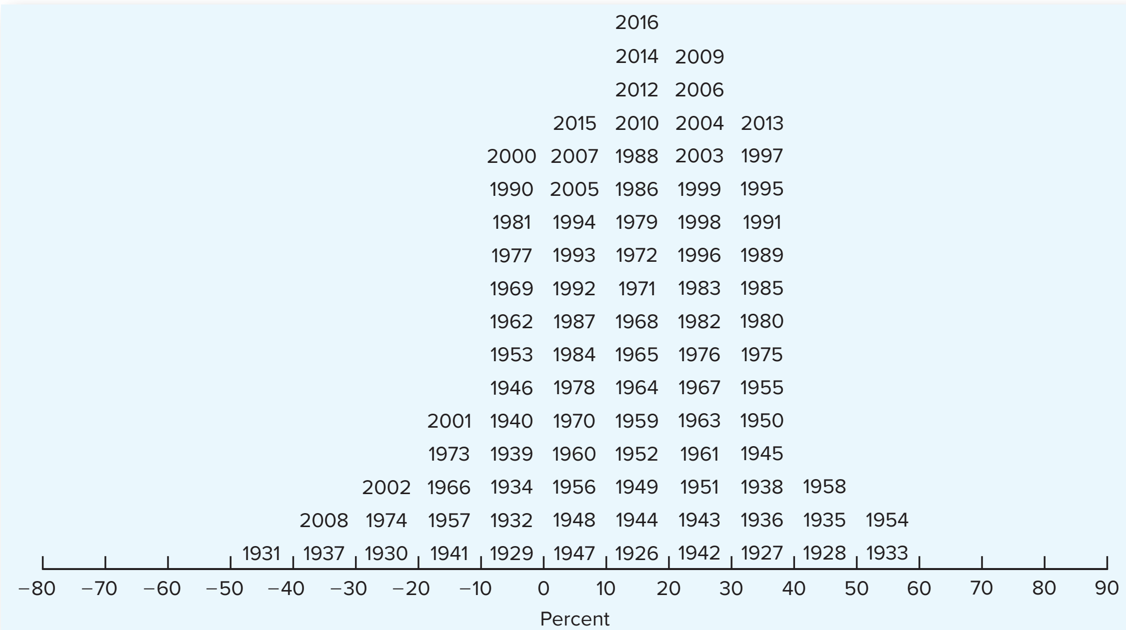
We have already seen that the year-to-year returns on common stocks tend to be more volatile than the returns on, say, long-term government bonds. We now discuss measuring this variability of stock returns so we can begin examining the subject of risk.

FREQUENCY DISTRIBUTIONS AND VARIABILITY

To get started, we can draw a *frequency distribution* for the common stock returns like the one in Figure 12.9. What we have done here is to count the number of times the annual return on the common stock portfolio falls within each 10 percent range. For example, in Figure 12.9, the height of 17 times in the range of 10 to 20 percent means that 17 of the 91 annual returns were in that range.

What we need to do now is to actually measure the spread in returns. We know, for example, that the return on small stocks in a typical year was 16.6 percent. We now want

FIGURE 12.9 Frequency Distribution of Returns on Large-Company Stocks: 1926–2016



SOURCE: Morningstar, 2017, author calculations.

variance
The average squared difference between the actual return and the average return.

standard deviation
The positive square root of the variance.

For an easy-to-read review of basic stats, check out www.robertniles.com/stats/.

to know how much the actual return deviates from this average in a typical year. In other words, we need a measure of the volatility of the return. The **variance** and its square root, the **standard deviation**, are the most commonly used measures of volatility. We describe how to calculate them next.

THE HISTORICAL VARIANCE AND STANDARD DEVIATION

The variance essentially measures the average squared difference between the actual returns and the average return. The bigger this number is, the more the actual returns tend to differ from the average return. Also, the larger the variance or standard deviation is, the more spread out the returns will be.

The way we will calculate the variance and standard deviation will depend on the specific situation. In this chapter, we are looking at historical returns; so the procedure we describe here is the correct one for calculating the *historical* variance and standard deviation. If we were examining projected future returns, then the procedure would be different. We describe this procedure in the next chapter.

To illustrate how we calculate the historical variance, suppose a particular investment had returns of 10 percent, 12 percent, 3 percent, and −9 percent over the last four years. The average return is (.10 + .12 + .03 − .09)/4 = .04, or 4%. Notice that the return is never actually equal to 4 percent. Instead, the first return deviates from the average by .10 − .04 = .06, the second return deviates from the average by .12 − .04 = .08, and so on. To compute the variance, we square each of these deviations, add them, and divide the result by the number of returns less 1, or 3 in this case. Most of this information is summarized in the following table:

	(1) Actual Return	(2) Average Return	(3) Deviation (1) − (2)	(4) Squared Deviation
	.10	.04	.06	.0036
	.12	.04	.08	.0064
	.03	.04	−.01	.0001
	−.09	.04	−.13	.0169
Totals	.16		.00	.0270

In the first column, we write the four actual returns. In the third column, we calculate the difference between the actual returns and the average by subtracting 4 percent. Finally, in the fourth column, we square the numbers in the third column to get the squared deviations from the average.

The variance can now be calculated by dividing .0270, the sum of the squared deviations, by the number of returns less 1. Let Var(R), or σ^2 (read this as "sigma squared"), stand for the variance of the return:

$$\text{Var}(R) = \sigma^2 = .027/(4 - 1) = .009$$

The standard deviation is the square root of the variance. So, if SD(R), or σ, stands for the standard deviation of return:

$$\text{SD}(R) = \sigma = \sqrt{.009} = .09487$$

The square root of the variance is used because the variance is measured in "squared" percentages and is hard to interpret. The standard deviation is an ordinary percentage, so the answer could be written as 9.487 percent.

In the preceding table, notice that the sum of the deviations is equal to zero. This will always be the case, and it provides a good way to check your work. In general, if we have T historical returns, where T is some number, we can write the historical variance as:

$$\text{Var}(R) = \frac{1}{T-1}[(R_1 - \overline{R})^2 + \cdots + (R_T - \overline{R})^2]$$ 12.3

This formula tells us to do what we just did: Take each of the T individual returns ($R_1, R_2, \ldots$) and subtract the average return, $\overline{R}$; square the results, and add them; and finally, divide this total by the number of returns less 1, ($T - 1$). The standard deviation is always the square root of Var(R). Standard deviations are a widely used measure of volatility. Our nearby *Work the Web* box gives a real-world example.

Calculating the Variance and Standard Deviation — EXAMPLE 12.2

Suppose the Supertech Company and the Hyperdrive Company have experienced the following returns in the last four years:

Year	Supertech Return	Hyperdrive Return
2014	−.20	.05
2015	.50	.09
2016	.30	−.12
2017	.10	.20

What are the average returns? The variances? The standard deviations? Which investment was more volatile?

To calculate the average returns, we add the returns and divide by 4. The results are:

Supertech average return $= \overline{R} = .70/4 = .175$
Hyperdrive average return $= \overline{R} = .22/4 = .055$

To calculate the variance for Supertech, we can summarize the relevant calculations as follows:

Year	(1) Actual Return	(2) Average Return	(3) Deviation (1) − (2)	(4) Squared Deviation
2014	−.20	.175	−.375	.140625
2015	.50	.175	.325	.105625
2016	.30	.175	.125	.015625
2017	.10	.175	−.075	.005625
Totals	.70		.000	.267500

Because there are four years of returns, we calculate the variance by dividing .2675 by (4 − 1) = 3:

	Supertech	Hyperdrive
Variance (σ^2)	.2675/3 = .0892	.0529/3 = .0176
Standard deviation (σ)	$\sqrt{.0892} = .2986$	$\sqrt{.0176} = .1328$

For practice, verify that you get the same answer as we do for Hyperdrive. Notice that the standard deviation for Supertech, 29.86 percent, is a little more than twice Hyperdrive's 13.28 percent; Supertech is the more volatile investment.

THE HISTORICAL RECORD

Figure 12.10 summarizes much of our discussion of capital market history so far. It displays average returns, standard deviations, and frequency distributions of annual returns on a common scale. In Figure 12.10, for example, notice that the standard deviation for the small-stock portfolio (31.9 percent per year) is more than 10 times larger than the T-bill portfolio's standard deviation (3.1 percent per year). We will return to these figures momentarily.

WORK THE WEB

Standard deviations are widely reported for mutual funds. For example, the Fidelity Magellan Fund was one of the better-known mutual funds in the United States at the time this was written. How volatile is it? To find out, we went to www.morningstar.com, entered the ticker symbol FMAGX, and clicked the "Ratings & Risk" link. Here is what we found:

MPT Statistics FMAGX

3-Year | 5-Year | 10-Year | 15-Year

3-Year Trailing	Index	R-Squared	Beta	Alpha	Treynor Ratio	Currency
vs. Best-Fit Index						
FMAGX	Russell 3000 Growth TR USD	95.66	0.99	-0.42	—	USD
vs. Standard Index						
FMAGX	S&P 500 TR USD	92.53	1.04	-1.36	7.26	USD
Category: LG	S&P 500 TR USD	83.21	1.02	-3.04	5.47	USD

12/31/2016

Volatility Measures FMAGX

3-Year | 5-Year | 10-Year | 15-Year

3-Year Trailing	Standard Deviation	Return	Sharpe Ratio	Sortino Ratio	Bear Market Percentile Rank
FMAGX	11.63	7.70	0.68	1.21	—
S&P 500 TR USD	10.74	8.87	0.83	1.51	—
Category: LG	12.12	5.70	0.51	0.89	—

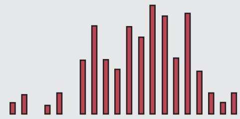
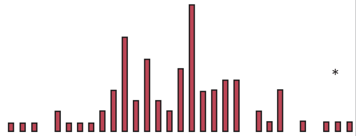
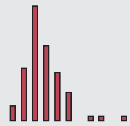
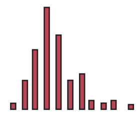
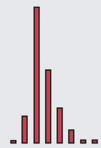
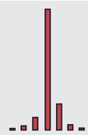
12/31/2016

The standard deviation for the Fidelity Magellan Fund is 11.63 percent. When you consider that the average stock has a standard deviation of about 50 percent, this seems like a low number. The reason for the low standard deviation has to do with the power of diversification, a topic we discuss in the next chapter. The return column is the average return, so over the last three years, investors in the Magellan Fund gained 7.70 percent per year. Also, under the Volatility Measures section, you will see the Sharpe ratio. The Sharpe ratio is calculated as the risk premium of the asset divided by the standard deviation. As such, it is a measure of return relative to the level of risk taken (as measured by standard deviation). The "beta" for the Fidelity Magellan Fund is .99. We will have more to say about this number—lots more—in the next chapter.

Questions

1. *Go to the Morningstar website at www.morningstar.com. What does the Sortino ratio measure? What does the Bear Market Percentile Rank measure?*
2. *Get a quote for the Fidelity Magellan Fund at Morningstar. What are the five sectors that have the highest percentage investment for this fund? What are the five stocks with the highest percentage investment?*

FIGURE 12.10 **Historical Returns, Standard Deviations, and Frequency Distributions: 1926–2016**

Series	Average Return	Standard Deviation	Frequency Distribution
Large-company stocks	12.0%	19.9%	
Small-company stocks	16.6	31.9	
Long-term corporate bonds	6.3	8.4	
Long-term government bonds	6.0	9.9	
Intermediate-term government bonds	5.3	5.6	
U.S. Treasury bills	3.4	3.1	
Inflation	3.0	4.1	

*The 1933 small-company stocks total return was 142.9 percent.

SOURCE: Morningstar, 2017, author calculations.

NORMAL DISTRIBUTION

For many different random events in nature, a particular frequency distribution, the **normal distribution** (or *bell curve*), is useful for describing the probability of ending up in a given range. For example, the idea behind "grading on a curve" comes from the fact that exam score distributions often resemble a bell curve.

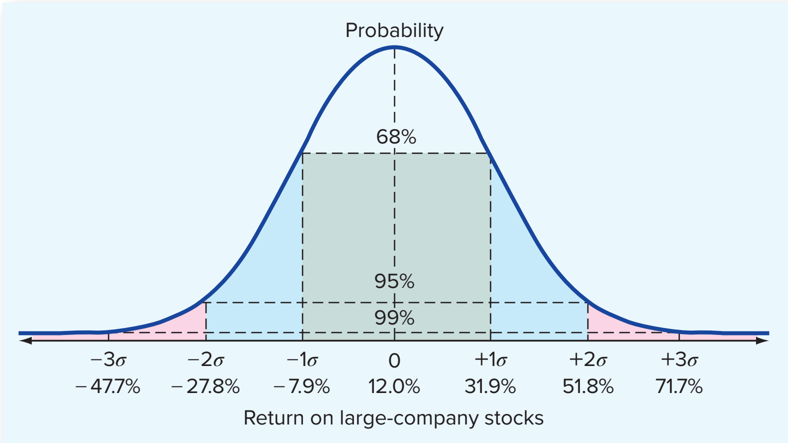
normal distribution
A symmetric, bell-shaped frequency distribution that is completely defined by its mean and standard deviation.

Figure 12.11 illustrates a normal distribution and its distinctive bell shape. As you can see, this distribution has a much cleaner appearance than the actual return distributions illustrated in Figure 12.10. Even so, like the normal distribution, the actual distributions do appear to be at least roughly mound-shaped and symmetric. When this is true, the normal distribution is often a very good approximation.

Also, keep in mind that the distributions in Figure 12.10 are based on only 91 yearly observations, whereas Figure 12.11 is, in principle, based on an infinite number. So,

FIGURE 12.11

The Normal Distribution



NOTE: Illustrated returns are based on the historical return and standard deviation for a portfolio of large-company common stocks.

if we had been able to observe returns for, say, 1,000 years, we might have filled in a lot of the irregularities and ended up with a much smoother picture in Figure 12.10. For our purposes, it is enough to observe that the returns are at least roughly normally distributed.

The usefulness of the normal distribution stems from the fact that it is completely described by the average and the standard deviation. If you have these two numbers, then there is nothing else to know. For example, with a normal distribution, the probability that we will end up within one standard deviation of the average is about 2/3. The probability that we will end up within two standard deviations is about 95 percent. Finally, the probability of being more than three standard deviations away from the average is less than 1 percent. These ranges and the probabilities are illustrated in Figure 12.11.

To see why this is useful, recall from Figure 12.10 that the standard deviation of returns on the large-company stocks is 19.9 percent. The average return is 12.0 percent. So, assuming that the frequency distribution is at least approximately normal, the probability that the return in a given year is in the range of −7.9 to 31.9 percent (12.0 percent plus or minus one standard deviation, 19.9 percent) is about 2/3. This range is illustrated in Figure 12.11. In other words, there is about one chance in three that the return will be *outside* this range. This literally tells you that, if you buy stocks in large companies, you should expect to be outside this range in one year out of every three. This reinforces our earlier observations about stock market volatility. However, there is only a 5 percent chance (approximately) that we would end up outside the range of −27.8 to 51.8 percent (12.0% plus or minus 2 × 19.9%). These points are also illustrated in Figure 12.11.

THE SECOND LESSON

Our observations concerning the year-to-year variability in returns are the basis for our second lesson from capital market history. On average, bearing risk is handsomely rewarded; but in a given year, there is a significant chance of a dramatic change in value. Our second lesson is this: The greater the potential reward, the greater is the risk.

2008: A YEAR TO REMEMBER

To reinforce our point concerning stock market volatility, consider that just a few short years ago, 2008 entered the record books as one of the worst years for stock market investors in

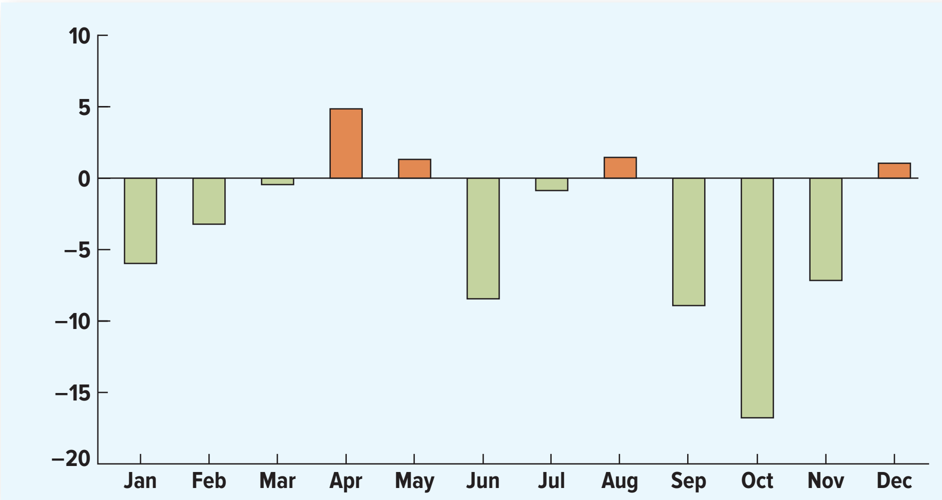


FIGURE 12.12

S&P 500 Monthly Returns: 2008

U.S. history. How bad was it? As shown in several exhibits in the chapter (e.g., Table 12.1), the widely followed S&P 500 index plunged 37 percent. Of the 500 stocks in the index, 485 were down for the year.

Over the period 1926–2016, only the year 1931 had a lower return than 2008 (−44 percent versus −37 percent). Making matters worse, the downdraft continued with a further decline of 8.43 percent in January 2009. In all, from November 2007 (when the decline began) through March 2009 (when it ended), the S&P 500 lost 50 percent of its value.

Figure 12.12 shows the month-by-month performance of the S&P 500 during 2008. As indicated, returns were negative in 8 of the 12 months. Most of the damage occurred in the fall, with investors losing almost 17 percent in October alone. Small stocks fared no better. They also fell 37 percent for the year (with a 21 percent drop in October), their worst performance since losing 58 percent in 1937.

As Figure 12.12 suggests, stock prices were highly volatile during the year. Oddly, the S&P had 126 up days and 126 down days (remember the markets are closed weekends and holidays). Of course, the down days were much worse on average. To see how extraordinary volatility was in 2008, consider that there were 18 days during which the value of the S&P changed by more than 5 percent. There were only 17 such moves between 1956 and 2007!

The drop in stock prices was a global phenomenon, and many of the world's major markets were off by much more than the S&P. China, India, and Russia, for example, all experienced declines of more than 50 percent. Tiny Iceland saw share prices drop by more than 90 percent for the year. Trading on the Icelandic exchange was temporarily suspended on October 9. In what has to be a modern record for a single day, stocks fell by 76 percent when trading resumed on October 14.

Were there any bright spots in 2008 for U.S. investors? The answer is yes because, as stocks tanked, bonds soared, particularly U.S. Treasury bonds. In fact, long-term Treasuries gained 40 percent, while shorter-term Treasury bonds were up 13 percent. Long-term corporate bonds did less well, but still managed to finish in positive territory, up 9 percent. These returns were especially impressive considering that the rate of inflation, as measured by the CPI, was essentially zero.

Of course, stock prices can be volatile in both directions. From March 2009 through February 2011, a period of about 700 days, the S&P 500 doubled in value. This climb was the fastest doubling since 1936 when the S&P did it in just 500 days. So, what lessons should investors take away from this very recent, and very turbulent, bit of capital market history? First, and most obviously, stocks have significant risk! But there is a second, equally important lesson. Depending on the mix, a diversified portfolio of stocks and bonds might have suffered in 2008, but the losses would have been much smaller than those experienced by an all-stock portfolio. In other words, diversification matters, a point we will examine in detail in our next chapter.

USING CAPITAL MARKET HISTORY

Based on the discussion in this section, you should begin to have an idea of the risks and rewards from investing. For example, in early 2017, Treasury bills were paying about .4 percent. Suppose we had an investment that we thought had about the same risk as a portfolio of large-firm common stocks. At a minimum, what return would this investment have to offer for us to be interested?

From Table 12.3, we see that the risk premium on large-company stocks has been 8.6 percent historically, so a reasonable estimate of our required return would be this premium plus the T-bill rate, $.4\% + 8.6 = 9\%$. This may strike you as being high; but if we were thinking of starting a new business, then the risks of doing so might resemble those of investing in small-company stocks. In this case, the historical risk premium is 13.2 percent, so, at a minimum, we might require as much as 13.6 percent from such an investment.

We will discuss the relationship between risk and required return in more detail in the next chapter. For now, you should notice that a projected internal rate of return, or IRR, on a risky investment in the 10 to 20 percent range isn't particularly outstanding. It depends on the level of risk. This, too, is an important lesson from capital market history.

EXAMPLE 12.3 Investing in Growth Stocks

The term *growth stock* is frequently used as a euphemism for small-company stock. Are such investments suitable for "widows and orphans"? Before answering, you should consider the historical volatility. For example, from the historical record, what is the approximate probability that you will actually lose more than 15 percent of your money in a single year if you buy a portfolio of stocks of such companies?

Looking back at Figure 12.10, we see that the average return on small-company stocks is 16.6 percent and the standard deviation is 31.9 percent. Assuming the returns are approximately normal, there is about a 1/3 probability that you will experience a return outside the range of −15.3 to 48.5 percent ($16.6\% \pm 31.9\%$).

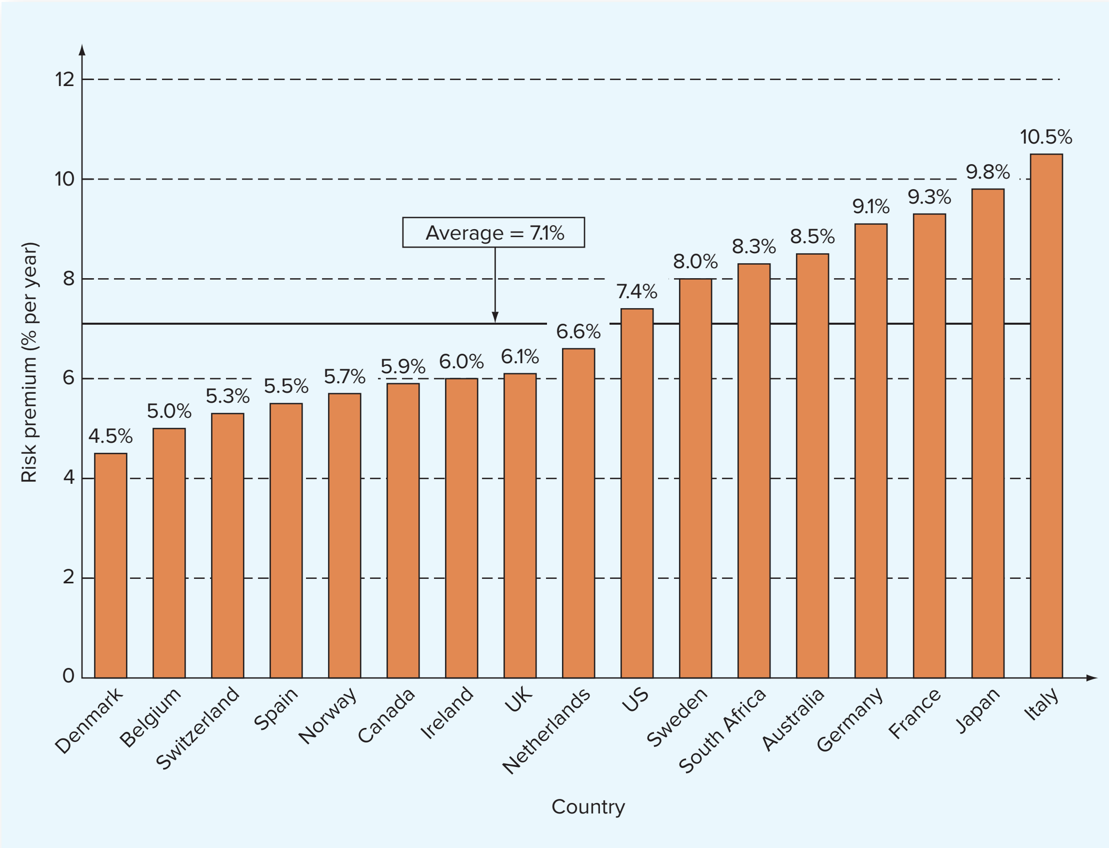
Because the normal distribution is symmetric, the odds of being above or below this range are equal. There is a 1/6 chance (half of 1/3) that you will lose more than −15.3 percent. You should expect this to happen once in every six years, on average. Such investments can be *very* volatile, and they are not well suited for those who cannot afford the risk.

MORE ON THE STOCK MARKET RISK PREMIUM

As we have discussed, the historical stock market risk premium has been substantial. In fact, based on standard economic models, it has been argued that the historical risk premium is *too* big and is an overestimate of what is likely to happen in the future.

Of course, any time we use the past to predict the future, there is the danger that the past period we observe isn't representative of what the future will hold. For example, in

FIGURE 12.13 **Stock Market Risk Premiums for 17 Countries: 1900–2005**



SOURCE: Based on Dimson, Elroy et al., "The Worldwide Equity Premium: A Smaller Puzzle," in *Handbook of the Equity Risk Premium*, Rajnish Mehra, ed., Amsterdam: Elsevier, 2007.

this chapter, we studied the period 1926–2016. Perhaps investors got lucky over this period and earned particularly high returns. Data from earlier years is available, though it is not of the same quality. With that caveat in mind, researchers have traced returns back to 1802, and the risk premiums seen in the pre-1926 era are perhaps a little smaller, but not dramatically so.

Another possibility is that the U.S. stock market experience was unusually good. Investors in at least some other major countries did not do as well because their financial markets were nearly or completely wiped out because of revolution, war, and/or hyperinflation. A recent study addresses this issue by examining data from 1900–2005 for 17 countries.

Figure 12.13 shows the historical average stock market risk premium for all 17 countries over the 106-year period. Looking at the numbers, the U.S. risk premium is the 8th highest at 7.4 percent (which differs from our earlier estimate because of the differing time periods examined). The overall average risk premium is 7.1 percent. These numbers make it clear that U.S. investors did well, but not exceptionally so relative to investors in many other countries.

So, is the U.S. stock market risk premium estimated from 1926–2016 too high? The evidence seems to suggest that the answer is "maybe a little." One thing we haven't stressed so far is that even with 106 years of data, the average risk premium is still not measured with great precision. From a statistical standpoint, the standard error associated with the U.S.

estimated risk premium of 7.4 percent is about 2 percent.[4] Even a one standard error range covers 5.4 to 9.4 percent.

Concept Questions

12.4a In words, how do we calculate a variance? A standard deviation?

12.4b With a normal distribution, what is the probability of ending up more than one standard deviation below the average?

12.4c Assuming that long-term corporate bonds have an approximately normal distribution, what is the approximate probability of earning 14.7 percent or more in a given year? With T-bills, roughly what is this probability?

12.4d What is the second lesson from capital market history?

12.5 More about Average Returns

Excel Master It!
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Thus far in this chapter, we have looked closely at simple average returns. But there is another way of computing an average return. The fact that average returns are calculated two different ways leads to some confusion, so our goal in this section is to explain the two approaches and also the circumstances under which each is appropriate.

ARITHMETIC VERSUS GEOMETRIC AVERAGES

Let's start with a simple example. Suppose you buy a particular stock for $100. Unfortunately, the first year you own it, it falls to $50. The second year you own it, it rises back to $100, leaving you where you started (no dividends were paid).

What was your average return on this investment? Common sense seems to say that your average return must be exactly zero because you started with $100 and ended with $100. But if we calculate the returns year-by-year, we see that you lost 50 percent the first year (you lost half of your money). The second year, you made 100 percent (you doubled your money). Your average return over the two years was (−50% + 100)/2 = 25%!

Which is correct, 0 percent or 25 percent? Both are correct: They just answer different questions. The 0 percent is called the **geometric average return**. The 25 percent is called the **arithmetic average return**. The geometric average return answers the question, "What was your average compound return per year over a particular period?" The arithmetic average return answers the question, "What was your return in an average year over a particular period?"

geometric average return
The average compound return earned per year over a multiyear period.

arithmetic average return
The return earned in an average year over a multiyear period.

Notice that, in previous sections, the average returns we calculated were all arithmetic averages and we already know how to calculate them. What we need to do now is (1) learn how to calculate geometric averages and (2) learn the circumstances under which one average is more meaningful than the other.

CALCULATING GEOMETRIC AVERAGE RETURNS

First, to illustrate how we calculate a geometric average return, suppose a particular investment had annual returns of 10 percent, 12 percent, 3 percent, and −9 percent over the last four years. The geometric average return over this four-year period is calculated as $(1.10 \times 1.12 \times 1.03 \times .91)^{1/4} - 1 = .0366$, or 3.66%. In contrast, the average arithmetic return we have been calculating is $(.10 + .12 + .03 - .09)/4 = .04$, or 4.0%.

[4]Recall from basic "sadistics" that the standard error of a sample mean is the sample standard deviation divided by the square root of the sample size. In our case, the standard deviation over the 1900–2005 period was 19.6 percent, so the standard error is $.196/\sqrt{106} = .019$.

IN THEIR OWN WORDS ...

Jeremy J. Siegel on Stocks for the Long Run

The most fascinating characteristic about the data on real financial market returns that I collected is the stability of the long-run real equity returns. The compound annual (geometric) real return on U.S. stocks averaged 6.7% per year from 1802 through 2013, and this return had remained remarkably stable over long-term periods. From 1802 through 1871, the real return averaged 6.7%; from 1871, when the Cowles Foundation data became available, through 1925, the real return on stocks averaged 6.6% per year; and since 1925, which the well-known Ibbotson data cover, the real return has averaged 6.7%. Despite the fact that the price level has increased over ten times since the end of the Second World War, real stock returns have still averaged 6.8%.

The long-run stability of real returns on stocks is strongly indicative of *mean reversion of equity return*. Mean reversion means that stock returns can be very volatile in the short run, but show a remarkable stability in the long run. When my research was first published, there was much skepticism of the mean reversion properties of equity market returns, but now this concept is widely accepted for stocks. If mean reversion prevails, portfolios geared for the long term should have a greater share of equities than short-term portfolios. This conclusion has long been the "conventional" wisdom on investing, but it does not follow if stock returns follow a random walk, a concept widely accepted by academics in the 1970s and 1980s.

When my data first appeared, there was also much discussion of "survivorship bias," the fact that the U.S. stock returns are unusually good because the U.S. was the most successful capitalist country. But three British researchers, Elroy Dimson, Paul Marsh, and Michael Staunton, surveyed stock returns in 16 countries since the beginning of the 20th century and wrote up their results in a book entitled *Triumph of the Optimists.* The authors concluded that U.S. stock returns do not give a distorted picture of the superiority of stocks over bonds worldwide.

Jeremy J. Siegel is the Russell E. Palmer Professor of Finance at The Wharton School of the University of Pennsylvania and author of Stocks for the Long Run *and* The Future for Investors. *His research covers macroeconomics and monetary policy, financial market returns, and long-term economic trends.*

In general, if we have T years of returns, the geometric average return over these T years is calculated using this formula:

$$\text{Geometric average return} = [(1 + R_1) \times (1 + R_2) \times \ldots \times (1 + R_T)]^{1/T} - 1 \qquad (12.4)$$

This formula tells us that four steps are required:

1. Take each of the T annual returns $R_1, R_2, \ldots, R_T$ and add 1 to each (after converting them to decimals!).
2. Multiply the numbers from Step 1 together.
3. Take the result from Step 2 and raise it to the power of $1/T$.
4. Finally, subtract 1 from the result of Step 3. The result is the geometric average return.

Calculating the Geometric Average Return — EXAMPLE 12.4

Calculate the geometric average return for S&P 500 large-cap stocks for the first five years in Table 12.1, 1926–1930.

First, convert percentages to decimal returns, add 1, and then calculate their product:

S&P 500 Returns	Product
13.75	1.1375
35.70	×1.3570
45.08	×1.4508
−8.80	× .9120
−25.13	× .7487
	1.5291

Notice that the number 1.5291 is what our investment is worth after five years if we started with a $1 investment. The geometric average return is then calculated as follows:

Geometric average return = $1.5291^{1/5} - 1 = .0887$, or 8.87%

The geometric average return is about 8.87 percent in this example. Here is a tip: If you are using a financial calculator, you can enter $1 as the present value, $1.5291 as the future value, and 5 as the number of periods. Then, solve for the unknown rate. You should get the same answer we did.

One thing you may have noticed in our examples thus far is that the geometric average returns seem to be smaller. This will always be true (as long as the returns are not all identical, in which case the two "averages" would be the same). To illustrate, Table 12.4 shows the arithmetic averages and standard deviations from Figure 12.10, along with the geometric average returns.

As shown in Table 12.4, the geometric averages are all smaller (before rounding), but the magnitude of the difference varies quite a bit. The reason is that the difference is greater for more volatile investments. In fact, there is a useful approximation. Assuming all the numbers are expressed in decimals (as opposed to percentages), the geometric average return is approximately equal to the arithmetic average return minus half the variance. For example, looking at the large-company stocks, the arithmetic average is .120 and the standard deviation is .199, implying that the variance is .040. The approximate geometric average is thus $.120 - .040/2 = .100$, which is the same as the actual value in this case.

EXAMPLE 12.5 More Geometric Averages

Take a look back at Figure 12.4. There, we showed the value of a $1 investment after 91 years. Use the value for the large-company stock investment to check the geometric average in Table 12.4.

In Figure 12.4, the large-company investment grew to $6,029.16 over 91 years. The geometric average return is thus

Geometric average return = $6{,}029.16^{1/91} - 1 = .1000$, or 10.0%

This 10.0% is the value shown in Table 12.4. For practice, check some of the other numbers in Table 12.4 the same way.

TABLE 12.4
Geometric versus Arithmetic Average Returns: 1926–2016

Series	Average Return: Geometric	Average Return: Arithmetic	Standard Deviation
Large-company stocks	10.0%	12.0%	19.9%
Small-company stocks	12.0	16.6	31.9
Long-term corporate bonds	6.0	6.3	8.4
Long-term government bonds	5.5	6.0	9.9
Intermediate-term government bonds	5.3	5.3	5.6
U.S. Treasury bills	3.4	3.4	3.1
Inflation	2.9	3.0	4.1

SOURCE: Morningstar, 2017, author calculations.

ARITHMETIC AVERAGE RETURN OR GEOMETRIC AVERAGE RETURN?

When we look at historical returns, the difference between the geometric and arithmetic average returns isn't too hard to understand. To put it slightly differently, the geometric average tells you what you actually earned per year on average, compounded annually. The arithmetic average tells you what you earned in a typical year. You should use whichever one answers the question you want answered.

A somewhat trickier question concerns which average return to use when forecasting future wealth levels, and there's a lot of confusion on this point among analysts and financial planners. First, let's get one thing straight: If you *know* the true arithmetic average return, then this is what you should use in your forecast. For example, if you know the arithmetic return is 10 percent, then your best guess of the value of a $1,000 investment in 10 years is the future value of $1,000 at 10 percent for 10 years, or $2,593.74.

The problem we face is that we usually have only *estimates* of the arithmetic and geometric returns, and estimates have errors. In this case, the arithmetic average return is probably too high for longer periods and the geometric average is probably too low for shorter periods. You should regard long-run projected wealth levels calculated using arithmetic averages as optimistic. Short-run projected wealth levels calculated using geometric averages are probably pessimistic.

The good news is that there is a simple way of combining the two averages, which we will call *Blume's formula*.[5] Suppose we have calculated geometric and arithmetic return averages from N years of data, and we wish to use these averages to form a T-year average return forecast, $R(T)$, where T is less than N. Here's how we do it:

$$R(T) = \frac{T-1}{N-1} \times \text{Geometric average} + \frac{N-T}{N-1} \times \text{Arithmetic average} \quad \textbf{12.5}$$

For example, suppose that, from 25 years of annual returns data, we calculate an arithmetic average return of 12 percent and a geometric average return of 9 percent. From these averages, we wish to make 1-year, 5-year, and 10-year average return forecasts. These three average return forecasts are calculated as follows:

$$R(1) = \frac{1-1}{24} \times 9\% + \frac{25-1}{24} \times 12\% = 12\%$$

$$R(5) = \frac{5-1}{24} \times 9\% + \frac{25-5}{24} \times 12\% = 11.5\%$$

$$R(10) = \frac{10-1}{24} \times 9\% + \frac{25-10}{24} \times 12\% = 10.875\%$$

We see that 1-year, 5-year, and 10-year forecasts are 12 percent, 11.5 percent, and 10.875 percent, respectively.

As a practical matter, Blume's formula says that if you are using averages calculated over a long period (such as the 91 years we use) to forecast up to a decade or so into the future, then you should use the arithmetic average. If you are forecasting a few decades into the future (as you might do for retirement planning), then you should split the difference between the arithmetic and geometric average returns. Finally, if for some reason you are doing very long forecasts covering many decades, use the geometric average.

This concludes our discussion of geometric versus arithmetic averages. One last note: In the future, when we say "average return," we mean arithmetic unless we explicitly say otherwise.

[5]This elegant result is due to Marshall Blume ("Unbiased Estimates of Long-Run Expected Rates of Return," *Journal of the American Statistical Association,* September 1974, pp. 634–38).

Concept Questions

12.5a If you want to forecast what the stock market is going to do over the next year, should you use an arithmetic or geometric average?

12.5b If you want to forecast what the stock market is going to do over the next century, should you use an arithmetic or geometric average?

12.6 Capital Market Efficiency

Capital market history suggests that the market values of stocks and bonds can fluctuate widely from year to year. Why does this occur? At least part of the answer is that prices change because new information arrives, and investors reassess asset values based on that information.

The behavior of market prices has been extensively studied. A question that has received particular attention is whether prices adjust quickly and correctly when new information arrives. A market is said to be "efficient" if this is the case. To be more precise, in an **efficient capital market**, current market prices fully reflect available information. By this we mean that, based on available information, there is no reason to believe that the current price is too low or too high.

efficient capital market
A market in which security prices reflect available information.

The concept of market efficiency is a rich one, and much has been written about it. A full discussion of the subject goes beyond the scope of our study of corporate finance. Because the concept figures so prominently in studies of market history, we briefly describe the key points here.

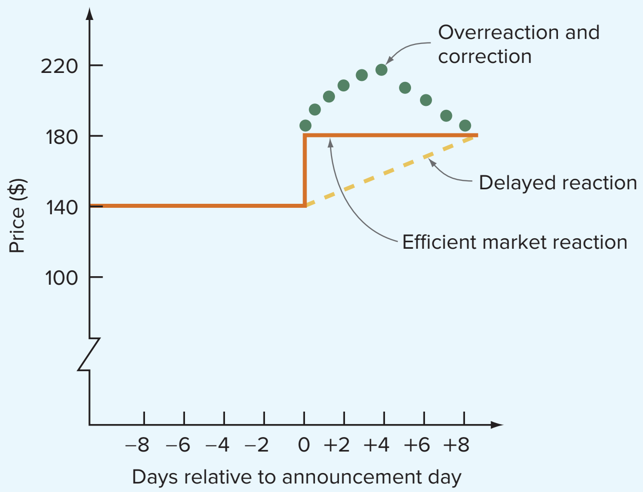
PRICE BEHAVIOR IN AN EFFICIENT MARKET

To illustrate how prices behave in an efficient market, suppose the F-Stop Camera Corporation (FCC) has, through years of secret research and development, developed a camera with an autofocusing system whose speed will double that of the autofocusing systems now available. FCC's capital budgeting analysis suggests that launching the new camera will be a highly profitable move; in other words, the NPV appears to be positive and substantial. The key assumption thus far is that FCC has not released any information about the new system; the fact of its existence is "inside" information only.

Now consider a share of stock in FCC. In an efficient market, its price reflects what is known about FCC's current operations and profitability, and it reflects the market opinion about FCC's potential for future growth and profits. The value of the new autofocusing system is not reflected because the market is unaware of the system's existence.

If the market agrees with FCC's assessment of the value of the new project, FCC's stock price will rise when the decision to launch is made public. For example, assume the announcement is made in a press release on Wednesday morning. In an efficient market, the price of shares in FCC will adjust quickly to this new information. Investors should not be able to buy the stock on Wednesday afternoon and make a profit on Thursday. This would imply that it took the stock market a full day to realize the implication of the FCC press release. If the market is efficient, the price of shares of FCC stock on Wednesday afternoon will already reflect the information contained in the Wednesday morning press release.

Figure 12.14 presents three possible stock price adjustments for FCC. In Figure 12.14, Day 0 represents the announcement day. As illustrated, before the announcement, FCC's stock sells for \$140 per share. The NPV per share of the new system is, say, \$40, so the new price will be \$180 once the value of the new project is fully reflected.



Efficient market reaction: The price instantaneously adjusts to and fully reflects new information; there is no tendency for subsequent increases and decreases to occur.
Delayed reaction: The price partially adjusts to the new information; eight days elapse before the price completely reflects the new information.
Overreaction: The price overadjusts to the new information; it overshoots the new price and subsequently corrects.

FIGURE 12.14

Reaction of Stock Price to New Information in Efficient and Inefficient Markets

The solid line in Figure 12.14 represents the path taken by the stock price in an efficient market. In this case, the price adjusts immediately to the new information and no further changes in the price of the stock take place. The broken line in Figure 12.14 depicts a delayed reaction. Here it takes the market eight days or so to fully absorb the information. Finally, the dotted line illustrates an overreaction and subsequent adjustment to the correct price.

The broken line and the dotted line in Figure 12.14 illustrate paths that the stock price might take in an inefficient market. If, for example, stock prices don't adjust immediately to new information (the broken line), then buying stock immediately following the release of new information and then selling it several days later would be a positive NPV activity because the price is too low for several days after the announcement.

THE EFFICIENT MARKETS HYPOTHESIS

The **efficient markets hypothesis (EMH)** asserts that well-organized capital markets, such as the NYSE, are efficient markets, at least as a practical matter. In other words, an advocate of the EMH might argue that although inefficiencies may exist, they are relatively small and uncommon.

efficient markets hypothesis (EMH)
The hypothesis that actual capital markets, such as the NYSE, are efficient.

If a market is efficient, then there is a very important implication for market participants: All investments in that market are zero NPV investments. The reason is not complicated. If prices are neither too low nor too high, then the difference between the market value of an investment and its cost is zero; hence, the NPV is zero. As a result, in an efficient market, investors get exactly what they pay for when they buy securities, and firms receive exactly what their stocks and bonds are worth when they sell them.

What makes a market efficient is competition among investors. Many individuals spend their entire lives trying to find mispriced stocks. For any given stock, they study what has

Look under the "Contents" link at www.investorhome.com for more info on the EMH.

happened in the past to the stock price and the stock's dividends. They learn, to the extent possible, what a company's earnings have been, how much the company owes to creditors, what taxes it pays, what businesses it is in, what new investments are planned, how sensitive it is to changes in the economy, and so on.

Not only is there a great deal to know about any particular company, but there is also a powerful incentive for knowing it—namely, the profit motive. If you know more about some company than other investors in the marketplace, you can profit from that knowledge by investing in the company's stock if you have good news and by selling it if you have bad news.

The logical consequence of all this information gathering and analysis is that mispriced stocks will become fewer and fewer. In other words, because of competition among investors, the market will become increasingly efficient. A kind of equilibrium comes into being with which there is just enough mispricing around for those who are best at identifying it to make a living at it. For most other investors, the activity of information gathering and analysis will not pay.[6]

SOME COMMON MISCONCEPTIONS ABOUT THE EMH

No other idea in finance has attracted as much attention as that of efficient markets, and not all of the attention has been flattering. Rather than rehash the arguments here, we will be content to observe that some markets are more efficient than others. For example, financial markets on the whole are probably much more efficient than real asset markets.

Having said this, we can also say that much of the criticism of the EMH is misguided because it is based on a misunderstanding of what the hypothesis says and what it doesn't say. For example, when the notion of market efficiency was first publicized and debated in the popular financial press, it was often characterized by words to the effect that "throwing darts at the financial page will produce a portfolio that can be expected to do as well as any managed by professional security analysts."[7]

Confusion over statements of this sort has often led to a failure to understand the implications of market efficiency. For example, sometimes it is wrongly argued that market efficiency means that it doesn't matter how you invest your money because the efficiency of the market will protect you from making a mistake. However, a random dart thrower might wind up with all of the darts sticking into one or two high-risk stocks that deal in genetic engineering. Would you really want all of your money in two such stocks?

A contest run by *The Wall Street Journal* provides a good example of the controversy surrounding market efficiency. Each month, the *Journal* asked four professional money managers to pick one stock each. At the same time, it threw four darts at the stock page to select a comparison group. In the 147 five-and one-half month contests from July 1990 to September 2002, the pros won 90 times.

The fact that the pros are ahead of the darts by 90 to 57 suggests that markets are not efficient. Or does it? One problem is that the darts naturally tend to select stocks of average risk. The pros are playing to win and naturally select riskier stocks, or so it is argued. If this is true, then, on average, we *expect* the pros to win. Furthermore, the pros' picks are

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[6]The idea behind the EMH can be illustrated by the following short story: A student was walking down the hall with her finance professor when they both saw a $20 bill on the ground. As the student bent down to pick it up, the professor shook his head slowly and, with a look of disappointment on his face, said patiently to the student, "Don't bother. If it were really there, someone else would have picked it up already." The moral of the story reflects the logic of the efficient markets hypothesis: If you think you have found a pattern in stock prices or a simple device for picking winners, you probably have not.

[7]Malkiel, B. G., *A Random Walk Down Wall Street,* revised and updated ed. New York: Norton, 2016.

IN THEIR OWN WORDS ...

Richard Roll on Market Efficiency

The concept of an efficient market is a special application of the "no free lunch" principle. In an efficient financial market, costless trading policies will not generate "excess" returns. After adjusting for the riskiness of the policy, the trader's return will be no larger than the return of a randomly selected portfolio, at least on average.

This is often thought to imply something about the amount of "information" reflected in asset prices. However, it really doesn't mean that prices reflect all information nor even that they reflect publicly available information. Instead it means that the connection between unreflected information and prices is too subtle and tenuous to be easily or costlessly detected.

Relevant information is difficult and expensive to uncover and evaluate. Thus, if costless trading policies are ineffective, there must exist some traders who make a living by "beating the market." They cover their costs (including the opportunity cost of their time) by trading. The existence of such traders is actually a necessary precondition for markets to become efficient. Without such professional traders, prices would fail to reflect everything that is cheap and easy to evaluate.

Efficient market prices should approximate a random walk, meaning that they will appear to fluctuate more or less randomly. Prices can fluctuate nonrandomly to the extent that their departure from randomness is expensive to discern. Also, observed price series can depart from apparent randomness due to changes in preferences and expectations, but this is really a technicality and does not imply a free lunch relative to current investor sentiments.

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announced to the public at the start. This publicity may boost the prices of the shares involved somewhat, leading to a partially self-fulfilling prophecy. Unfortunately, the *Journal* discontinued the contest in 2002, so this test of market efficiency is no longer ongoing.

More than anything else, what efficiency implies is that the price a firm will obtain when it sells a share of its stock is a "fair" price in the sense that it reflects the value of that stock given the information available about the firm. Shareholders do not have to worry that they are paying too much for a stock with a low dividend or some other sort of characteristic because the market has already incorporated that characteristic into the price. We sometimes say that the information has been "priced out."

The concept of efficient markets can be explained further by replying to a frequent objection. It is sometimes argued that the market cannot be efficient because stock prices fluctuate from day to day. If the prices are right, the argument goes, then why do they change so much and so often? From our discussion of the market, we can see that these price movements are in no way inconsistent with efficiency. Investors are bombarded with information every day. The fact that prices fluctuate is, at least in part, a reflection of that information flow. In fact, the absence of price movements in a world that changes as rapidly as ours would suggest inefficiency.

THE FORMS OF MARKET EFFICIENCY

It is common to distinguish between three forms of market efficiency. Depending on the degree of efficiency, we say that markets are either *weak form efficient*, *semistrong form efficient*, or *strong form efficient*. The difference between these forms relates to what information is reflected in prices.

We start with the extreme case. If the market is strong form efficient, then *all* information of *every* kind is reflected in stock prices. In such a market, there is no such thing as inside information. Therefore, in our FCC example, we apparently were assuming that the market was not strong form efficient.

Casual observation, particularly in recent years, suggests that inside information does exist, and it can be valuable to possess. Whether it is lawful or ethical to use that information is another issue. In any event, we conclude that private information about a particular stock may exist and may not be currently reflected in the price of the stock. For example, prior knowledge of a takeover attempt could be very valuable.

The second form of efficiency, semistrong form efficiency, is the most controversial. If a market is semistrong form efficient, then all *public* information is reflected in the stock price. The reason this form is controversial is that it implies that a security analyst who tries to identify mispriced stocks using, for example, financial statement information, is wasting time because that information is already reflected in the current price.

The third form of efficiency, weak form efficiency, suggests that, at a minimum, the current price of a stock reflects the stock's own past prices. In other words, studying past prices in an attempt to identify mispriced securities is futile if the market is weak form efficient. Although this form of efficiency might seem rather mild, it implies that searching for patterns in historical prices that will be useful in identifying mispriced stocks will not work (although this practice is quite common).

What does capital market history say about market efficiency? Here again, there is great controversy. At the risk of going out on a limb, we can say that the evidence seems to tell us three things. First, prices appear to respond rapidly to new information, and the response is at least not grossly different from what we would expect in an efficient market. Second, the future of market prices, particularly in the short run, is difficult to predict based on publicly available information. Third, if mispriced stocks exist, then there is no obvious means of identifying them. Put another way, simpleminded schemes based on public information will probably not be successful.

Concept Questions

12.6a What is an efficient market?

12.6b What are the forms of market efficiency?

12.7 Summary and Conclusions

This chapter has explored the subject of capital market history. Such history is useful because it tells us what to expect in the way of returns from risky assets. We summarized our study of market history with two key lessons:

1. Risky assets, on average, earn a risk premium. There is a reward for bearing risk.
2. The greater the potential reward from a risky investment, the greater is the risk.

These lessons have significant implications for the financial manager. We will consider these implications in the chapters ahead.

We also discussed the concept of market efficiency. In an efficient market, prices adjust quickly and correctly to new information. Consequently, asset prices in efficient markets are rarely too high or too low. How efficient capital markets (such as the NYSE) are is a matter of debate; but, at a minimum, they are probably much more efficient than most real asset markets.

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Can you answer the following *Connect* Quiz questions?

Section 12.1 Chase Bank pays an annual dividend of $1.05 per share on its common stock. One year ago, this stock sold for $48 per share. Today, the stock is priced to sell at $31 per share. What is the capital gains yield?

Section 12.3 The risk premium is computed as the excess return that a security earns over and above the rate for what?

Section 12.4 How are risk and reward related?

Section 12.5 A stock produced annual rates of return of 11 percent, –17 percent, 2 percent, and 14 percent over the past four years, respectively. What is the geometric average return for this period?

Section 12.6 Corporate insiders cannot benefit financially from the inside information they possess in what type of market?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

12.1 **Recent Return History** Use Table 12.1 to calculate the average return over the years 1996 through 2000 for large-company stocks, long-term government bonds, and Treasury bills.

12.2 **More Recent Return History** Calculate the standard deviation for each security type using information from Problem 12.1. Which of the investments was the most volatile over this period?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

12.1 We calculate the averages as follows:

Actual Returns			
Year	Large-Company Stocks	Long-Term Government Bonds	Treasury Bills
1996	.2296	.0013	.0514
1997	.3336	.1202	.0519
1998	.2858	.1445	.0486
1999	.2104	–.0751	.0480
2000	–.0910	.1722	.0598
Average	.1937	.0726	.0519

12.2 We first need to calculate the deviations from the average returns. Using the averages from Problem 12.1, we get the following values:

Deviations from Average Returns			
Year	Large-Company Stocks	Long-Term Government Bonds	Treasury Bills
1996	.0359	−.0713	−.0005
1997	.1399	.0476	.0000
1998	.0921	.0719	−.0033
1999	.0167	−.1477	−.0039
2000	−.2847	.0996	.0079
Total	.0000	.0000	.0000

We square these deviations and calculate the variances and standard deviations:

Squared Deviations from Average Returns			
Year	Large-Company Stocks	Long-Term Government Bonds	Treasury Bills
1996	.0012902	.0050865	.0000003
1997	.0195776	.0022639	.0000000
1998	.0084861	.0051667	.0000112
1999	.0002796	.0218212	.0000155
2000	.0810427	.0099162	.0000618
Variance	.0276691	.0110636	.0000222
Std dev	.1663402	.1051838	.0047104

To calculate the variances, we added the squared deviations and divided by 4, the number of returns less 1. Notice that the stocks had much more volatility than the bonds, with a much larger average return. For large-company stocks, this was a particularly good period: The average return was 19.37 percent.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Investment Selection** [LO4] Given that AK Steel was up by about 359 percent for 2016, why didn't all investors hold this stock?
2. **Investment Selection** [LO4] Given that Endo International was down by 73 percent for 2016, why did some investors hold the stock? Why didn't they sell out before the price declined so sharply?
3. **Risk and Return** [LO2, 3] We have seen that over long periods, stock investments have tended to substantially outperform bond investments. However, it is common to observe investors with long horizons holding portfolios composed entirely of bonds. Are such investors irrational?
4. **Market Efficiency Implications** [LO4] Explain why a characteristic of an efficient market is that investments in that market have zero NPVs.

5. **Efficient Markets Hypothesis [LO4]** A stock market analyst is able to identify mispriced stocks by comparing the average price for the last 10 days to the average price for the last 60 days. If this is true, what do you know about the market?
6. **Semistrong Efficiency [LO4]** If a market is semistrong form efficient, is it also weak form efficient? Explain.
7. **Efficient Markets Hypothesis [LO4]** What are the implications of the efficient markets hypothesis for investors who buy and sell stocks in an attempt to "beat the market"?
8. **Stocks versus Gambling [LO4]** Critically evaluate the following statement: Playing the stock market is like gambling. Such speculative investing has no social value other than the pleasure people get from this form of gambling.
9. **Efficient Markets Hypothesis [LO4]** Several celebrated investors and stock pickers frequently mentioned in the financial press have recorded huge returns on their investments over the past two decades. Is the success of these particular investors an invalidation of the EMH? Explain.
10. **Efficient Markets Hypothesis [LO4]** For each of the following scenarios, discuss whether profit opportunities exist from trading in the stock of the firm under the conditions that (1) the market is not weak form efficient, (2) the market is weak form but not semistrong form efficient, (3) the market is semistrong form but not strong form efficient, and (4) the market is strong form efficient.
    a. The stock price has risen steadily each day for the past 30 days.
    b. The financial statements for a company were released three days ago, and you believe you've uncovered some anomalies in the company's inventory and cost control reporting techniques that are causing the firm's true liquidity strength to be understated.
    c. You observe that the senior managers of a company have been buying a lot of the company's stock on the open market over the past week.

QUESTIONS AND PROBLEMS

Mc Graw Hill Education connect

BASIC
(Questions 1–12)

1. **Calculating Returns [LO1]** Suppose a stock had an initial price of $65 per share, paid a dividend of $1.45 per share during the year, and had an ending share price of $71. Compute the percentage total return.
2. **Calculating Yields [LO1]** In Problem 1, what was the dividend yield? The capital gains yield?
3. **Return Calculations [LO1]** Rework Problems 1 and 2 assuming the ending share price is $58.
4. **Calculating Returns [LO1]** Suppose you bought a bond with an annual coupon of 7 percent one year ago for $1,010. The bond sells for $985 today.
    a. Assuming a $1,000 face value, what was your total dollar return on this investment over the past year?
    b. What was your total nominal rate of return on this investment over the past year?
    c. If the inflation rate last year was 3 percent, what was your total real rate of return on this investment?
5. **Nominal versus Real Returns [LO2]** What was the average annual return on large-company stocks from 1926 through 2016:
    a. In nominal terms?
    b. In real terms?

6. **Bond Returns** **[LO2]** What is the historical real return on long-term government bonds? On long-term corporate bonds?

7. **Calculating Returns and Variability** **[LO1]** Using the following returns, calculate the arithmetic average returns, the variances, and the standard deviations for X and Y.

	Returns	
Year	X	Y
1	12%	25%
2	28	34
3	9	13
4	−7	−27
5	10	14

8. **Risk Premiums** **[LO2, 3]** Refer to Table 12.1 in the text and look at the period from 1970 through 1975.
   a. Calculate the arithmetic average returns for large-company stocks and T-bills over this period.
   b. Calculate the standard deviation of the returns for large-company stocks and T-bills over this period.
   c. Calculate the observed risk premium in each year for the large-company stocks versus the T-bills. What was the average risk premium over this period? What was the standard deviation of the risk premium over this period?
   d. Is it possible for the risk premium to be negative before an investment is undertaken? Can the risk premium be negative after the fact? Explain.

9. **Calculating Returns and Variability** **[LO1]** You've observed the following returns on Crash-n-Burn Computer's stock over the past five years: 8 percent, −15 percent, 19 percent, 31 percent, and 21 percent.
   a. What was the arithmetic average return on the company's stock over this five-year period?
   b. What was the variance of the company's returns over this period? The standard deviation?

10. **Calculating Real Returns and Risk Premiums** **[LO1]** For Problem 9, suppose the average inflation rate over this period was 3.1 percent and the average T-bill rate over the period was 3.9 percent.
   a. What was the average real return on the company's stock?
   b. What was the average nominal risk premium on the company's stock?

11. **Calculating Real Rates** **[LO1]** Given the information in Problem 10, what was the average real risk-free rate over this time period? What was the average real risk premium?

12. **Effects of Inflation** **[LO2]** Look at Table 12.1 and Figure 12.7 in the text. When were T-bill rates at their highest over the period from 1926 through 2016? Why do you think they were so high during this period? What relationship underlies your answer?

INTERMEDIATE
(Questions 13–22)

13. **Calculating Investment Returns** **[LO1]** You bought one of Great White Shark Repellant Co.'s 5.8 percent coupon bonds one year ago for $1,030. These bonds make annual payments and mature 14 years from now. Suppose you decide to sell your bonds today, when the required return on the bonds is 5.1 percent. If the inflation rate was 3.9 percent over the past year, what was your total real return on investment?

14. **Calculating Returns and Variability [LO1]** You find a certain stock that had returns of 9 percent, −16 percent, 18 percent, and 14 percent for four of the last five years. If the average return of the stock over this period was 10.3 percent, what was the stock's return for the missing year? What is the standard deviation of the stock's return?

15. **Arithmetic and Geometric Returns [LO1]** A stock has had returns of 8 percent, 26 percent, 14 percent, −17 percent, 31 percent, and −1 percent over the last six years. What are the arithmetic and geometric average returns for the stock?

16. **Arithmetic and Geometric Returns [LO1]** A stock has had the following year-end prices and dividends:

Year	Price	Dividend
1	$63.40	—
2	70.20	$.85
3	79.18	.95
4	75.32	1.03
5	84.18	1.11
6	98.62	1.20

What are the arithmetic and geometric average returns for the stock?

17. **Using Return Distributions [LO3]** Suppose the returns on long-term corporate bonds are normally distributed. Based on the historical record, what is the approximate probability that your return on these bonds will be less than −2.1 percent in a given year? What range of returns would you expect to see 95 percent of the time? What range would you expect to see 99 percent of the time?

18. **Using Return Distributions [LO3]** Assuming that the returns from holding small-company stocks are normally distributed, what is the approximate probability that your money will double in value in a single year? What about triple in value?

19. **Distributions [LO3]** In Problem 18, what is the probability that the return is less than −100 percent (think)? What are the implications for the distribution of returns?

20. **Blume's Formula [LO1]** Over a 40-year period, an asset had an arithmetic return of 11.2 percent and a geometric return of 9.4 percent. Using Blume's formula, what is your best estimate of the future annual returns over 5 years? 10 years? 20 years?

21. **Blume's Formula [LO1, 2]** Assume that the historical return on large-company stocks is a predictor of the future returns. What return would you estimate for large-company stocks over the next year? The next 10 years? 20 years? 40 years?

22. **Calculating Returns [LO2, 3]** Refer to Table 12.1 in the text and look at the period from 1973 through 1980:

a. Calculate the average return for Treasury bills and the average annual inflation rate (consumer price index) for this period.

b. Calculate the standard deviation of Treasury bill returns and inflation over this period.

c. Calculate the real return for each year. What is the average real return for Treasury bills?

d. Many people consider Treasury bills risk-free. What do these calculations tell you about the potential risks of Treasury bills?

CHALLENGE
(Questions 23–24)

23. **Using Probability Distributions** [LO3] Suppose the returns on large-company stocks are normally distributed. Based on the historical record, use the NORMDIST function in Excel® to determine the probability that in any given year you will lose money by investing in common stock.

24. **Using Probability Distributions** [LO3] Suppose the returns on long-term corporate bonds and T-bills are normally distributed. Based on the historical record, use the NORMDIST function in Excel® to answer the following questions:
    a. What is the probability that in any given year, the return on long-term corporate bonds will be greater than 10 percent? Less than 0 percent?
    b. What is the probability that in any given year, the return on T-bills will be greater than 10 percent? Less than 0 percent?
    c. In 1979, the return on long-term government bonds was −2.76 percent. How likely is it that such a low return will recur at some point in the future? T-bills had a return of 10.56 percent in this same year. How likely is it that such a high return on T-bills will recur at some point in the future?

EXCEL MASTER IT! PROBLEM

xlsx

As we have seen, over the 1926–2016 period, small company stocks had the highest return and the highest risk, while U.S. Treasury bills had the lowest return and the lowest risk. While we certainly hope you have a 91-year holding period, likely your investment will be for fewer years. One way risk and return is examined over a shorter investment period is by using rolling returns and standard deviations. Suppose you have a series of annual returns and you want to calculate a three-year rolling average return. You would calculate the first rolling average at Year 3 using the returns for the first three years. The next rolling average would be calculated using the returns from Years 2, 3, and 4.

a. Using the annual returns for large company stocks and Treasury bills, and inflation, calculate both the 5- and 10-year rolling average return and standard deviation.
b. Over how many 5-year periods did Treasury bills outperform large company stocks? How many 10-year periods?
c. Over how many 5-year periods did Treasury bills have a larger standard deviation than large company stocks? Over how many 10-year periods?
d. Graph the rolling 5-year and 10-year average returns for large company stocks and Treasury bills.
e. What conclusions do you draw from the above results?

MINICASE

A Job at S&S Air

You recently graduated from college, and your job search led you to S&S Air. Because you felt the company's business was taking off, you accepted a job offer. The first day on the job, while you are finishing your employment paperwork, Chris Guthrie, who works in Finance, stops by to inform you about the company's 401(k) plan.

A 401(k) plan is a retirement plan offered by many companies. Such plans are tax-deferred savings vehicles, meaning that any deposits you make into the plan are deducted from your current pretax income, so no current taxes are paid on the money. For example, assume your salary will be $50,000 per year. If you contribute $3,000 to the 401(k) plan, you will pay taxes on only $47,000 in income. There are also no taxes paid on any capital gains or income while you are invested in the plan, but you do pay taxes when you withdraw money at retirement. As is fairly common, the company also has a 5 percent match. This means that the company will match your contribution up to 5 percent of your salary, but you must contribute to get the match.

The 401(k) plan has several options for investments, most of which are mutual funds. A mutual fund is a portfolio of assets. When you purchase shares in a mutual fund, you are actually purchasing partial ownership of the fund's assets. The return of the fund is the weighted average of the return of the assets owned by the fund, minus any expenses. The largest expense is typically the management fee, paid to the fund manager. The management fee is compensation for the manager, who makes all of the investment decisions for the fund.

S&S Air uses Bledsoe Financial Services as its 401(k) plan administrator. Here are the investment options offered for employees:

Company Stock One option in the 401(k) plan is stock in S&S Air. The company is currently privately held. However, when you interviewed with the owners, Mark Sexton and Todd Story, they informed you the company stock was expected to go public in the next three to four years. Until then, a company stock price is simply set each year by the board of directors.

Bledsoe S&P 500 Index Fund This mutual fund tracks the S&P 500. Stocks in the fund are weighted exactly the same as the S&P 500. This means the fund return is approximately the return on the S&P 500, minus expenses. Because an index fund purchases assets based on the composition of the index it is following, the fund manager is not required to research stocks and make investment decisions. The result is that the fund expenses are usually low. The Bledsoe S&P 500 Index Fund charges expenses of .15 percent of assets per year.

Bledsoe Small-Cap Fund This fund primarily invests in small-capitalization stocks. As such, the returns of the fund are more volatile. The fund can also invest 10 percent of its assets in companies based outside the United States. This fund charges 1.70 percent in expenses.

Bledsoe Large-Company Stock Fund This fund invests primarily in large-capitalization stocks of companies based in the United States. The fund is managed by Evan Bledsoe and has outperformed the market in six of the last eight years. The fund charges 1.50 percent in expenses.

Bledsoe Bond Fund This fund invests in long-term corporate bonds issued by U.S.-domiciled companies. The fund is restricted to investments in bonds with an investment-grade credit rating. This fund charges 1.40 percent in expenses.

Bledsoe Money Market Fund This fund invests in short-term, high credit-quality debt instruments, which include Treasury bills. As such, the return on the money market fund is only slightly higher than the return on Treasury bills. Because of the credit quality and short-term nature of the investments, there is only a very slight risk of a negative return. The fund charges .60 percent in expenses.

QUESTIONS

1. What advantages do the mutual funds offer compared to the company stock?
2. Assume that you invest 5 percent of your salary and receive the full 5 percent match from S&S Air. What EAR do you earn from the match? What conclusions do you draw about matching plans?
3. Assume you decide you should invest at least part of your money in large-capitalization stocks of companies based in the United States. What are the advantages and disadvantages of choosing the Bledsoe Large-Company Stock Fund compared to the Bledsoe S&P 500 Index Fund?
4. The returns on the Bledsoe Small-Cap Fund are the most volatile of all the mutual funds offered in the 401(k) plan. Why would you ever want to invest in this fund? When you examine the expenses of the mutual funds, you will notice that this fund also has the highest expenses. Does this affect your decision to invest in this fund?
5. A measure of risk-adjusted performance that is often used is the Sharpe ratio. The Sharpe ratio is calculated as the risk premium of an asset divided by its standard deviation. The standard deviation and return of the funds over the past 10 years are listed in the following table. Calculate the Sharpe ratio for each of these funds. Assume that the expected return and standard deviation of the company stock will be 17 percent and 70 percent, respectively. Calculate the Sharpe ratio for the company stock. How appropriate is the Sharpe ratio for these assets? When would you use the Sharpe ratio?

	10-Year Annual Return	Standard Deviation
Bledsoe S&P 500 Index Fund	6.88%	10.75%
Bledsoe Small-Cap Fund	9.29	12.81
Bledsoe Large-Company Stock Fund	3.56	10.99
Bledsoe Bond Fund	5.27	7.12

6. What portfolio allocation would you choose? Why? Explain your thinking carefully.

Chapter

13 Return, Risk, and the Security Market Line

IN JANUARY 2017, Constellation Brands, Volkswagen, and Chipotle all made major announcements. Constellation Brands, best-known as the importer of Modelo and Corona beers, announced that its sales were up 10 percent from the previous year and that profits had exceeded analysts' estimates. German auto maker Volkswagen announced that it had agreed in principle to pay a $4.3 billion fine to settle a U.S. Justice Department probe into the company's diesel engine emissions scandal. For Chipotle, the company announced that its fourth quarter profit would be 50 to 58 cents per share, well below analysts' estimates of 96 cents. You might expect that these three cases represent good news for Constellation Brands and bad news for Volkswagen and Chipotle, and usually you would be right. But here, Constellation Brands's stock price dropped about 7 percent, Volkswagen's stock jumped by about 3.4 percent, and Chipotle's stock price rose about 5 percent.

So we see that stock price reactions do not always match what we might expect based on news. So when is good news really good news? The answer is fundamental to understanding risk and return, and—the good news is—this chapter explores it in some detail.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Show how to calculate expected returns, variance, and standard deviation.

LO2 Discuss the impact of diversification.

LO3 Summarize the systematic risk principle.

LO4 Describe the security market line and the risk–return trade-off.

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In our last chapter, we learned some important lessons from capital market history. Most important, we learned that there is a reward, on average, for bearing risk. We called this reward a *risk premium*. The second lesson is that this risk premium is larger for riskier investments. This chapter explores the economic and managerial implications of this basic idea.

Thus far, we have concentrated mainly on the return behavior of a few large portfolios. We need to expand our consideration to include individual assets. Specifically, we have two tasks to accomplish. First, we have to define risk and discuss how to measure it. We then must quantify the relationship between an asset's risk and its required return.

When we examine the risks associated with individual assets, we find there are two types of risk: Systematic and unsystematic. This distinction is crucial because, as we will see, systematic risk affects almost all assets in the economy, at least to some degree, whereas unsystematic risk affects at most a small number of assets. We then develop the principle of diversification, which shows that highly diversified portfolios will tend to have almost no unsystematic risk.

The principle of diversification has an important implication: To a diversified investor, only systematic risk matters. It follows that in deciding whether to buy a particular individual asset, a diversified investor will be concerned only with that asset's systematic risk. This is a key observation, and it allows us to say a great deal about the risks and returns on individual assets. In particular, it is the basis for a famous relationship between risk and return called the *security market line*, or the SML. To develop the SML, we introduce the equally famous "beta" coefficient, one of the centerpieces of modern finance. Beta and the SML are key concepts because they supply us with at least part of the answer to the question of how to determine the required return on an investment.

Expected Returns and Variances

13.1

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In our previous chapter, we discussed how to calculate average returns and variances using historical data. We now begin to discuss how to analyze returns and variances when the information we have concerns future possible returns and their probabilities.

EXPECTED RETURN

We start with a straightforward case. Consider a single period of time—say a year. We have two stocks, L and U, which have the following characteristics: Stock L is expected to have a return of 25 percent in the coming year. Stock U is expected to have a return of 20 percent for the same period.

In a situation like this, if all investors agreed on the expected returns, why would anyone want to hold Stock U? After all, why invest in one stock when the expectation is that another will do better? Clearly, the answer must depend on the risk of the two investments. The return on Stock L, although it is *expected* to be 25 percent, could actually turn out to be higher or lower.

For example, suppose the economy booms. In this case, we think Stock L will have a 70 percent return. If the economy enters a recession, we think the return will be −20 percent. In this case, we say that there are two *states of the economy*, which means that these are the only two possible situations. This setup is oversimplified, of course, but it allows us to illustrate some key ideas without a lot of computation.

Suppose we think a boom and a recession are equally likely to happen, for a 50–50 chance of each. Table 13.1 illustrates the basic information we have described and some additional information about Stock U. Notice that Stock U earns 30 percent if there is a recession and 10 percent if there is a boom.

Obviously, if you buy one of these stocks, say Stock U, what you earn in any particular year depends on what the economy does during that year. However, suppose the probabilities stay the same through time. If you hold Stock U for a number of years, you'll earn 30 percent about half the time and 10 percent the other half. In this case, we say that your **expected return** on Stock U, $E(R_U)$, is 20 percent:

expected return
The return on a risky asset expected in the future.

$$E(R_U) = .50 \times 30\% + .50 \times 10\% = 20\%$$

In other words, you should expect to earn 20 percent from this stock, on average.

TABLE 13.1

States of the Economy and Stock Returns

State of Economy	Probability of State of Economy	Rate of Return If State Occurs	
		Stock L	Stock U
Recession	.50	−20%	30%
Boom	.50	70	10
	1.00		

TABLE 13.2
Calculation of Expected Return

		Stock L		Stock U	
(1) State of Economy	(2) Probability of State of Economy	(3) Rate of Return If State Occurs	(4) Product (2) × (3)	(5) Rate of Return If State Occurs	(6) Product (2) × (5)
Recession	.50	−.20	−.10	.30	.15
Boom	.50	.70	.35	.10	.05
	1.00		$E(R_L)$ = .25, or 25%		$E(R_U)$ = .20, or 20%

For Stock L, the probabilities are the same, but the possible returns are different. Here, we lose 20 percent half the time, and we gain 70 percent the other half. The expected return on L, $E(R_L)$, is 25 percent:

$$E(R_L) = .50 \times -20\% + .50 \times 70\% = 25\%$$

Table 13.2 illustrates these calculations.

In our previous chapter, we defined the risk premium as the difference between the return on a risky investment and that on a risk-free investment, and we calculated the historical risk premiums on some different investments. Using our projected returns, we can calculate the *projected*, or *expected*, *risk premium* as the difference between the expected return on a risky investment and the certain return on a risk-free investment.

For example, suppose risk-free investments are currently offering 8 percent. We will say that the risk-free rate, which we label as R_f, is 8 percent. Given this, what is the projected risk premium on Stock U? On Stock L? Because the expected return on Stock U, $E(R_U)$, is 20 percent, the projected risk premium is:

Risk premium = Expected return − Risk-free rate (13.1)

$$= E(R_U) - R_f$$
$$= 20\% - 8$$
$$= 12\%$$

Similarly, the risk premium on Stock L is $25\% - 8 = 17\%$.

In general, the expected return on a security or other asset is equal to the sum of the possible returns multiplied by their probabilities. So, if we had 100 possible returns, we would multiply each one by its probability and sum the results. The result would be the expected return. The risk premium would then be the difference between this expected return and the risk-free rate.

EXAMPLE 13.1 Unequal Probabilities

Look again at Tables 13.1 and 13.2. Suppose you think a boom will occur only 20 percent of the time instead of 50 percent. What are the expected returns on Stocks U and L in this case? If the risk-free rate is 10 percent, what are the risk premiums?

The first thing to notice is that a recession must occur 80 percent of the time (1 − .20 = .80) because there are only two possibilities. With this in mind, we see that Stock U has a 30 percent return in 80 percent of the years and a 10 percent return in 20 percent of the years. To calculate the expected return, we again just multiply the possibilities by the probabilities and add up the results:

$$E(R_U) = .80 \times 30\% + .20 \times 10\% = 26\%$$

Table 13.3 summarizes the calculations for both stocks. Notice that the expected return on L is −2 percent.

TABLE 13.3
Calculation of Expected Return

		Stock L		Stock U	
(1) State of Economy	(2) Probability of State of Economy	(3) Rate of Return If State Occurs	(4) Product (2) × (3)	(5) Rate of Return If State Occurs	(6) Product (2) × (5)
Recession	.80	−.20	−.16	.30	.24
Boom	.20	.70	.14	.10	.02
			$E(R_L) = -.02$, or −2%		$E(R_U) = .26$ =, or 26%

The risk premium for Stock U is 26% − 10 = 16% in this case. The risk premium for Stock L is: −2% − 10 = −12%. This is a little odd; but, for reasons we discuss later, it is not impossible.

CALCULATING THE VARIANCE

To calculate the variances of the returns on our two stocks, we first determine the squared deviations from the expected return. We then multiply each possible squared deviation by its probability. We add these, and the result is the variance. The standard deviation, as always, is the square root of the variance.

To illustrate, let us return to the Stock U we originally discussed, which has an expected return of $E(R_U) = 20\%$. In a given year, it will actually return either 30 percent or 10 percent. The possible deviations are 30% − 20% = 10% and 10% − 20% = −10%. In this case, the variance is:

$$\text{Variance} = \sigma^2 = .50 \times .10^2 + .50 \times (-.10)^2 = .01$$

The standard deviation is the square root of this:

$$\text{Standard deviation} = \sigma = \sqrt{.01} = .10, \text{ or } 10\%$$

Table 13.4 summarizes these calculations for both stocks. Notice that Stock L has a much larger variance.

When we put the expected return and variability information for our two stocks together, we have the following:

	Stock L	Stock U
Expected return, $E(R)$	25%	20%
Variance, σ^2	.2025	.0100
Standard deviation, σ	45%	10%

Stock L has a higher expected return, but U has less risk. You could get a 70 percent return on your investment in L, but you could also lose 20 percent. Notice that an investment in U will always pay at least 10 percent.

Which of these two stocks should you buy? We can't really say; it depends on your personal preferences. We can be reasonably sure that some investors would prefer L to U and some would prefer U to L.

You've probably noticed that the way we have calculated expected returns and variances here is somewhat different from the way we did it in the last chapter. The reason is that, in Chapter 12, we were examining actual historical returns, so we estimated the average return and the variance based on some actual events. Here, we have projected *future* returns and their associated probabilities, so this is the information with which we must work.

TABLE 13.4
Calculation of Variance

(1) State of Economy	(2) Probability of State of Economy	(3) Return Deviation from Expected Return	(4) Squared Return Deviation from Expected Return	(5) Product (2) × (4)
Stock L				
Recession	.50	$-.20 - .25 = -.45$	$-.45^2 = .2025$	.10125
Boom	.50	$.70 - .25 = .45$	$.45^2 = .2025$	.10125
				$\sigma_L^2 = .20250$
Stock U				
Recession	.50	$.30 - .20 = .10$	$.10^2 = .01$	.005
Boom	.50	$.10 - .20 = -.10$	$-.10^2 = .01$	.005
				$\sigma_U^2 = .010$

EXAMPLE 13.2 More Unequal Probabilities

Going back to Example 13.1, what are the variances on the two stocks once we have unequal probabilities? The standard deviations?

We can summarize the needed calculations as follows:

(1) State of Economy	(2) Probability of State of Economy	(3) Return Deviation from Expected Return	(4) Squared Return Deviation from Expected Return	(5) Product (2) × (4)
Stock L				
Recession	.80	$-.20 - (-.02) = -.18$	.0324	.02592
Boom	.20	$.70 - (-.02) = .72$	.5184	.10368
				$\sigma_L^2 = .12960$
Stock U				
Recession	.80	$.30 - .26 = .04$	.0016	.00128
Boom	.20	$.10 - .26 = -.16$	.0256	.00512
				$\sigma_U^2 = .00640$

Based on these calculations, the standard deviation for L is $\sigma_L = \sqrt{.1296} = .36$, or 36%. The standard deviation for U is much smaller: $\sigma_U = \sqrt{.0064} = .08$, or 8%.

Concept Questions

13.1a How do we calculate the expected return on a security?

13.1b In words, how do we calculate the variance of the expected return?

13.2 Portfolios

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Thus far in this chapter, we have concentrated on individual assets considered separately. However, most investors actually hold a **portfolio** of assets. All we mean by this is that investors tend to own more than just a single stock, bond, or other asset. Given this, portfolio return and portfolio risk are of obvious relevance. Accordingly, we now discuss portfolio expected returns and variances.

TABLE 13.5

Expected Return on an Equally Weighted Portfolio of Stock L and Stock U

(1) State of Economy	(2) Probability of State of Economy	(3) Portfolio Return If State Occurs	(4) Product (2) × (3)
Recession	.50	$.50 \times -20\% + .50 \times 30\% = 5\%$	.025
Boom	.50	$.50 \times 70\% + .50 \times 10\% = 40\%$	.200
			$E(R_P) = .225$, or 22.5%

PORTFOLIO WEIGHTS

There are many equivalent ways of describing a portfolio. The most convenient approach is to list the percentage of the total portfolio's value that is invested in each portfolio asset. We call these percentages the **portfolio weights**.

For example, if we have \$50 in one asset and \$150 in another, our total portfolio is worth \$200. The percentage of our portfolio in the first asset is \$50/\$200 = .25. The percentage of our portfolio in the second asset is \$150/\$200, or .75. Our portfolio weights are .25 and .75. Notice that the weights have to sum to 1.00 because all of our money is invested somewhere.[1]

portfolio
A group of assets such as stocks and bonds held by an investor.

portfolio weight
The percentage of a portfolio's total value that is invested in a particular asset.

PORTFOLIO EXPECTED RETURNS

Let's go back to Stocks L and U. You put half your money in each. The portfolio weights are obviously .50 and .50. What is the pattern of returns on this portfolio? The expected return?

To answer these questions, suppose the economy actually enters a recession. In this case, half your money (the half in L) loses 20 percent. The other half (the half in U) gains 30 percent. Your portfolio return, R_P, in a recession is:

$$R_P = .50 \times -20\% + .50 \times 30\% = 5\%$$

Table 13.5 summarizes the remaining calculations. Notice that when a boom occurs, your portfolio will return 40 percent:

$$R_P = .50 \times 70\% + .50 \times 10\% = 40\%$$

As indicated in Table 13.5, the expected return on your portfolio, $E(R_P)$, is 22.5 percent.

We can save ourselves some work by calculating the expected return more directly. Given these portfolio weights, we could have reasoned that we expect half of our money to earn 25 percent (the half in L) and half of our money to earn 20 percent (the half in U). Our portfolio expected return is thus:

$$\begin{aligned} E(R_P) &= .50 \times E(R_L) + .50 \times E(R_U) \\ &= .50 \times 25\% + .50 \times 20\% \\ &= 22.5\% \end{aligned}$$

This is the same portfolio expected return we calculated previously.

This method of calculating the expected return on a portfolio works no matter how many assets there are in the portfolio. Suppose we had n assets in our portfolio, where n is any number. If we let x_i stand for the percentage of our money in Asset i, then the expected return would be:

$$\mathbf{E(R_P) = x_1 \times E(R_1) + x_2 \times E(R_2) + \cdots + x_n \times E(R_n)} \quad \textbf{13.2}$$

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[1]Some of it could be in cash, of course, but we would then just consider the cash to be one of the portfolio assets.

This says that the expected return on a portfolio is a straightforward combination of the expected returns on the assets in that portfolio. This seems somewhat obvious; but, as we will examine next, the obvious approach is not always the right one.

EXAMPLE 13.3 Portfolio Expected Return

Suppose we have the following projections for three stocks:

State of Economy	Probability of State of Economy	Returns If State Occurs		
		Stock A	Stock B	Stock C
Boom	.40	10%	15%	20%
Bust	.60	8	4	0

We want to calculate portfolio expected returns in two cases. First, what would be the expected return on a portfolio with equal amounts invested in each of the three stocks? Second, what would be the expected return if half of the portfolio were in A, with the remainder equally divided between B and C?

Based on what we've learned from our earlier discussions, we can determine that the expected returns on the individual stocks are (check these for practice):

$$E(R_A) = 8.8\%$$
$$E(R_B) = 8.4\%$$
$$E(R_C) = 8.0\%$$

If a portfolio has equal investments in each asset, the portfolio weights are all the same. Such a portfolio is said to be *equally weighted*. Because there are three stocks in this case, the weights are all equal to 1/3. The portfolio expected return is thus:

$$E(R_P) = (1/3) \times 8.8\% + (1/3) \times 8.4\% + (1/3) \times 8\% = 8.4\%$$

In the second case, verify that the portfolio expected return is 8.5 percent.

PORTFOLIO VARIANCE

From our earlier discussion, the expected return on a portfolio that contains equal investments in Stocks U and L is 22.5 percent. What is the standard deviation of return on this portfolio? Simple intuition might suggest that because half of the money has a standard deviation of 45 percent and the other half has a standard deviation of 10 percent, the portfolio's standard deviation might be calculated as:

$$\sigma_P = .50 \times 45\% + .50 \times 10\% = 27.5\%$$

Unfortunately, this approach is completely incorrect!

Let's see what the standard deviation really is. Table 13.6 summarizes the relevant calculations. As we see, the portfolio's variance is about .031, and its standard deviation is less than we thought—it's only 17.5 percent. What is illustrated here is that the variance on a portfolio is not generally a simple combination of the variances of the assets in the portfolio.

We can illustrate this point a little more dramatically by considering a slightly different set of portfolio weights. Suppose we put 2/11 (about 18 percent) in L and the other 9/11 (about 82 percent) in U. If a recession occurs, this portfolio will have a return of:

$$R_P = (2/11) \times -20\% + (9/11) \times 30\% = 20.91\%$$

TABLE 13.6

Variance on an Equally Weighted Portfolio of Stock L and Stock U

(1) State of Economy	(2) Probability of State of Economy	(3) Portfolio Return If State Occurs	(4) Squared Deviation from Expected Return	(5) Product (2) × (4)
Recession	.50	5%	$(.05 - .225)^2 = .030625$	.0153125
Boom	.50	40	$(.40 - .225)^2 = .030625$	.0153125
				$\sigma_P^2 = .030625$
			$\sigma_P = \sqrt{.030625} = .175$, or 17.5%	

If a boom occurs, this portfolio will have a return of:

$$R_P = (2/11) \times 70\% + (9/11) \times 10\% = 20.91\%$$

Notice that the return is the same no matter what happens. No further calculations are needed: This portfolio has a zero variance. Apparently, combining assets into portfolios can substantially alter the risks faced by the investor. This is a crucial observation, and we will begin to explore its implications in the next section.

Portfolio Variance and Standard Deviation

EXAMPLE 13.4

In Example 13.3, what are the standard deviations on the two portfolios? To answer, we first have to calculate the portfolio returns in the two states. We will work with the second portfolio, which has 50 percent in Stock A and 25 percent in each of Stocks B and C. The relevant calculations can be summarized as follows:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs			
		Stock A	Stock B	Stock C	Portfolio
Boom	.40	10%	15%	20%	13.75%
Bust	.60	8	4	0	5.00

The portfolio return when the economy booms is calculated as:

$$E(R_P) = .50 \times 10\% + .25 \times 15\% + .25 \times 20\% = 13.75\%$$

The return when the economy goes bust is calculated the same way. The expected return on the portfolio is 8.5 percent. The variance is thus:

$$\sigma_P^2 = .40 \times (.1375 - .085)^2 + .60 \times (.05 - .085)^2$$

$$= .0018375$$

The standard deviation is about 4.3 percent. For our equally weighted portfolio, check to see that the standard deviation is about 5.4 percent.

Concept Questions

13.2a What is a portfolio weight?

13.2b How do we calculate the expected return on a portfolio?

13.2c Is there a simple relationship between the standard deviation on a portfolio and the standard deviations of the assets in the portfolio?

13.3 Announcements, Surprises, and Expected Returns

Now that we know how to construct portfolios and evaluate their returns, we begin to describe more carefully the risks and returns associated with individual securities. Thus far, we have measured volatility by looking at the difference between the actual return on an asset or portfolio, R, and the expected return, $E(R)$. We now look at why those deviations exist.

EXPECTED AND UNEXPECTED RETURNS

To begin, for concreteness, we consider the return on the stock of a company called Flyers. What will determine this stock's return in, say, the coming year?

The return on any stock traded in a financial market is composed of two parts. First, the normal, or expected, return from the stock is the part of the return that shareholders in the market predict or expect. This return depends on the information shareholders have that bears on the stock, and it is based on the market's understanding today of the important factors that will influence the stock in the coming year.

The second part of the return on the stock is the uncertain, or risky, part. This is the portion that comes from unexpected information revealed within the year. A list of all possible sources of such information would be endless, but here are a few examples:

- News about Flyers research.
- Government figures released on gross domestic product (GDP).
- The results from the latest arms control talks.
- The news that Flyers sales figures are higher than expected.
- A sudden, unexpected drop in interest rates.

Based on this discussion, one way to express the return on Flyers stock in the coming year would be:

$$\textbf{Total return} = \textbf{Expected return} + \textbf{Unexpected return}$$
$$R = E(R) + U \qquad \textbf{13.3}$$

where R stands for the actual total return in the year, $E(R)$ stands for the expected part of the return, and U stands for the unexpected part of the return. What this says is that the actual return, R, differs from the expected return, $E(R)$, because of surprises that occur during the year. In any given year, the unexpected return will be positive or negative; but, through time, the average value of U will be zero. This means that on average, the actual return equals the expected return.

ANNOUNCEMENTS AND NEWS

We need to be careful when we talk about the effect of news items on the return. For example, suppose Flyers's business is such that the company prospers when GDP grows at a relatively high rate and suffers when GDP is relatively stagnant. In this case, in deciding what return to expect this year from owning stock in Flyers, shareholders either implicitly or explicitly must think about what GDP is likely to be for the year.

When the government actually announces GDP figures for the year, what will happen to the value of Flyers's stock? Obviously, the answer depends on what figure is released. More to the point, however, the impact depends on how much of that figure is *new* information.

At the beginning of the year, market participants will have some idea or forecast of what the yearly GDP will be. To the extent that shareholders have predicted GDP, that prediction will already be factored into the expected part of the return on the stock, E(R). On the other hand, if the announced GDP is a surprise, the effect will be part of U, the unanticipated portion of the return. As an example, suppose shareholders in the market had forecast that the GDP increase this year would be .5 percent. If the actual announcement this year is exactly .5 percent, the same as the forecast, then the shareholders don't really learn anything, and the announcement isn't news. There will be no impact on the stock price as a result. This is like receiving confirmation of something you suspected all along; it doesn't reveal anything new.

A common way of saying that an announcement isn't news is to say that the market has already "discounted" the announcement. The use of the word *discount* here is different from the use of the term in computing present values, but the spirit is the same. When we discount a dollar in the future, we say it is worth less to us because of the time value of money. When we discount an announcement or a news item, we say that it has less of an impact on the price because the market already knew much of it.

Going back to Flyers, suppose the government announces that the actual GDP increase during the year has been 1.5 percent. Now shareholders have learned something—namely, that the increase is one percentage point higher than they had forecast. This difference between the actual result and the forecast, one percentage point in this example, is sometimes called the *innovation* or the *surprise*.

This distinction explains why what seems to be good news can actually be bad news (and vice versa). Going back to the companies we discussed in our chapter opener, even though Constellation Brands beat sales and profit estimates, investors were concerned about slowing beer sales and the potential for tariffs on the company's imports. For Chipotle, earnings were below estimates and same-store sales had declined, but the decline was lower than previous quarters, indicating a possible reversal in falling sales caused by a previous foodborne contamination problem. An additional cause of the decreased earnings—an increase in the price of avocados—was not expected to continue.

In the case of Volkswagen, even though its $4.3 billion settlement seems negative, it actually was a positive for investors. The Justice Department probe had centered on "dieselgate," a reference to excess emissions from diesel engines in Volkswagen vehicles. Volkswagen had programmed certain models to activate controls that worked only during emissions tests, allowing the cars to meet the emissions standards for NO_x. During normal operations, the cars emitted as much as 40 times more NO_x than under testing conditions. Even though the settlement was large, investors had been worried that the probe would drag on much longer and that the fine would be much higher.

To summarize, an announcement can be broken into two parts: the anticipated, or expected, part and the surprise, or innovation:

Announcement = Expected part + Surprise 13.4

The expected part of any announcement is the part of the information that the market uses to form the expectation, E(R), of the return on the stock. The surprise is the news that influences the unanticipated return on the stock, U.

Our discussion of market efficiency in the previous chapter bears on this discussion. We are assuming that relevant information known today is already reflected in the expected return. This is identical to saying that the current price reflects relevant publicly available information. We are implicitly assuming that markets are at least reasonably efficient in the semistrong form.

Henceforth, when we speak of news, we will mean the surprise part of an announcement and not the portion that the market has expected and therefore already discounted.

Concept Questions

13.3a What are the two basic parts of a return?

13.3b Under what conditions will a company's announcement have no effect on common stock prices?

13.4 Risk: Systematic and Unsystematic

The unanticipated part of the return, that portion resulting from surprises, is the true risk of any investment. After all, if we always receive exactly what we expect, then the investment is perfectly predictable and, by definition, risk-free. In other words, the risk of owning an asset comes from surprises—unanticipated events.

There are important differences, though, among various sources of risk. Returning to our example in the previous section, look back at the list of news stories that could impact the return on Flyers's stock. Some of these stories are directed specifically at Flyers, and some are more general. Which of the news items are of specific importance to Flyers?

Announcements about interest rates or GDP are clearly important for nearly all companies, whereas news about Flyers's president, its research, or its sales is of specific interest to Flyers. We will distinguish between these two types of events because, as we will see, they have different implications.

SYSTEMATIC AND UNSYSTEMATIC RISK

systematic risk
A risk that influences a large number of assets. Also called *market risk*.

unsystematic risk
A risk that affects at most a small number of assets. Also called *unique* or *asset-specific risk*.

The first type of surprise—the one that affects many assets—we will label **systematic risk**. A systematic risk is one that influences a large number of assets, each to a greater or lesser extent. Because systematic risks have marketwide effects, they are sometimes called *market risks*.

The second type of surprise we will call **unsystematic risk**. An unsystematic risk is one that affects a single asset or a small group of assets. Because these risks are unique to individual companies or assets, they are sometimes called *unique* or *asset-specific risks*. We will use these terms interchangeably.

As we have seen, uncertainties about general economic conditions (such as GDP, interest rates, or inflation) are examples of systematic risks. These conditions affect nearly all companies to some degree. An unanticipated increase, or surprise, in inflation, for example, affects wages and the costs of the supplies that companies buy; it affects the value of the assets that companies own; and it affects the prices at which companies sell their products. Forces such as these, to which all companies are susceptible, are the essence of systematic risk.

In contrast, the announcement of an oil strike by a company will primarily affect that company and, perhaps, a few others (such as primary competitors and suppliers). It is unlikely to have much of an effect on the world oil market, or on the affairs of companies not in the oil business, so this is an unsystematic event.

SYSTEMATIC AND UNSYSTEMATIC COMPONENTS OF RETURN

The distinction between a systematic risk and an unsystematic risk is never really as exact as we make it out to be. Even the most narrow and peculiar bit of news about a company ripples through the economy. This is true because every enterprise, no matter how tiny, is a part of the economy. It's like the tale of a kingdom that was lost because one horse lost a shoe. This is mostly hairsplitting. Some risks are clearly much more general than others. We'll see some evidence on this point in just a moment.

The distinction between the types of risk allows us to break down the surprise portion, U, of the return on the Flyers stock into two parts. Earlier, we had the actual return broken down into its expected and surprise components:

$$R = \mathrm{E}(R) + U$$

We now recognize that the total surprise component for Flyers, U, has a systematic and an unsystematic component, so:

$$\boldsymbol{R = \mathrm{E}(R) + \textbf{Systematic portion} + \textbf{Unsystematic portion}}$$ 13.5

Because it is traditional, we will use the Greek letter epsilon, ϵ, to stand for the unsystematic portion. Because systematic risks are often called market risks, we will use the letter m to stand for the systematic part of the surprise. With these symbols, we can rewrite the formula for the total return:

$$\begin{aligned} R &= \mathrm{E}(R) + U \\ &= \mathrm{E}(R) + m + \epsilon \end{aligned}$$

The important thing about the way we have broken down the total surprise, U, is that the unsystematic portion, ϵ, is more or less unique to Flyers. For this reason, it is unrelated to the unsystematic portion of the return on most other assets. To see why this is important, we need to return to the subject of portfolio risk.

Concept Questions

13.4a What are the two basic types of risk?

13.4b What is the distinction between the two types of risk?

Diversification and Portfolio Risk 13.5

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We've seen earlier that portfolio risks can, in principle, be quite different from the risks of the assets that make up the portfolio. We now look more closely at the riskiness of an individual asset versus the risk of a portfolio of many different assets. We will once again examine some market history to get an idea of what happens with actual investments in U.S. capital markets.

THE EFFECT OF DIVERSIFICATION: ANOTHER LESSON FROM MARKET HISTORY

For more about risk and diversification, visit **www.investopedia.com/university**.

In our previous chapter, we saw that the standard deviation of the annual return on a portfolio of 500 large common stocks has historically been about 20 percent per year. Does this mean that the standard deviation of the annual return on a typical stock in that group of 500 is about 20 percent? As you might suspect by now, the answer is no. This is an extremely important observation.

To illustrate the relationship between portfolio size and portfolio risk, Table 13.7 illustrates typical average annual standard deviations for equally weighted portfolios that contain different numbers of randomly selected NYSE securities.

In Column 2 of Table 13.7, we see that the standard deviation for a "portfolio" of one security is about 49 percent. What this means is that if you randomly selected a single NYSE stock and put all your money into it, your standard deviation of return would typically be a substantial 49 percent per year. If you were to randomly select two stocks and invest

TABLE 13.7

Standard Deviations of Annual Portfolio Returns

(1) Number of Stocks in Portfolio	(2) Average Standard Deviation of Annual Portfolio Returns	(3) Ratio of Portfolio Standard Deviation to Standard Deviation of a Single Stock
1	49.24%	1.00
2	37.36	.76
4	29.69	.60
6	26.64	.54
8	24.98	.51
10	23.93	.49
20	21.68	.44
30	20.87	.42
40	20.46	.42
50	20.20	.41
100	19.69	.40
200	19.42	.39
300	19.34	.39
400	19.29	.39
500	19.27	.39
1,000	19.21	.39

SOURCE: These figures are from Table 1 in Statman, M., "How Many Stocks Make a Diversified Portfolio?" *Journal of Financial and Quantitative Analysis* 22, September 1987, 353–63. They were derived from Elton, E. J. and Gruber, M. J., "Risk Reduction and Portfolio Size: An Analytical Solution," *Journal of Business* 50, October 1977, 415–37.

half your money in each, your standard deviation would be about 37 percent on average, and so on.

The important thing to notice in Table 13.7 is that the standard deviation declines as the number of securities is increased. By the time we have 100 randomly chosen stocks, the portfolio's standard deviation has declined by about 60 percent, from 49 percent to about 20 percent. With 500 securities, the standard deviation is 19.27 percent, similar to the 20 percent we saw in our previous chapter for the large common stock portfolio. The small difference exists because the portfolio securities and time periods examined are not identical.

THE PRINCIPLE OF DIVERSIFICATION

Figure 13.1 illustrates the point we've been discussing. What we have plotted is the standard deviation of return versus the number of stocks in the portfolio. Notice in Figure 13.1 that the benefit in terms of risk reduction from adding securities drops off as we add more and more. By the time we have 10 securities, most of the effect is already realized; and by the time we get to 30 or so, there is little remaining benefit.

Figure 13.1 illustrates two key points. First, some of the riskiness associated with individual assets can be eliminated by forming portfolios. The process of spreading an investment across assets (and thereby forming a portfolio) is called *diversification*. The **principle of diversification** tells us that spreading an investment across many assets will eliminate some of the risk. The blue shaded area in Figure 13.1, labeled "diversifiable risk," is the part that can be eliminated by diversification.

principle of diversification
Spreading an investment across a number of assets will eliminate some, but not all, of the risk.

The second point is equally important. There is a minimum level of risk that cannot be eliminated by diversifying. This minimum level is labeled "nondiversifiable risk" in

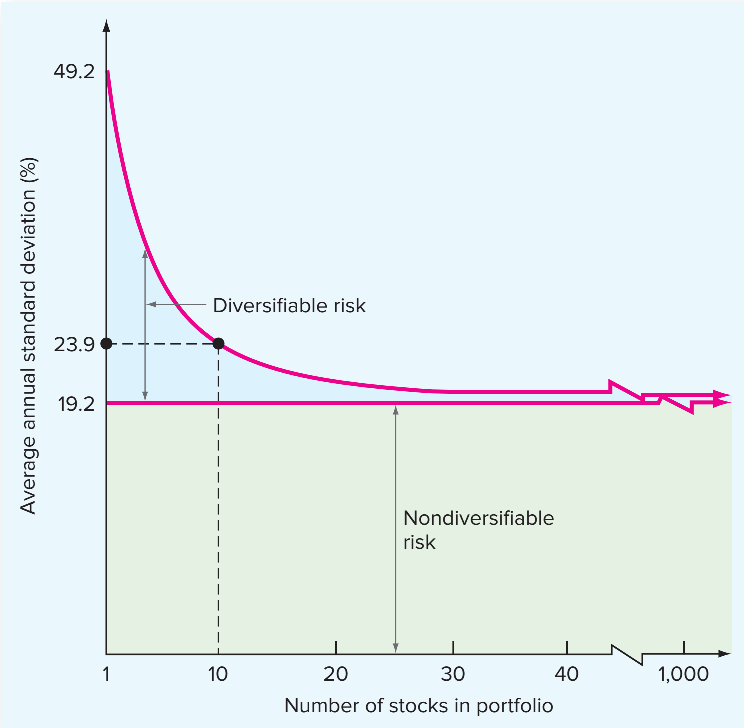

FIGURE 13.1

Portfolio Diversification

Figure 13.1. Taken together, these two points are another important lesson from capital market history: Diversification reduces risk, but only up to a point. Put another way, some risk is diversifiable and some is not.

To give a recent example of the impact of diversification, the S&P 500, which is a widely followed stock market index of 500 large, well-known U.S. stocks, was up about 12 percent in 2016. As we saw in our previous chapter, this gain represents an average year for a portfolio of large-cap stocks. The biggest individual winners for the year were Nvidia (up a whopping 224 percent), ONEOK (up 147 percent), and Freeport-McMoRan (up 95 percent). But not all 500 stocks were up: The losers included TripAdvisor (down 46 percent), Perrigo (down 42 percent), and Vertex Pharmaceuticals (down 41 percent). Again, the lesson is clear: Diversification reduces exposure to extreme outcomes, both good and bad.

DIVERSIFICATION AND UNSYSTEMATIC RISK

From our discussion of portfolio risk, we know that some of the risk associated with individual assets can be diversified away and some cannot. We are left with an obvious question: Why is this so? It turns out that the answer hinges on the distinction we made earlier between systematic and unsystematic risk.

By definition, an unsystematic risk is one that is particular to a single asset or, at most, a small group. For example, if the asset under consideration is stock in a single company, the discovery of positive NPV projects such as successful new products and innovative cost savings will tend to increase the value of the stock. Unanticipated lawsuits, industrial accidents, strikes, and similar events will tend to decrease future cash flows and thereby reduce share values.

Here is the important observation: If we held only a single stock, the value of our investment would fluctuate because of company-specific events. If we hold a large portfolio, on the other hand, some of the stocks in the portfolio will go up in value because of positive company-specific events and some will go down in value because of negative events. The net effect on the overall value of the portfolio will be relatively small because these effects will tend to cancel each other out.

Now we see why some of the variability associated with individual assets is eliminated by diversification. When we combine assets into portfolios, the unique, or unsystematic, events—both positive and negative—tend to "wash out" once we have more than just a few assets.

This is an important point that bears repeating:

Unsystematic risk is essentially eliminated by diversification, so a portfolio with many assets has almost no unsystematic risk.

In fact, the terms *diversifiable risk* and *unsystematic risk* are often used interchangeably.

DIVERSIFICATION AND SYSTEMATIC RISK

We've seen that unsystematic risk can be eliminated by diversifying. What about systematic risk? Can it also be eliminated by diversification? The answer is no because, by definition, a systematic risk affects almost all assets to some degree. As a result, no matter how many assets we put into a portfolio, the systematic risk doesn't go away. For obvious reasons, the terms *systematic risk* and *nondiversifiable risk* are used interchangeably.

Because we have introduced so many different terms, it is useful to summarize our discussion before moving on. What we have seen is that the total risk of an investment, as measured by the standard deviation of its return, can be written as:

Total risk = Systematic risk + Unsystematic risk 13.6

Systematic risk is also called *nondiversifiable risk* or *market risk*. Unsystematic risk is also called *diversifiable risk*, *unique risk*, or *asset-specific risk*. For a well-diversified portfolio, the unsystematic risk is negligible. For such a portfolio, essentially all of the risk is systematic.

Concept Questions

13.5a What happens to the standard deviation of return for a portfolio if we increase the number of securities in the portfolio?

13.5b What is the principle of diversification?

13.5c Why is some risk diversifiable? Why is some risk not diversifiable?

13.5d Why can't systematic risk be diversified away?

13.6 Systematic Risk and Beta

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The question that we now begin to address is this: What determines the size of the risk premium on a risky asset? Put another way, why do some assets have a larger risk premium than other assets? The answer to these questions, as we discuss next, is also based on the distinction between systematic and unsystematic risk.

THE SYSTEMATIC RISK PRINCIPLE

Thus far, we've seen that the total risk associated with an asset can be decomposed into two components: Systematic and unsystematic risk. We have also seen that unsystematic risk can be essentially eliminated by diversification. The systematic risk present in an asset, on the other hand, cannot be eliminated by diversification.

Based on our study of capital market history, we know that there is a reward, on average, for bearing risk. We now need to be more precise about what we mean by risk. The **systematic risk principle** states that the reward for bearing risk depends only on the systematic risk of an investment. The underlying rationale for this principle is straightforward: Because unsystematic risk can be eliminated at virtually no cost (by diversifying), there is no reward for bearing it. Put another way, the market does not reward risks that are borne unnecessarily.

systematic risk principle
The expected return on a risky asset depends only on that asset's systematic risk.

The systematic risk principle has a remarkable and very important implication:

The expected return on an asset depends only on that asset's systematic risk.

There is an obvious corollary to this principle: No matter how much total risk an asset has, only the systematic portion is relevant in determining the expected return (and the risk premium) on that asset.

For more about beta, see www.investools.com and money.msn.com.

MEASURING SYSTEMATIC RISK

Because systematic risk is the crucial determinant of an asset's expected return, we need some way of measuring the level of systematic risk for different investments. The specific measure we will use is called the **beta coefficient**, for which we will use the Greek symbol β. A beta coefficient, or beta for short, tells us how much systematic risk a particular asset has relative to an average asset. By definition, an average asset has a beta of 1.0 relative to itself. An asset with a beta of .50, therefore, has half as much systematic risk as an average asset; an asset with a beta of 2.0 has twice as much.

beta coefficient
The amount of systematic risk present in a particular risky asset relative to that in an average asset.

Table 13.8 contains the estimated beta coefficients for the stocks of some well-known companies. The range of betas in Table 13.8 is typical for stocks of large U.S. corporations. Betas outside this range occur, but they are less common.

The important thing to remember is that the expected return, and thus the risk premium, of an asset depends only on its systematic risk. Because assets with larger betas have greater systematic risks, they will have greater expected returns. From Table 13.8, an investor who buys stock in Coca-Cola, with a beta of .74, should expect to earn less, on average, than an investor who buys stock in Apple, with a beta of about 1.44.

TABLE 13.8
Beta Coefficients for Selected Companies

	Beta Coefficient (β_i)
Johnson & Johnson	.67
Coca-Cola	.74
Twitter	.85
Pfizer	.99
Tesla	1.19
Ford	1.29
Apple	1.44
CBS Corporation	1.71

SOURCE: Yahoo! Finance, 2017.

One cautionary note is in order: Not all betas are created equal. Different providers use somewhat different methods for estimating betas, and significant differences sometimes occur. As a result, it is a good idea to look at several sources. See our nearby *Work the Web* box for more about beta.

WORK THE WEB

You can find beta estimates at many sites on the web. One of the best is finance.yahoo.com. Here is a snapshot of the "Statistics" screen for Sears Holdings (SHLD), parent of Sears and K-Mart stores:

Stock Price History	
Beta	1.44
52-Week Change [3]	-52.89%
S&P500 52-Week Change [3]	20.11%
52 Week High [3]	19.12
52 Week Low [3]	8.00

Management Effectiveness	
Return on Assets (ttm)	-8.07%
Return on Equity (ttm)	N/A

Balance Sheet	
Total Cash (mrq)	258M
Total Cash Per Share (mrq)	2.41
Total Debt (mrq)	4.46B
Total Debt/Equity (mrq)	N/A
Current Ratio (mrq)	1.04
Book Value Per Share (mrq)	-22.12

The reported beta for Sears is 1.44, which means that Sears has about one and one-half times the systematic risk of a typical stock. You would expect that the company is very risky and, looking at the other numbers, we agree. Sears's ROA is negative 8.07 percent, which indicates the company lost money over the past year, but the ROE is not reported. Why? If you look at the book value per share, it is negative. In this case, the larger the loss, the larger the ROE! That's not good. Given this, Sears appears to be a good candidate for a high beta.

Questions

1. *As we mentioned, the book value per share of stock for Sears is negative. What is the current book value per share reported on this website?*
2. *What growth rate are analysts projecting for Sears? How does this growth rate compare to the industry?*

Total Risk versus Beta

EXAMPLE 13.5

Consider the following information about two securities. Which has greater total risk? Which has greater systematic risk? Greater unsystematic risk? Which asset will have a higher risk premium?

	Standard Deviation	Beta
Security A	40%	.50
Security B	20	1.50

From our discussion in this section, Security A has greater total risk, but it has substantially less systematic risk. Because total risk is the sum of systematic and unsystematic risk, Security A must have greater unsystematic risk. Finally, from the systematic risk principle, Security B will have a higher risk premium and a greater expected return, despite the fact that it has less total risk.

PORTFOLIO BETAS

Earlier, we saw that the riskiness of a portfolio has no simple relationship to the risks of the assets in the portfolio. A portfolio beta, however, can be calculated, just like a portfolio expected return. For example, looking again at Table 13.8, suppose you put half of your money in Apple and half in Coca-Cola. What would the beta of this combination be? Because Apple has a beta of 1.44 and Coca-Cola has a beta of .74, the portfolio's beta, β_P, would be:

$$\begin{aligned}\beta_P &= .50 \times \beta_{Apple} + .50 \times \beta_{Coca\text{-}Cola} \\ &= .50 \times 1.44 + .50 \times .74 \\ &= 1.09\end{aligned}$$

In general, if we had many assets in a portfolio, we would multiply each asset's beta by its portfolio weight and then add the results to get the portfolio's beta.

Portfolio Betas

EXAMPLE 13.6

Suppose we had the following investments:

Security	Amount Invested	Expected Return	Beta
Stock A	$1,000	8%	.80
Stock B	2,000	12	.95
Stock C	3,000	15	1.10
Stock D	4,000	18	1.40

What is the expected return on this portfolio? What is the beta of this portfolio? Does this portfolio have more or less systematic risk than an average asset?

To answer, we first have to calculate the portfolio weights. Notice that the total amount invested is $10,000. Of this, $1,000/10,000 = 10% is invested in Stock A. Similarly, 20 percent is invested in Stock B, 30 percent is invested in Stock C, and 40 percent is invested in Stock D. The expected return, $E(R_P)$, is:

$$\begin{aligned} E(R_P) &= .10 \times E(R_A) + .20 \times E(R_B) + .30 \times E(R_C) + .40 \times E(R_D) \\ &= .10 \times 8\% + .20 \times 12\% + .30 \times 15\% + .40 \times 18\% \\ &= 14.9\% \end{aligned}$$

Similarly, the portfolio beta, β_P, is:

$$\begin{aligned} \beta_P &= .10 \times \beta_A + .20 \times \beta_B + .30 \times \beta_C + .40 \times \beta_D \\ &= .10 \times .80 + .20 \times .95 + .30 \times 1.10 + .40 \times 1.40 \\ &= 1.16 \end{aligned}$$

This portfolio has an expected return of 14.9 percent and a beta of 1.16. Because the beta is larger than 1, this portfolio has greater systematic risk than an average asset.

Betas are easy to find on the web. Try **finance.yahoo.com** and **money.cnn.com**.

Concept Questions

13.6a What is the systematic risk principle?

13.6b What does a beta coefficient measure?

13.6c True or false: The expected return on a risky asset depends on that asset's total risk. Explain.

13.6d How do you calculate a portfolio beta?

13.7 The Security Market Line

We're now in a position to see how risk is rewarded in the marketplace. To begin, suppose that Asset A has an expected return of $E(R_A) = 20\%$ and a beta of $\beta_A = 1.6$. Furthermore, suppose that the risk-free rate is $R_f = 8\%$. Notice that a risk-free asset, by definition, has no systematic risk (or unsystematic risk), so a risk-free asset has a beta of zero.

BETA AND THE RISK PREMIUM

Consider a portfolio made up of Asset A and a risk-free asset. We can calculate some different possible portfolio expected returns and betas by varying the percentages invested in these two assets. For example, if 25 percent of the portfolio is invested in Asset A, then the expected return is:

$$\begin{aligned} E(R_P) &= .25 \times E(R_A) + (1 - .25) \times R_f \\ &= .25 \times 20\% + .75 \times 8\% \\ &= 11\% \end{aligned}$$

Similarly, the beta on the portfolio, β_P, would be:

$$\begin{aligned} \beta_P &= .25 \times \beta_A + (1 - .25) \times 0 \\ &= .25 \times 1.6 \\ &= .40 \end{aligned}$$

Notice that because the weights have to add up to 1, the percentage invested in the risk-free asset is equal to 1 minus the percentage invested in Asset A.

One thing that you might wonder about is whether it is possible for the percentage invested in Asset A to exceed 100 percent. The answer is yes. This can happen if the investor borrows at the risk-free rate. For example, suppose an investor has $100 and borrows an additional $50 at 8 percent, the risk-free rate. The total investment in Asset A would be $150, or 150 percent of the investor's wealth. The expected return in this case would be:

$$\begin{aligned} E(R_P) &= 1.50 \times E(R_A) + (1 - 1.50) \times R_f \\ &= 1.50 \times 20\% - .50 \times 8\% \\ &= 26\% \end{aligned}$$

The beta on the portfolio would be:

$$\begin{aligned} \beta_P &= 1.50 \times \beta_A + (1 - 1.50) \times 0 \\ &= 1.50 \times 1.6 \\ &= 2.4 \end{aligned}$$

We can calculate some other possibilities, as follows:

Percentage of Portfolio in Asset A	Portfolio Expected Return	Portfolio Beta
0%	8%	.0
25	11	.4
50	14	.8
75	17	1.2
100	20	1.6
125	23	2.0
150	26	2.4

In Figure 13.2A, these portfolio expected returns are plotted against the portfolio betas. Notice that all the combinations fall on a straight line.

The Reward-to-Risk Ratio What is the slope of the straight line in Figure 13.2A? As always, the slope of a straight line is equal to "the rise over the run." In this case, as we move out of the risk-free asset into Asset A, the beta increases from zero to 1.6

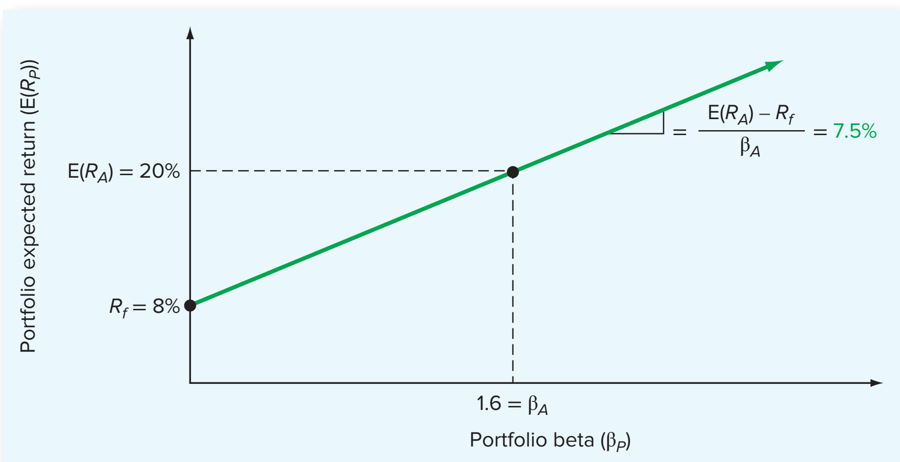


FIGURE 13.2A

Portfolio Expected Returns and Betas for Asset A

(a "run" of 1.6). At the same time, the expected return goes from 8 percent to 20 percent, a "rise" of 12 percent. The slope of the line is thus 12%/1.6 = 7.5%.

Notice that the slope of our line is the risk premium on Asset A, $E(R_A) - R_f$, divided by Asset A's beta, β_A:

$$\begin{aligned}\text{Slope} &= \frac{E(R_A) - R_f}{\beta_A}\\ &= \frac{.20 - .08}{1.6} = .075, \text{ or } 7.5\%\end{aligned}$$

What this tells us is that Asset A offers a *reward-to-risk* ratio of 7.5 percent.[2] In other words, Asset A has a risk premium of 7.5 percent per "unit" of systematic risk.

The Basic Argument Now suppose we consider a second asset, Asset B. This asset has a beta of 1.2 and an expected return of 16 percent. Which investment is better, Asset A or Asset B? You might think that, once again, we really cannot say—some investors might prefer A; some investors might prefer B. Actually, we can say: A is better because, as we will demonstrate, B offers inadequate compensation for its level of systematic risk, at least, relative to A.

To begin, we calculate different combinations of expected returns and betas for portfolios of Asset B and a risk-free asset, just as we did for Asset A. For example, if we put 25 percent in Asset B and the remaining 75 percent in the risk-free asset, the portfolio's expected return will be:

$$\begin{aligned}E(R_P) &= .25 \times E(R_B) + (1 - .25) \times R_f\\ &= .25 \times 16\% + .75 \times 8\%\\ &= 10\%\end{aligned}$$

Similarly, the beta on the portfolio, β_P, will be:

$$\begin{aligned}\beta_P &= .25 \times \beta_B + (1 - .25) \times 0\\ &= .25 \times 1.2\\ &= .30\end{aligned}$$

Some other possibilities are as follows:

Percentage of Portfolio in Asset B	Portfolio Expected Return	Portfolio Beta
0%	8%	.0
25	10	.3
50	12	.6
75	14	.9
100	16	1.2
125	18	1.5
150	20	1.8

When we plot these combinations of portfolio expected returns and portfolio betas in Figure 13.2B, we get a straight line as we did for Asset A.

[2]This ratio is sometimes called the *Treynor index*, after one of its originators.

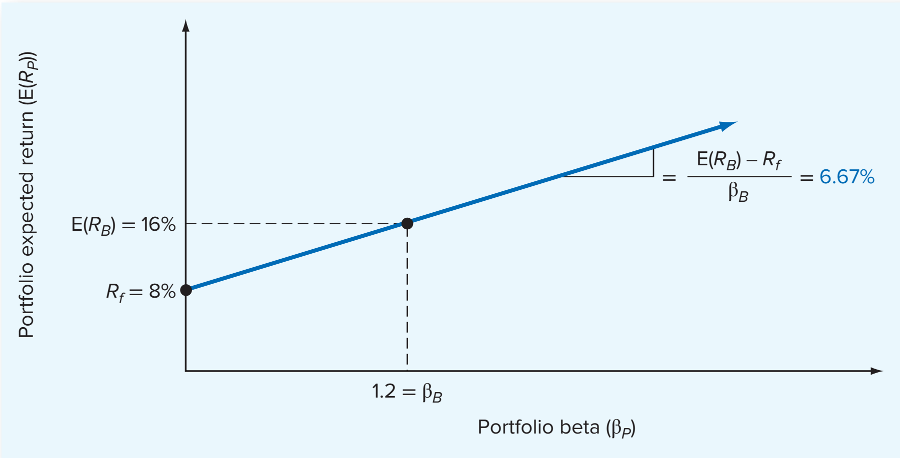


FIGURE 13.2B

Portfolio Expected Returns and Betas for Asset B

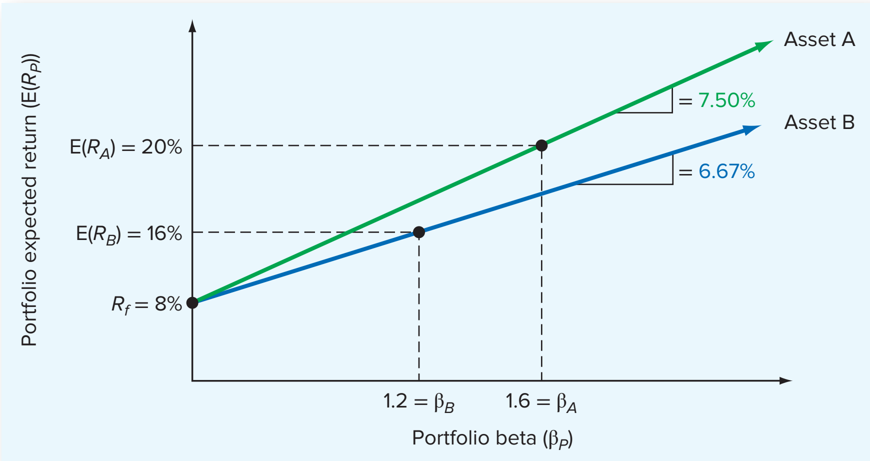


FIGURE 13.2C

Portfolio Expected Returns and Betas for Both Assets

The key thing to notice is that when we compare the results for Assets A and B, as in Figure 13.2C, the line describing the combinations of expected returns and betas for Asset A is higher than the one for Asset B. This tells us that for any given level of systematic risk (as measured by β), some combination of Asset A and the risk-free asset always offers a larger return. This is why we were able to state that Asset A is a better investment than Asset B.

Another way of seeing that A offers a superior return for its level of risk is to note that the slope of our line for Asset B is:

$$\text{Slope} = \frac{E(R_B) - R_f}{\beta_B}$$

$$= \frac{.16 - .08}{1.2} = .0667, \text{ or } 6.67\%$$

Asset B has a reward-to-risk ratio of 6.67 percent, which is less than the 7.5 percent offered by Asset A.

The Fundamental Result The situation we have described for Assets A and B could not persist in a well-organized, active market, because investors would be attracted to Asset A and away from Asset B. As a result, Asset A's price would rise and Asset B's price would fall. Because prices and returns move in opposite directions, A's expected return would decline and B's would rise.

This buying and selling would continue until the two assets plotted on exactly the same line, which means they would offer the same reward for bearing risk. In other words, in an active, competitive market, we must have the situation that:

$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_B) - R_f}{\beta_B}$$

This is the fundamental relationship between risk and return.

Our basic argument can be extended to more than just two assets. In fact, no matter how many assets we have, we will always reach the same conclusion:

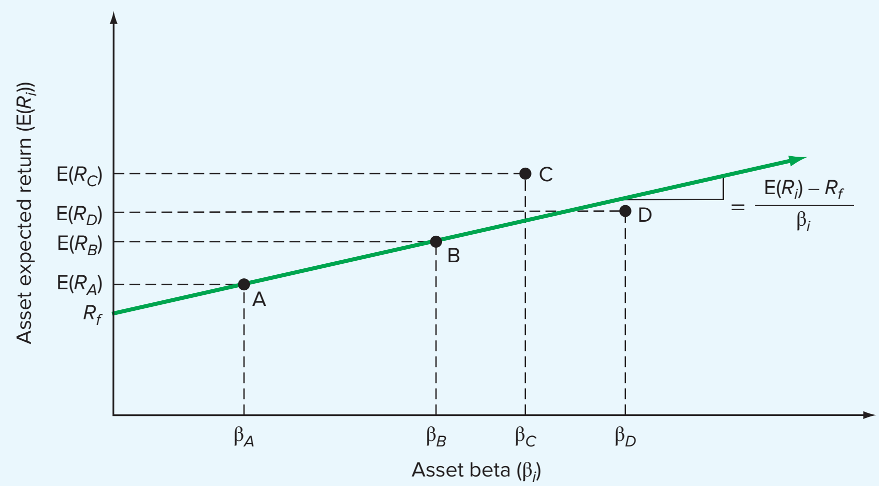
The reward-to-risk ratio must be the same for all the assets in the market.

This result is really not so surprising. What it says is that, for example, if one asset has twice as much systematic risk as another asset, its risk premium will be twice as large.

Because all of the assets in the market must have the same reward-to-risk ratio, they all must plot on the same line. This argument is illustrated in Figure 13.3. As shown, Assets A and B plot directly on the line and have the same reward-to-risk ratio. If an asset plotted above the line, such as C in Figure 13.3, its price would rise and its expected return would fall until it plotted exactly on the line. Similarly, if an asset plotted below the line, such as D in Figure 13.3, its expected return would rise until it too plotted directly on the line. As an aside, it is common to refer to the vertical distance between an asset's expected return and the SML as the asset's "alpha."

FIGURE 13.3

Expected Returns and Systematic Risk



The fundamental relationship between beta and expected return is that all assets must have the same reward-to-risk ratio, $[E(R_i) - R_f]/\beta_i$. This means that they would all plot on the same straight line. Assets A and B are examples of this behavior. Asset C's expected return is too high; Asset D's is too low.

The arguments we have presented apply to active, competitive, well-functioning markets. The financial markets, such as the NYSE, best meet these criteria. Other markets, such as real asset markets, may or may not meet these criteria. For this reason, these concepts are most useful in examining financial markets. We will focus on such markets here. As we discuss in a later section, the information about risk and return gleaned from financial markets is crucial in evaluating the investments that a corporation makes in real assets.

Buy Low, Sell High — EXAMPLE 13.7

An asset is said to be *overvalued* if its price is too high given its expected return and risk. Suppose you observe the following situation:

Security	Beta	Expected Return
SWMS Co.	1.3	14%
Insec Co.	.8	10

The risk-free rate is currently 6 percent. Is one of the two securities overvalued relative to the other?

To answer, we compute the reward-to-risk ratio for both. For SWMS, this ratio is (14% − 6)/1.3 = 6.15%. For Insec, this ratio is 5 percent. What we conclude is that Insec offers an insufficient expected return for its level of risk, at least relative to SWMS. Because its expected return is too low, its price is too high. In other words, Insec is overvalued relative to SWMS, and we would expect to see its price fall relative to SWMS's. Notice that we could also say SWMS is undervalued relative to Insec.

THE SECURITY MARKET LINE

The line that results when we plot expected returns and beta coefficients is obviously of some importance, so it's time we gave it a name. This line, which we use to describe the relationship between systematic risk and expected return in financial markets, is usually called the **security market line (SML)**. After NPV, the SML is arguably the most important concept in modern finance.

security market line (SML)
A positively sloped straight line displaying the relationship between expected return and beta.

Market Portfolios It will be very useful to know the equation of the SML. There are many different ways we could write it, but one way is particularly common. Suppose we consider a portfolio made up of all of the assets in the market. Such a portfolio is called a market portfolio, and we will express the expected return on this market portfolio as $E(R_M)$.

Because all the assets in the market must plot on the SML, so must a market portfolio made up of those assets. To determine where it plots on the SML, we need to know the beta of the market portfolio, β_M. Because this portfolio is representative of all of the assets in the market, it must have average systematic risk. In other words, it has a beta of 1. We could express the slope of the SML as:

$$\text{SML slope} = \frac{E(R_M) - R_f}{\beta_M} = \frac{E(R_M) - R_f}{1} = E(R_M) - R_f$$

The term $E(R_M) - R_f$ is often called the **market risk premium** because it is the risk premium on a market portfolio.

market risk premium
The slope of the SML, which is the difference between the expected return on a market portfolio and the risk-free rate.

The Capital Asset Pricing Model To finish up, if we let $E(R_i)$ and β_i stand for the expected return and beta, respectively, on any asset in the market, then we know that asset must plot on the SML. As a result, we know that its reward-to-risk ratio is the same as the overall market's:

$$\frac{E(R_i) - R_f}{\beta_i} = E(R_M) - R_f$$

If we rearrange this, then we can write the equation for the SML as:

$$\mathbf{E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i} \qquad \mathbf{13.7}$$

capital asset pricing model (CAPM)
The equation of the SML showing the relationship between expected return and beta.

This result is the famous **capital asset pricing model (CAPM)**.

The CAPM shows that the expected return for a particular asset depends on three things:

1. *The pure time value of money*: As measured by the risk-free rate, R_f, this is the reward for merely waiting for your money, without taking any risk.
2. *The reward for bearing systematic risk*: As measured by the market risk premium, $E(R_M) - R_f$, this component is the reward the market offers for bearing an average amount of systematic risk in addition to waiting.
3. *The amount of systematic risk*: As measured by β_i, this is the amount of systematic risk present in a particular asset or portfolio, relative to that in an average asset.

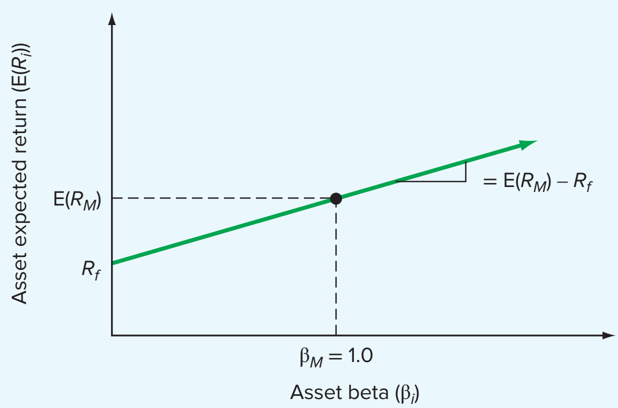
By the way, the CAPM works for portfolios of assets just as it does for individual assets. In an earlier section, we saw how to calculate a portfolio's β. To find the expected return on a portfolio, we use this β in the CAPM equation.

Figure 13.4 summarizes our discussion of the SML and the CAPM. As before, we plot expected return against beta. Now we recognize that, based on the CAPM, the slope of the SML is equal to the market risk premium, $E(R_M) - R_f$.

This concludes our presentation of concepts related to the risk–return trade-off. For future reference, Table 13.9 summarizes the various concepts in the order in which we discussed them.

FIGURE 13.4

The Security Market Line (SML)



The slope of the security market line is equal to the market risk premium—that is, the reward for bearing an average amount of systematic risk. The equation describing the SML can be written:

$$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$$

which is the capital asset pricing model (CAPM).

Risk and Return

EXAMPLE 13.8

Suppose the risk-free rate is 4 percent, the market risk premium is 8.6 percent, and a particular stock has a beta of 1.3. Based on the CAPM, what is the expected return on this stock? What would the expected return be if the beta were to double?

With a beta of 1.3, the risk premium for the stock is 1.3 × 8.6%, or 11.18 percent. The risk-free rate is 4 percent, so the expected return is 15.18 percent. If the beta were to double to 2.6, the risk premium would double to 22.36 percent, so the expected return would be 26.36 percent.

TABLE 13.9

Summary of Risk and Return

I.	**Total Risk**
	The *total risk* of an investment is measured by the variance or, more commonly, the standard deviation of its return.
II.	**Total Return**
	The *total return* on an investment has two components: The expected return and the unexpected return. The unexpected return comes about because of unanticipated events. The risk from investing stems from the possibility of an unanticipated event.
III.	**Systematic and Unsystematic Risks**
	Systematic risks (also called *market risks*) are unanticipated events that affect almost all assets to some degree because the effects are economy-wide. *Unsystematic risks* are unanticipated events that affect single assets or small groups of assets. Unsystematic risks are also called *unique* or *asset-specific risks*.
IV.	**The Effect of Diversification**
	Some, but not all, of the risk associated with a risky investment can be eliminated by diversification. The reason is that unsystematic risks, which are unique to individual assets, tend to wash out in a large portfolio, but systematic risks, which affect all of the assets in a portfolio to some extent, do not.
V.	**The Systematic Risk Principle and Beta**
	Because unsystematic risk can be freely eliminated by diversification, the *systematic risk principle* states that the reward for bearing risk depends only on the level of systematic risk. The level of systematic risk in a particular asset, relative to the average, is given by the beta of that asset.
VI.	**The Reward-to-Risk Ratio and the Security Market Line**
	The *reward-to-risk ratio* for Asset *i* is the ratio of its risk premium, $E(R_i) - R_f$, to its beta, β_i: $\frac{E(R_i) - R_f}{\beta_i}$ In a well-functioning market, this ratio is the same for every asset. As a result, when asset expected returns are plotted against asset betas, all assets plot on the same straight line, called the *security market line* (SML).
VII.	**The Capital Asset Pricing Model**
	From the SML, the expected return on Asset *i* can be written: $E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$ This is the *capital asset pricing model* (CAPM). The expected return on a risky asset has three components. The first is the pure time value of money (R_f), the second is the market risk premium $[E(R_M) - R_f]$, and the third is the beta for that asset (β_i).

Concept Questions

13.7a What is the fundamental relationship between risk and return in well-functioning markets?

13.7b What is the security market line? Why must all assets plot directly on the SML in a well-functioning market?

13.7c What is the capital asset pricing model (CAPM)? What does it tell us about the required return on a risky investment?

13.8 The SML and the Cost of Capital: A Preview

Our goal in studying risk and return is twofold. First, risk is an extremely important consideration in almost all business decisions, so we want to discuss what risk is and how it is rewarded in the market. Our second purpose is to learn what determines the appropriate discount rate for future cash flows. We briefly discuss this second subject now; we will discuss it in more detail in a subsequent chapter.

THE BASIC IDEA

The security market line tells us the reward for bearing risk in financial markets. At an absolute minimum, any new investment our firm undertakes must offer an expected return that is no worse than what the financial markets offer for the same risk. The reason for this is that our shareholders can always invest for themselves in the financial markets.

The only way we benefit our shareholders is by finding investments with expected returns that are superior to what the financial markets offer for the same risk. Such an investment will have a positive NPV. So, if we ask, "What is the appropriate discount rate?" the answer is that we should use the expected return offered in financial markets on investments with the same systematic risk.

In other words, to determine whether an investment has a positive NPV, we essentially compare the expected return on that new investment to what the financial market offers on an investment with the same beta. This is why the SML is so important: It tells us the "going rate" for bearing risk in the economy.

THE COST OF CAPITAL

cost of capital
The minimum required return on a new investment.

The appropriate discount rate on a new project is the minimum expected rate of return an investment must offer to be attractive. This minimum required return is often called the **cost of capital** associated with the investment. It is called this because the required return is what the firm must earn on its capital investment in a project just to break even. It can be interpreted as the opportunity cost associated with the firm's capital investment.

Notice that when we say an investment is attractive if its expected return exceeds what is offered in financial markets for investments of the same risk, we are effectively using the internal rate of return (IRR) criterion that we developed and discussed in Chapter 9. The only difference is that now we have a much better idea of what determines the required return on an investment. This understanding will be critical when we discuss cost of capital and capital structure in Part 6 of our book.

Concept Questions

13.8a If an investment has a positive NPV, would it plot above or below the SML? Why?

13.8b What is meant by the term *cost of capital*?

Summary and Conclusions 13.9

This chapter has covered the essentials of risk. Along the way, we have introduced a number of definitions and concepts. The most important of these is the security market line, or SML. The SML is important because it tells us the reward offered in financial markets for bearing risk. Once we know this, we have a benchmark against which we can compare the returns expected from real asset investments to determine if they are desirable.

Because we have covered quite a bit of ground, it's useful to summarize the basic economic logic underlying the SML as follows:

1. Based on capital market history, there is a reward for bearing risk. This reward is the risk premium on an asset.
2. The total risk associated with an asset has two parts: Systematic risk and unsystematic risk. Unsystematic risk can be freely eliminated by diversification (this is the principle of diversification), so only systematic risk is rewarded. As a result, the risk premium on an asset is determined by its systematic risk. This is the systematic risk principle.
3. An asset's systematic risk, relative to the average, can be measured by its beta coefficient, β_i. The risk premium on an asset is then given by its beta coefficient multiplied by the market risk premium, $[E(R_M) - R_f] \times \beta_i$.
4. The expected return on an asset, $E(R_i)$, is equal to the risk-free rate, R_f, plus the risk premium:

   $$E(R_i) = R_f + [E(R_M) - R_f] \times \beta_i$$

   This is the equation of the SML, and it is often called the capital asset pricing model (CAPM).

This chapter completes our discussion of risk and return. Now that we have a better understanding of what determines a firm's cost of capital for an investment, the next several chapters will examine more closely how firms raise the long-term capital needed for investment.

CONNECT TO FINANCE

Connect Finance offers you plenty of opportunities to practice mastering these concepts. Log on to connect.mheducation.com to learn more. If you like what you see, ask your professor about using *Connect Finance*!

Can you answer the following *Connect* Quiz questions?

Section 13.1 A stock is expected to earn 15 percent in a boom economy and 7 percent in a normal economy. There is a 35 percent chance the economy will boom and a 65 percent chance the economy will be normal. What is the standard deviation of these returns?

Section 13.5 Which type of risk can be eliminated through diversification?

Section 13.6 Beta is a measure of what?

Section 13.7 The slope of the security market line is equal to what?

Section 13.8 Where would a negative net present value project appear on a security market line graph?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

13.1 Expected Return and Standard Deviation This problem will give you some practice calculating measures of prospective portfolio performance. There are two assets and three states of the economy:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs	
		Stock A	Stock B
Recession	.20	−.15	.20
Normal	.50	.20	.30
Boom	.30	.60	.40

What are the expected returns and standard deviations for these two stocks?

13.2 Portfolio Risk and Return Using the information in the previous problem, suppose you have \$20,000 total. If you put \$15,000 in Stock A and the remainder in Stock B, what will be the expected return and standard deviation of your portfolio?

13.3 Risk and Return Suppose you observe the following situation:

Security	Beta	Expected Return
Cooley, Inc.	1.8	22.00%
Moyer Co.	1.6	20.44

If the risk-free rate is 7 percent, are these securities correctly priced? What would the risk-free rate have to be if they are correctly priced?

13.4 CAPM Suppose the risk-free rate is 8 percent. The expected return on the market is 16 percent. If a particular stock has a beta of .7, what is its expected return based on the CAPM? If another stock has an expected return of 24 percent, what must its beta be?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

13.1 The expected returns are just the possible returns multiplied by the associated probabilities:

$$E(R_A) = (.20 \times -.15) + (.50 \times .20) + (.30 \times .60) = .25\text{, or } 25\%$$

$$E(R_B) = (.20 \times .20) + (.50 \times .30) + (.30 \times .40) = .31\text{, or } 31\%$$

The variances are given by the sums of the squared deviations from the expected returns multiplied by their probabilities:

$$\begin{aligned}\sigma_A^2 &= .20 \times (-.15 - .25)^2 + .50 \times (.20 - .25)^2 + .30 \times (.60 - .25)^2\\ &= (.20 \times -.40^2) + (.50 \times -.05^2) + (.30 \times .35^2)\\ &= (.20 \times .16) + (.50 \times .0025) + (.30 \times .1225)\\ &= .0700\end{aligned}$$

$$\begin{aligned}\sigma_B^2 &= .20 \times (.20 - .31)^2 + .50 \times (.30 - .31)^2 + .30 \times (.40 - .31)^2\\ &= (.20 \times -.11^2) + (.50 \times -.01^2) + (.30 \times .09^2)\\ &= (.20 \times .0121) + (.50 \times .0001) + (.30 \times .0081)\\ &= .0049\end{aligned}$$

The standard deviations are thus:

$$\sigma_A = \sqrt{.0700} = .2646, \text{ or } 26.46\%$$

$$\sigma_B = \sqrt{.0049} = .07, \text{ or } 7\%$$

13.2 The portfolio weights are \$15,000/\$20,000 = .75 and \$5,000/\$20,000 = .25. The expected return is thus:

$$\begin{aligned}E(R_P) &= .75 \times E(R_A) + .25 \times E(R_B)\\ &= (.75 \times .25) + (.25 \times .31)\\ &= .265, \text{ or } 26.5\%\end{aligned}$$

Alternatively, we could calculate the portfolio's return in each of the states:

State of Economy	Probability of State of Economy	Portfolio Return If State Occurs
Recession	.20	(.75 × −.15) + (.25 × .20) = −.0625
Normal	.50	(.75 × .20) + (.25 × .30) = .2250
Boom	.30	(.75 × .60) + (.25 × .40) = .5500

The portfolio's expected return is:

$$E(R_P) = (.20 \times -.0625) + (.50 \times .2250) + (.30 \times .5500) = .265, \text{ or } 26.5\%$$

This is the same as we had before.

The portfolio's variance is:

$$\begin{aligned}\sigma_P^2 &= .20 \times (-.0625 - .265)^2 + .50 \times (.225 - .265)^2\\ &\quad + .30 \times (.55 - .265)^2\\ &= .0466\end{aligned}$$

So the standard deviation is $\sqrt{.0466}$ = .2159, or 21.59%.

13.3 If we compute the reward-to-risk ratios, we get (.22 − .07)/1.8 = .0833, or 8.33% for Cooley versus 8.4% for Moyer. Relative to that of Cooley, Moyer's expected return is too high, so its price is too low. If they are correctly priced, then they must offer the same reward-to-risk ratio. The risk-free rate would have to be such that:

$$(.22 - R_f)/1.8 = (.2044 - R_f)/1.6$$

With a little algebra, we find that the risk-free rate must be 8 percent:

$$\begin{aligned}.2\% - R_f &= (.2044 - R_f)(1.8/1.6)\\ .22 - .2044 \times 1.125 &= R_f - R_f \times 1.125\\ R_f &= .08, \text{ or } 8\%\end{aligned}$$

13.4 Because the expected return on the market is 16 percent, the market risk premium is $.16 - .08 = .08$, or 8%. The first stock has a beta of .7, so its expected return is $.08 + .7 \times .08 = .136$, or 13.6%.

For the second stock, notice that the risk premium is $.24\% - .08 = .16$, or 16%. Because this is twice as large as the market risk premium, the beta must be exactly equal to 2. We can verify this using the CAPM:

$$\begin{aligned} E(R_i) &= R_f + [E(R_M) - R_f] \times \beta_i \\ .24 &= .08 + (.16 - .08) \times \beta_i \\ \beta_i &= .16/.08 \\ &= 2.0 \end{aligned}$$

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Diversifiable and Nondiversifiable Risks** [LO3] In broad terms, why are some risks diversifiable? Why are some risks nondiversifiable? Does it follow that an investor can control the level of unsystematic risk in a portfolio, but not the level of systematic risk?
2. **Information and Market Returns** [LO3] Suppose the government announces that, based on a just-completed survey, the growth rate in the economy is likely to be 2 percent in the coming year, as compared to 5 percent for the past year. Will security prices increase, decrease, or stay the same following this announcement? Does it make any difference whether the 2 percent figure was anticipated by the market? Explain.
3. **Systematic versus Unsystematic Risk** [LO3] Classify the following events as mostly systematic or mostly unsystematic. Is the distinction clear in every case?
   - **a.** Short-term interest rates increase unexpectedly.
   - **b.** The interest rate a company pays on its short-term debt borrowing is increased by its bank.
   - **c.** Oil prices unexpectedly decline.
   - **d.** An oil tanker ruptures, creating a large oil spill.
   - **e.** A manufacturer loses a multimillion-dollar product liability suit.
   - **f.** A Supreme Court decision substantially broadens producer liability for injuries suffered by product users.
4. **Systematic versus Unsystematic Risk** [LO3] Indicate whether the following events might cause stocks in general to change price, and whether they might cause Big Widget Corp.'s stock to change price:
   - **a.** The government announces that inflation unexpectedly jumped by 2 percent last month.
   - **b.** Big Widget's quarterly earnings report, just issued, generally fell in line with analysts' expectations.
   - **c.** The government reports that economic growth last year was at 3 percent, which generally agreed with most economists' forecasts.
   - **d.** The directors of Big Widget die in a plane crash.
   - **e.** Congress approves changes to the tax code that will increase the top marginal corporate tax rate. The legislation had been debated for the previous six months.

5. **Expected Portfolio Returns [LO1]** If a portfolio has a positive investment in every asset, can the expected return on the portfolio be greater than that on every asset in the portfolio? Can it be less than that on every asset in the portfolio? If you answer yes to one or both of these questions, give an example to support your answer.
6. **Diversification [LO2]** True or false: The most important characteristic in determining the expected return of a well-diversified portfolio is the variance of the individual assets in the portfolio. Explain.
7. **Portfolio Risk [LO2]** If a portfolio has a positive investment in every asset, can the standard deviation on the portfolio be less than that on every asset in the portfolio? What about the portfolio beta?
8. **Beta and CAPM [LO4]** Is it possible that a risky asset could have a beta of zero? Explain. Based on the CAPM, what is the expected return on such an asset? Is it possible that a risky asset could have a negative beta? What does the CAPM predict about the expected return on such an asset? Can you give an explanation for your answer?
9. **Alpha [LO4]** In our discussion of the SML, we defined alpha. What does alpha measure? What alpha would you like to see on your investments?
10. **Alpha [LO4]** Common advice on Wall Street is "Keep your alpha high and your beta low." Why?
11. **Corporate Downsizing [LO1]** In recent years, it has been common for companies to experience significant stock price changes in reaction to announcements of massive layoffs. Critics charge that such events encourage companies to fire long-time employees and that Wall Street is cheering them on. Do you agree or disagree?
12. **Earnings and Stock Returns [LO1]** As indicated by a number of examples in this chapter, earnings announcements by companies are closely followed by, and frequently result in, share price revisions. Two issues should come to mind. First, earnings announcements concern past periods. If the market values stocks based on expectations of the future, why are numbers summarizing past performance relevant? Second, these announcements concern accounting earnings. Going back to Chapter 2, such earnings may have little to do with cash flow—so, again, why are they relevant?

QUESTIONS AND PROBLEMS

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BASIC
(Questions 1–19)

1. **Determining Portfolio Weights [LO1]** What are the portfolio weights for a portfolio that has 115 shares of Stock A that sell for $43 per share and 180 shares of Stock B that sell for $19 per share?
2. **Portfolio Expected Return [LO1]** You own a portfolio that has $3,480 invested in Stock A and $7,430 invested in Stock B. If the expected returns on these stocks are 8 percent and 11 percent, respectively, what is the expected return on the portfolio?
3. **Portfolio Expected Return [LO1]** You own a portfolio that is invested 35 percent in Stock X, 20 percent in Stock Y, and 45 percent in Stock Z. The expected returns on these three stocks are 9 percent, 15 percent, and 12 percent, respectively. What is the expected return on the portfolio?
4. **Portfolio Expected Return [LO1]** You have $10,000 to invest in a stock portfolio. Your choices are Stock X with an expected return of 12.1 percent and Stock Y with

an expected return of 9.8 percent. If your goal is to create a portfolio with an expected return of 10.85 percent, how much money will you invest in Stock X? In Stock Y?

5. **Calculating Expected Return [LO1]** Based on the following information, calculate the expected return:

State of Economy	Probability of State of Economy	Portfolio Return If State Occurs
Recession	.20	−.08
Boom	.80	.15

6. **Calculating Expected Return [LO1]** Based on the following information, calculate the expected return:

State of Economy	Probability of State of Economy	Portfolio Return If State Occurs
Recession	.10	−.15
Normal	.60	.09
Boom	.30	.23

7. **Calculating Returns and Standard Deviations [LO1]** Based on the following information, calculate the expected return and standard deviation for Stock A and Stock B:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs	
		Stock A	Stock B
Recession	.10	.04	−.17
Normal	.60	.09	.12
Boom	.30	.17	.27

8. **Calculating Expected Returns [LO1]** A portfolio is invested 25 percent in Stock G, 55 percent in Stock J, and 20 percent in Stock K. The expected returns on these stocks are 11 percent, 9 percent, and 15 percent, respectively. What is the portfolio's expected return? How do you interpret your answer?

9. **Returns and Variances [LO1]** Consider the following information:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs		
		Stock A	Stock B	Stock C
Boom	.75	.08	.17	.24
Bust	.25	.11	−.05	−.08

a. What is the expected return on an equally weighted portfolio of these three stocks?

b. What is the variance of a portfolio invested 20 percent each in A and B and 60 percent in C?

10. **Returns and Standard Deviations [LO1]** Consider the following information:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs		
		Stock A	Stock B	Stock C
Boom	.10	.35	.40	.27
Good	.60	.16	.17	.08
Poor	.25	−.01	−.03	−.04
Bust	.05	−.12	−.18	−.09

a. Your portfolio is invested 30 percent each in A and C, and 40 percent in B. What is the expected return of the portfolio?

b. What is the variance of this portfolio? The standard deviation?

11. Calculating Portfolio Betas [LO4] You own a stock portfolio invested 20 percent in Stock Q, 30 percent in Stock R, 35 percent in Stock S, and 15 percent in Stock T. The betas for these four stocks are .79, 1.23, 1.13, and 1.36, respectively. What is the portfolio beta?

12. Calculating Portfolio Betas [LO4] You own a portfolio equally invested in a risk-free asset and two stocks. If one of the stocks has a beta of 1.17 and the total portfolio is equally as risky as the market, what must the beta be for the other stock in your portfolio?

13. Using CAPM [LO4] A stock has a beta of 1.15, the expected return on the market is 10.3 percent, and the risk-free rate is 3.1 percent. What must the expected return on this stock be?

14. Using CAPM [LO4] A stock has an expected return of 10.2 percent, the risk-free rate is 3.9 percent, and the market risk premium is 7.2 percent. What must the beta of this stock be?

15. Using CAPM [LO4] A stock has an expected return of 10.45 percent, its beta is .93, and the risk-free rate is 3.6 percent. What must the expected return on the market be?

16. Using CAPM [LO4] A stock has an expected return of 11.85 percent, its beta is 1.24, and the expected return on the market is 10.2 percent. What must the risk-free rate be?

17. Using the SML [LO4] Asset W has an expected return of 11.8 percent and a beta of 1.10. If the risk-free rate is 3.3 percent, complete the following table for portfolios of Asset W and a risk-free asset. Illustrate the relationship between portfolio expected return and portfolio beta by plotting the expected returns against the betas. What is the slope of the line that results?

Percentage of Portfolio in Asset W	Portfolio Expected Return	Portfolio Beta
0%		
25		
50		
75		
100		
125		
150		

18. Reward-to-Risk Ratios [LO4] Stock Y has a beta of 1.2 and an expected return of 11.1 percent. Stock Z has a beta of .80 and an expected return of 7.85 percent. If the risk-free rate is 2.4 percent and the market risk premium is 7.2 percent, are these stocks correctly priced?

19. Reward-to-Risk Ratios [LO4] In the previous problem, what would the risk-free rate have to be for the two stocks to be correctly priced?

INTERMEDIATE
(Questions 20–24)

20. Using CAPM [LO4] A stock has a beta of 1.12 and an expected return of 10.8 percent. A risk-free asset currently earns 2.7 percent.

a. What is the expected return on a portfolio that is equally invested in the two assets?

b. If a portfolio of the two assets has a beta of .92, what are the portfolio weights?

c. If a portfolio of the two assets has an expected return of 9 percent, what is its beta?

d. If a portfolio of the two assets has a beta of 2.24, what are the portfolio weights? How do you interpret the weights for the two assets in this case? Explain.

21. **Portfolio Returns [LO2]** Using information from the previous chapter on capital market history, determine the return on a portfolio that is equally invested in large-company stocks and long-term government bonds. What is the return on a portfolio that is equally invested in small-company stocks and Treasury bills?

22. **CAPM [LO4]** Using the CAPM, show that the ratio of the risk premiums on two assets is equal to the ratio of their betas.

23. **Portfolio Returns and Deviations [LO2]** Consider the following information about three stocks:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs		
		Stock A	Stock B	Stock C
Boom	.25	.21	.33	.55
Normal	.60	.17	.11	.09
Bust	.15	.00	−.21	−.45

a. If your portfolio is invested 40 percent each in A and B and 20 percent in C, what is the portfolio expected return? The variance? The standard deviation?

b. If the expected T-bill rate is 3.80 percent, what is the expected risk premium on the portfolio?

c. If the expected inflation rate is 3.30 percent, what are the approximate and exact expected real returns on the portfolio? What are the approximate and exact expected real risk premiums on the portfolio?

24. **Analyzing a Portfolio [LO2, 4]** You want to create a portfolio equally as risky as the market, and you have $1,000,000 to invest. Given this information, fill in the rest of the following table:

Asset	Investment	Beta
Stock A	$165,000	.80
Stock B	$350,000	1.09
Stock C		1.27
Risk-free asset		

CHALLENGE
(Questions 25–28)

25. **Analyzing a Portfolio [LO2, 4]** You have $100,000 to invest in a portfolio containing Stock X and Stock Y. Your goal is to create a portfolio that has an expected return of 12.7 percent. If Stock X has an expected return of 11.4 percent and a beta of 1.25, and Stock Y has an expected return of 8.68 percent and a beta of .85, how much money will you invest in Stock Y? How do you interpret your answer? What is the beta of your portfolio?

26. **Systematic versus Unsystematic Risk [LO3]** Consider the following information about Stocks I and II:

State of Economy	Probability of State of Economy	Rate of Return If State Occurs	
		Stock I	Stock II
Recession	.15	.03	−.23
Normal	.70	.20	.09
Irrational exuberance	.15	.08	.43

The market risk premium is 7 percent, and the risk-free rate is 3.5 percent. Which stock has the most systematic risk? Which one has the most unsystematic risk? Which stock is "riskier"? Explain.

27. **SML [LO4]** Suppose you observe the following situation:

Security	Beta	Expected Return
Pete Corp.	1.25	.1323
Repete Co.	.87	.0967

Assume these securities are correctly priced. Based on the CAPM, what is the expected return on the market? What is the risk-free rate?

28. **SML [LO4]** Suppose you observe the following situation:

		Return If State Occurs	
State of Economy	Probability of State of Economy	Stock A	Stock B
Bust	.15	−.08	−.10
Normal	.60	.11	.09
Boom	.25	.30	.27

a. Calculate the expected return on each stock.

b. Assuming the capital asset pricing model holds and Stock A's beta is greater than Stock B's beta by .35, what is the expected market risk premium?

EXCEL MASTER IT! PROBLEM

The CAPM is one of the most thoroughly researched models in financial economics. When beta is estimated in practice, a variation of CAPM called the market model is often used. To derive the market model, we start with the CAPM:

$$E(R_i) = R_f + \beta[E(R_M) - R_f]$$

Since CAPM is an equation, we can subtract the risk-free rate from both sides, which gives us:

$$E(R_i) - R_f = \beta[E(R_M) - R_f]$$

This equation is deterministic, by which we mean it is exact. In a regression, we realize that there is some indeterminate error. We need to formally recognize this in the equation by adding epsilon, ε, which represents this error:

$$E(R_i) - R_f = \beta[E(R_M) - R_f] + \varepsilon$$

Finally, think of the above equation in a regression. Since there is no intercept in the equation, the intercept is zero. However, when we estimate the regression equation, we can add an intercept term, which we will call alpha:

$$E(R_i) - R_f = \alpha_i + \beta[E(R_M) - R_f] + \varepsilon$$

This equation is often called the "market" model, though it is not the only equation with that name, which is a source of confusion. The intercept term is known as Jensen's alpha, and it represents the "excess" return. If CAPM holds exactly, this intercept should be zero.

If you think of alpha in terms of the SML, then if the alpha is positive, the stock plots above the SML, and if alpha is negative, the stock plots below the SML.

a. You want to estimate the market model for an individual stock and a mutual fund. First, go to finance.yahoo.com and download the adjusted prices for the last 61 months for an individual stock, a mutual fund, and the S&P 500. Next, go to the St. Louis Federal Reserve website at www.stlouisfed.org. You should find the FRED® database there. Look for the 1-Month Treasury Constant Maturity Rate and download this data. This series will be the proxy for the risk-free rate. When using this rate, you should be aware that this interest rate is the annualized interest rate. Since we are using monthly stock returns, you will need to adjust the 1-month T-bill rate. For the stock and mutual fund you select, estimate the beta and alpha using the market model. When you estimate the regression model, find the box that says "Residuals" and check this box when you do each regression. Because you are saving the residuals, you may want to save the regression output in a new worksheet.

1. Are the alpha and beta for each regression statistically different from zero?
2. How do you interpret the alpha and beta for the stock and the mutual fund?
3. Which of the two regression estimates has the highest R-squared? Is this what you would have expected? Why?

b. In part (a), you asked Excel to return the residuals of the regression, which is the epsilon in the regression equation. If you remember back to basic statistics, the residuals are the distance from each observation to the regression line. In this context, the residuals are the part of the monthly return that is not explained by the market model estimate. The residuals can be used to calculate the appraisal ratio, which is the alpha divided by the standard deviation of the residuals.

1. What do you think the appraisal ratio is intended to measure?
2. Calculate the appraisal ratios for the stock and the mutual fund. Which has a better appraisal ratio?
3. Often, the appraisal ratio is used to evaluate the performance of mutual fund managers. Why do you think the appraisal ratio is used more often for mutual funds, which are portfolios, than for individual stocks?

MINICASE

The Beta for Colgate-Palmolive

Joey Moss, a recent finance graduate, has just begun his job with the investment firm of Covili and Wyatt. Paul Covili, one of the firm's founders, has been talking to Joey about the firm's investment portfolio.

As with any investment, Paul is concerned about the risk of the investment as well as the potential return. More specifically, because the company holds a diversified portfolio, Paul is concerned about the systematic risk of current and potential investments. One such position the company currently holds is stock in Colgate-Palmolive (CL). Colgate-Palmolive is the well-known manufacturer of consumer products under brand names such as Colgate, Palmolive, Softsoap, Irish Spring, Ajax, and others.

Covili and Wyatt currently uses a commercial data vendor for information about its positions. Because of this, Paul is unsure exactly how the numbers provided are calculated. The data provider considers its methods proprietary, and it will not disclose how stock betas and other information are calculated. Paul is uncomfortable with not knowing exactly how these numbers are being computed and also believes that it could be less expensive to calculate the necessary statistics in-house. To explore this question, Paul has asked Joey to do the following assignments.

QUESTIONS

1. Go to finance.yahoo.com and download the ending monthly stock prices for Colgate-Palmolive for the last 60 months. Use the adjusted closing price, which adjusts for dividend payments and stock splits. Next, download the ending value of the S&P 500 index over the same

period. For the historical risk-free rate, go to the St. Louis Federal Reserve website (www.stlouisfed.org) and find the three-month Treasury bill secondary market rate. Download this file. What are the monthly returns, average monthly returns, and standard deviations for Colgate-Palmolive stock, the three-month Treasury bill, and the S&P 500 for this period?

2. Beta is often estimated by linear regression. A model commonly used is called the *market model*, which is:

$$R_t - R_{ft} = \alpha_i + \beta_i\,[R_{Mt} - R_{ft}] + \varepsilon_t$$

In this regression, R_t is the return on the stock and R_{ft} is the risk-free rate for the same period. R_{Mt} is the return on a stock market index such as the S&P 500 index; α_i is the regression intercept; β_i is the slope (and the stock's estimated beta); and ε_t represents the residuals for the regression. What do you think is the motivation for this particular regression? The intercept, α, is often called *Jensen's alpha*. What does it measure? If an asset has a positive Jensen's alpha, where would it plot with respect to the SML? What is the financial interpretation of the residuals in the regression?

3. Use the market model to estimate the beta for Colgate-Palmolive using the last 36 months of returns (the regression procedure in Excel is one easy way to do this). Plot the monthly returns on Colgate-Palmolive against the index and also show the fitted line.

4. When the beta of a stock is calculated using monthly returns, there is a debate over the number of months that should be used in the calculation. Rework the previous questions using the last 60 months of returns. How does this answer compare to what you calculated previously? What are some arguments for and against using shorter versus longer periods? Also, you've used monthly data, which is a common choice. You could have used daily, weekly, quarterly, or even annual data. What do you think are the issues here?

5. Compare your beta for Colgate-Palmolive to the beta you find on finance.yahoo.com. How similar are they? Why might they be different?

Chapter 14 Cost of Capital

WITH OVER 112,000 EMPLOYEES ON FIVE CONTINENTS, Germany-based BASF is a major international company. The company operates in a variety of industries, including agriculture, oil and gas, chemicals, and plastics. In an attempt to increase value, BASF launched Vision 2020, a comprehensive plan that included all functions within the company and challenged and encouraged all employees to act in an entrepreneurial manner. The major financial component of the strategy was that the company expected to earn its weighted average cost of capital, or WACC, plus a premium. So, what exactly is the WACC?

The WACC is the minimum return a company needs to earn to satisfy all of its investors, including stockholders, bondholders, and preferred stockholders. In 2017, for example, BASF pegged its cost of capital at 10 percent, the same WACC that it used during 2016, but down slightly from the 11 percent used in 2015. In this chapter, we learn how to compute a firm's cost of capital and find out what it means to the firm and its investors. We will also learn when to use the firm's cost of capital, and, perhaps more important, when not to use it.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Determine a firm's cost of equity capital.

LO2 Determine a firm's cost of debt.

LO3 Determine a firm's overall cost of capital and how to use it to value a company.

LO4 Explain how to correctly include flotation costs in capital budgeting projects.

LO5 Describe some of the pitfalls associated with a firm's overall cost of capital and what to do about them.

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Suppose you have just become the president of a large company, and the first decision you face is whether to go ahead with a plan to renovate the company's warehouse distribution system. The plan will cost the company $50 million, and it is expected to save $12 million per year after taxes over the next six years.

This is a familiar problem in capital budgeting. To address it, you would determine the relevant cash flows, discount them, and, if the net present value is positive, take on the project; if the NPV is negative, you would scrap it. So far, so good; but what should you use as the discount rate?

From our discussion of risk and return, you know that the correct discount rate depends on the riskiness of the project to renovate the warehouse distribution system. In particular, the new project will have a positive NPV only if its return exceeds what the financial markets offer on investments of similar risk. We called this minimum required return the *cost of capital* associated with the project.[1]

To make the right decision as president, you must examine what the capital markets have to offer and use this information to arrive at an estimate of the project's cost of capital. Our primary purpose in this chapter is to describe how to go about doing this. There are a variety of approaches to this task, and a number of conceptual and practical issues arise.

One of the most important concepts we develop is that of the *weighted average cost of capital* (WACC). This is the cost of capital for the firm as a whole, and it can be interpreted as the required return on the overall firm. In discussing the WACC, we will recognize the fact that a firm will normally raise capital in a variety of forms and that these different forms of capital may have different costs associated with them.

We also recognize in this chapter that taxes are an important consideration in determining the required return on an investment: We are always interested in valuing the aftertax cash flows from a project. We will therefore discuss how to incorporate taxes explicitly into our estimates of the cost of capital.

The Cost of Capital: Some Preliminaries 14.1

In Chapter 13, we developed the security market line, or SML, and used it to explore the relationship between the expected return on a security and its systematic risk. In our examination of the risky returns from buying securities, we took the viewpoint of, for example, a shareholder in the firm. This helped us to better understand the alternatives available to an investor in the capital markets.

In this chapter, we turn things around a bit and look more closely at the other side of the problem, which is how these returns and securities look from the viewpoint of the companies that issue them. The important fact to note is that the return an investor in a security receives is the cost of that security to the company that issued it.

REQUIRED RETURN VERSUS COST OF CAPITAL

When we say that the required return on an investment is, say, 10 percent, we usually mean that the investment will have a positive NPV only if its return exceeds 10 percent. Another way of interpreting the required return is to observe that the firm must earn 10 percent on the investment to compensate its investors for the use of the capital needed to finance the project. This is why we could also say that 10 percent is the cost of capital associated with the investment.

To illustrate the point further, imagine that we are evaluating a risk-free project. In this case, how to determine the required return is obvious: We look at the capital markets and observe the current rate offered by risk-free investments, and we use this rate to discount the project's cash flows. Thus, the cost of capital for a risk-free investment is the risk-free rate.

If a project is risky, then, assuming that all the other information is unchanged, the required return is obviously higher. In other words, the cost of capital for this project, if it is risky, is greater than the risk-free rate, and the appropriate discount rate would exceed the risk-free rate.

We will henceforth use the terms *required return*, *appropriate discount rate*, and *cost of capital* more or less interchangeably because, as the discussion in this section suggests,

[1]The term *cost of money* is also used.

they all mean essentially the same thing. The key fact to grasp is that the cost of capital associated with an investment depends on the risk of that investment. This is one of the most important lessons in corporate finance, so it bears repeating:

The cost of capital depends primarily on the use of the funds, not the source.

It is a common error to forget this crucial point and fall into the trap of thinking that the cost of capital for an investment depends primarily on how and where the capital is raised.

FINANCIAL POLICY AND COST OF CAPITAL

We know that the particular mixture of debt and equity a firm chooses to employ—its capital structure—is a managerial variable. In this chapter, we will take the firm's financial policy as given. In particular, we will assume that the firm has a fixed debt-equity ratio that it maintains. This ratio reflects the firm's *target* capital structure. How a firm might choose that ratio is the subject of a later chapter.

From the preceding discussion, we know that a firm's overall cost of capital will reflect the required return on the firm's assets as a whole. Given that a firm uses both debt and equity capital, this overall cost of capital will be a mixture of the returns needed to compensate its creditors and those needed to compensate its stockholders. In other words, a firm's cost of capital will reflect both its cost of debt capital and its cost of equity capital. We discuss these costs separately in the sections that follow.

Concept Questions

14.1a What is the primary determinant of the cost of capital for an investment?

14.1b What is the relationship between the required return on an investment and the cost of capital associated with that investment?

14.2 The Cost of Equity

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cost of equity
The return that equity investors require on their investment in the firm.

To open our discussion of cost of capital, we begin with the most difficult question: What is the firm's overall **cost of equity**? The reason this is a difficult question is that there is no way of directly observing the return that the firm's equity investors require on their investment. Instead, we must somehow estimate it. This section discusses two approaches to determining the cost of equity: The dividend growth model approach and the security market line (SML) approach.

THE DIVIDEND GROWTH MODEL APPROACH

The easiest way to estimate the cost of equity capital is to use the dividend growth model we developed in Chapter 8. Recall that, under the assumption that the firm's dividend will grow at a constant rate, g, the price per share of the stock, P_0, can be written as:

$$P_0 = \frac{D_0 \times (1 + g)}{R_E - g} = \frac{D_1}{R_E - g}$$

where D_0 is the dividend just paid and D_1 is the next period's projected dividend. Notice that we have used the symbol R_E (the E stands for equity) for the required return on the stock.

As we discussed in Chapter 8, we can rearrange this to solve for R_E as follows:

$$R_E = D_1/P_0 + g \tag{14.1}$$

Because R_E is the return that the shareholders require on the stock, it can be interpreted as the firm's cost of equity capital.

Implementing the Approach To estimate R_E using the dividend growth model approach, we obviously need three pieces of information: P_0, D_0, and g.[2] Of these, for a publicly traded, dividend-paying company, the first two can be observed directly, so they are easily obtained. Only the third component, the expected growth rate for dividends, must be estimated.

To illustrate how we estimate R_E, suppose Greater States Public Service, a large public utility, paid a dividend of $4 per share last year. The stock currently sells for $60 per share. You estimate that the dividend will grow steadily at a rate of 6 percent per year into the indefinite future. What is the cost of equity capital for Greater States?

Using the dividend growth model, we can calculate that the expected dividend for the coming year, D_1, is:

$$\begin{aligned} D_1 &= D_0 \times (1 + g) \\ &= \$4 \times 1.06 \\ &= \$4.24 \end{aligned}$$

Given this, the cost of equity, R_E, is:

$$\begin{aligned} R_E &= D_1/P_0 + g \\ &= \$4.24/\$60 + .06 \\ &= .1307, \text{ or } 13.07\% \end{aligned}$$

The cost of equity is 13.07 percent.

Estimating *g* To use the dividend growth model, we must come up with an estimate for g, the growth rate. There are essentially two ways of doing this: (1) Use historical growth rates or (2) use analysts' forecasts of future growth rates. Analysts' forecasts are available from a variety of sources. Naturally, different sources will have different estimates, so one approach might be to obtain multiple estimates and then average them.

Alternatively, we might observe dividends for the previous, say, five years, calculate the year-to-year growth rates, and average them. For example, suppose we observe the following for some company:

Year	Dividend
2013	$1.10
2014	1.20
2015	1.35
2016	1.40
2017	1.55

Growth estimates can be found at **www.zacks.com.**

We can calculate the percentage change in the dividend for each year as follows:

Year	Dividend	Dollar Change	Percentage Change
2013	$1.10	—	—
2014	1.20	$.10	9.09%
2015	1.35	.15	12.50
2016	1.40	.05	3.70
2017	1.55	.15	10.71

[2]Notice that if we have D_0 and g, we can simply calculate D_1 by multiplying D_0 by $(1 + g)$.

Notice that we calculated the change in the dividend on a year-to-year basis and then expressed the change as a percentage. In 2014 for example, the dividend rose from \$1.10 to \$1.20, an increase of \$.10. This represents a \$.10/\$1.10 = .0909, or 9.09% increase.

If we average the four growth rates, the result is (.0909 + .1250 + .0370 + .1071)/4 = .09, or 9%, so we could use this as an estimate for the expected growth rate, g. Notice that this 9 percent growth rate we have calculated is a simple, or arithmetic, average. Going back to Chapter 12, we also could calculate a geometric growth rate. Here, the dividend grows from \$1.10 to \$1.55 over a four-year period. What's the compound, or geometric, growth rate? See if you don't agree that it's 8.95 percent; you can view this as a simple time value of money problem where \$1.10 is the present value and \$1.55 is the future value.

As usual, the geometric average (8.95 percent) is lower than the arithmetic average (9 percent), but the difference here is not likely to be of any practical significance. In general, if the dividend has grown at a relatively steady rate, as we assume when we use this approach, then it can't make much difference which way we calculate the average dividend growth rate.

Advantages and Disadvantages of the Approach The primary advantage of the dividend growth model approach is its simplicity. It is both easy to understand and easy to use. There are a number of associated practical problems and disadvantages.

First and foremost, the dividend growth model is obviously applicable only to companies that pay dividends. This means that the approach is useless in many cases. Furthermore, even for companies that pay dividends, the key underlying assumption is that the dividend grows at a constant rate. As our previous example illustrates, this will never be *exactly* the case. More generally, the model is really applicable only to cases in which reasonably steady growth is likely to occur.

A second problem is that the estimated cost of equity is very sensitive to the estimated growth rate. For a given stock price, an upward revision of g by just one percentage point, for example, increases the estimated cost of equity by at least a full percentage point. Because D_1 will probably be revised upward as well, the increase will actually be somewhat larger than that.

Finally, this approach really does not explicitly consider risk. Unlike the SML approach (which we consider next), there is no direct adjustment for the riskiness of the investment. For example, there is no allowance for the degree of certainty or uncertainty surrounding the estimated growth rate for dividends. As a result, it is difficult to say whether or not the estimated return is commensurate with the level of risk.[3]

THE SML APPROACH

In Chapter 13, we discussed the security market line, or SML. Our primary conclusion was that the required or expected return on a risky investment depends on three things:

1. The risk-free rate, R_f.
2. The market risk premium, $E(R_M) - R_f$.
3. The systematic risk of the asset relative to average, which we called its beta coefficient, β.

Using the SML, we can write the expected return on the company's equity, $E(R_E)$, as:

$$E(R_E) = R_f + \beta_E \times [E(R_M) - R_f]$$

where β_E is the estimated beta. To make the SML approach consistent with the dividend growth model, we will drop the Es denoting expectations and henceforth write the required return from the SML, R_E, as:

$$\boldsymbol{R_E = R_f + \beta_E \times (R_M - R_f)} \qquad \textbf{14.2}$$

[3]There is an implicit adjustment for risk because the current stock price is used. All other things being equal, the higher the risk, the lower is the stock price. Further, the lower the stock price, the greater is the cost of equity, again assuming all the other information is the same.

Implementing the Approach To use the SML approach, we need a risk-free rate, R_f, an estimate of the market risk premium, $R_M - R_f$, and an estimate of the relevant beta, β_E. In Chapter 12, we saw that one estimate of the market risk premium (based on large common stocks) is about 7 percent. U.S. Treasury bills are paying about .40 percent as this chapter is being written, so we will use this as our risk-free rate. Beta coefficients for publicly traded companies are widely available.[4]

Betas and T-bill rates both can be found at **www.bloomberg.com**.

To illustrate, in Chapter 13, we saw that Tesla had an estimated beta of 1.19 (Table 13.8). We could estimate Tesla's cost of equity as:

$$\begin{aligned} R_{Tesla} &= R_f + \beta_{Tesla} \times (R_M - R_f) \\ &= .0040 + 1.19 \times .07 \\ &= .0873, \text{ or } 8.73\% \end{aligned}$$

Using the SML approach, we calculate that Tesla's cost of equity is about 8.73 percent.

Advantages and Disadvantages of the Approach The SML approach has two primary advantages. First, it explicitly adjusts for risk. Second, it is applicable to companies other than just those with steady dividend growth. It may be useful in a wider variety of circumstances.

There are drawbacks, of course. The SML approach requires that two things be estimated: The market risk premium and the beta coefficient. To the extent that our estimates are poor, the resulting cost of equity will be inaccurate. For example, our estimate of the market risk premium, 7 percent, is based on about 100 years of returns on particular stock portfolios and markets. Using different time periods or different stocks and markets could result in very different estimates.

Finally, as with the dividend growth model, we essentially rely on the past to predict the future when we use the SML approach. Economic conditions can change quickly; so as always, the past may not be a good guide to the future. In the best of all worlds, both approaches (the dividend growth model and the SML) are applicable and the two result in similar answers. If this happens, we might have some confidence in our estimates. We might also wish to compare the results to those for other similar companies as a reality check.

[4]We can also estimate beta coefficients directly by using historical data. For a discussion of how to do this, see Chapters 10, 11, and 13 in S. A. Ross, R. W. Westerfield, J. J. Jaffe, and B. D. Jordan, *Corporate Finance*, 11th ed. (New York: McGraw-Hill, 2016).

The Cost of Equity — EXAMPLE 14.1

Suppose stock in Alpha Air Freight has a beta of 1.2. The market risk premium is 7 percent, and the risk-free rate is 6 percent. Alpha's last dividend was $2 per share, and the dividend is expected to grow at 8 percent indefinitely. The stock currently sells for $30. What is Alpha's cost of equity capital?

We can start off by using the SML. Doing this, we find that the expected return on the common stock of Alpha Air Freight is:

$$\begin{aligned} R_E &= R_f + \beta_E \times (R_M - R_f) \\ &= .06 + 1.2 \times .07 \\ &= .144, \text{ or } 14.4\% \end{aligned}$$

This suggests that 14.4 percent is Alpha's cost of equity. We next use the dividend growth model. The projected dividend is $D_0 \times (1 + g) = \$2 \times 1.08 = \$2.16$, so the expected return using this approach is:

$$\begin{aligned} R_E &= D_1/P_0 + g \\ &= \$2.16/\$30 + .08 \\ &= .152, \text{ or } 15.2\% \end{aligned}$$

Our two estimates are reasonably close, so we might just average them to find that Alpha's cost of equity is approximately 14.8 percent.

Concept Questions

14.2a What do we mean when we say that a corporation's cost of equity capital is 16 percent?

14.2b What are two approaches to estimating the cost of equity capital?

14.3 The Costs of Debt and Preferred Stock

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In addition to ordinary equity, firms use debt and, to a lesser extent, preferred stock to finance their investments. As we discuss next, determining the costs of capital associated with these sources of financing is much easier than determining the cost of equity.

THE COST OF DEBT

cost of debt
The return that lenders require on the firm's debt.

The **cost of debt** is the return the firm's creditors demand on new borrowing. In principle, we could determine the beta for the firm's debt and then use the SML to estimate the required return on debt just as we estimated the required return on equity. This isn't really necessary, however.

Unlike a firm's cost of equity, its cost of debt can normally be observed either directly or indirectly: The cost of debt is the interest rate the firm must pay on new borrowing, and we can observe interest rates in the financial markets. For example, if the firm already has bonds outstanding, then the yield to maturity on those bonds is the market-required rate on the firm's debt.

Alternatively, if we know that the firm's bonds are rated, say, AA, then we can find the interest rate on newly issued AA-rated bonds. Either way, there is no need to estimate a beta for the debt because we can directly observe the rate we want to know.

There is one thing to be careful about, though. The coupon rate on the firm's outstanding debt is irrelevant here. That rate tells us roughly what the firm's cost of debt was back when the bonds were issued, not what the cost of debt is today.[5] This is why we have to look at the yield on the debt in today's marketplace. For consistency with our other notation, we will use the symbol R_D for the cost of debt.

EXAMPLE 14.2 The Cost of Debt

Suppose the General Tool Company issued a 30-year, 7 percent bond 8 years ago. The bond is currently selling for 96 percent of its face value, or $960. What is General Tool's cost of debt?

Going back to Chapter 7, we need to calculate the yield to maturity on this bond. Because the bond is selling at a discount, the yield is apparently greater than 7 percent, but not much greater because the discount is fairly small. You can check to see that the yield to maturity is about 7.37 percent, assuming annual coupons. General Tool's cost of debt, R_D, is 7.37 percent.

THE COST OF PREFERRED STOCK

Determining the *cost of preferred stock* is quite straightforward. As we discussed in Chapters 6 and 8, preferred stock has a fixed dividend paid every period forever, so a share of preferred stock is essentially a perpetuity. The cost of preferred stock, R_P, is thus:

14.3

$$R_P = D/P_0$$

[5]The firm's cost of debt based on its historical borrowing is sometimes called the *embedded debt cost*.

where D is the fixed dividend and P_0 is the current price per share of the preferred stock. Notice that the cost of preferred stock is equal to the dividend yield on the preferred stock. Alternatively, because preferred stocks are rated in much the same way as bonds, the cost of preferred stock can be estimated by observing the required returns on other, similarly rated shares of preferred stock.

Alabama Power Co.'s Cost of Preferred Stock — EXAMPLE 14.3

On January 2, 2018, Alabama Power Co. had two issues of ordinary preferred stock with a \$100 par value that traded on the NYSE. One issue paid \$4.64 annually per share and sold for \$99.70 per share. The other paid \$4.92 per share annually and sold for \$98.97 per share. What is Alabama Power's cost of preferred stock?

Using the first issue, we calculate that the cost of preferred stock is:

$$\begin{aligned} R_P &= D/P_0 \\ &= \$4.64/\$99.70 \\ &= .0465, \text{ or } 4.65\% \end{aligned}$$

Using the second issue, we calculate that the cost is:

$$\begin{aligned} R_P &= D/P_0 \\ &= \$4.92/98.97 \\ &= .0497, \text{ or } 4.97\% \end{aligned}$$

So, Alabama Power's cost of preferred stock appears to be about 4.81 percent.

Concept Questions

14.3a Why is the coupon rate a bad estimate of a firm's cost of debt?

14.3b How can the cost of debt be calculated?

14.3c How can the cost of preferred stock be calculated?

14.4 The Weighted Average Cost of Capital

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Now that we have the costs associated with the main sources of capital the firm employs, we need to worry about the specific mix. As we mentioned earlier, we will take this mix, which is the firm's capital structure, as given for now. Also, we will focus mostly on debt and ordinary equity in this discussion.

In Chapter 3, we mentioned that financial analysts frequently focus on a firm's total capitalization, which is the sum of its long-term debt and equity. This is particularly true in determining cost of capital; short-term liabilities are often ignored in the process. We will not explicitly distinguish between total value and total capitalization in the following discussion; the general approach is applicable with either.

THE CAPITAL STRUCTURE WEIGHTS

We will use the symbol E (for equity) to stand for the *market* value of the firm's equity. We calculate this by taking the number of shares outstanding and multiplying it by the price per share. Similarly, we will use the symbol D (for debt) to stand for the *market* value of the firm's debt. For long-term debt, we calculate this by multiplying the market price of a single bond by the number of bonds outstanding.

If there are multiple bond issues (as there normally would be), we repeat this calculation of D for each and then add up the results. If there is debt that is not publicly traded (because it is held by a life insurance company, for example), we must observe the yield on similar publicly traded debt and then estimate the market value of the privately held debt using this yield as the discount rate. For short-term debt, the book (accounting) values and market values should be somewhat similar, so we might use the book values as estimates of the market values.

Finally, we will use the symbol V (for value) to stand for the combined market value of the debt and equity:

$$V = E + D \tag{14.4}$$

If we divide both sides by V, we can calculate the percentages of the total capital represented by the debt and equity:

$$100\% = E/V + D/V \tag{14.5}$$

These percentages can be interpreted just like portfolio weights, and they are often called the *capital structure weights*.

For example, if the total market value of a company's stock were calculated as $200 million and the total market value of the company's debt were calculated as $50 million, then the combined value would be $250 million. Of this total, E/V = $200 million/$250 million = .80, so 80 percent of the firm's financing would be equity and the remaining 20 percent would be debt.

We emphasize here that the correct way to proceed is to use the *market* values of the debt and equity. Under certain circumstances, such as when calculating figures for a privately owned company, it may not be possible to get reliable estimates of these quantities. In this case, we might go ahead and use the accounting values for debt and equity. Although this would probably be better than nothing, we would have to take the answer with a grain of salt.

TAXES AND THE WEIGHTED AVERAGE COST OF CAPITAL

There is one final issue we need to discuss. Recall that we are always concerned with aftertax cash flows. If we are determining the discount rate appropriate to those cash flows, then the discount rate also needs to be expressed on an aftertax basis.

As we discussed previously in various places in this book (and as we will discuss later), the interest paid by a corporation is deductible for tax purposes. Payments to stockholders, such as dividends, are not. What this means, effectively, is that the government pays some of the interest. In determining an aftertax discount rate, we need to distinguish between the pretax and the aftertax cost of debt.

To illustrate, suppose a firm borrows $1 million at 9 percent interest. The corporate tax rate is 21 percent. What is the aftertax interest rate on this loan? The total interest bill will be $90,000 per year. This amount is tax deductible, however, so the $90,000 interest reduces the firm's tax bill by .21 × $90,000 = $18,900. The aftertax interest bill is $90,000 − 18,900 = $71,100. The aftertax interest rate is $71,100/$1 million = .0711, or 7.11%.

Notice that, in general, the aftertax interest rate is equal to the pretax rate multiplied by 1 minus the tax rate. If we use the symbol T_C to stand for the corporate tax rate, then the aftertax rate can be written as $R_D \times (1 - T_C)$. Using the numbers from the preceding paragraph, we find that the aftertax interest rate is $9\% \times (1 - .21) = 7.11\%$.

To get a feel for actual, industry-level WACCs, visit Professor Aswath Damodaran at **pages.stern.nyu.edu/~adamodar/** and look for "cost of capital by sector."

The Tax Cuts and Jobs Act of 2017 placed limitations on the amount of interest that can be deducted in certain situations. Throughout this chapter, we will assume all interest can be deducted. We will discuss this issue in greater detail in a subsequent chapter.

Bringing together the various topics we have discussed in this chapter, we now have the capital structure weights along with the cost of equity and the aftertax cost of debt. To calculate the firm's overall cost of capital, we multiply the capital structure weights by the associated costs and add them up. The total is the **weighted average cost of capital (WACC)**:

weighted average cost of capital (WACC)
The weighted average of the cost of equity and the aftertax cost of debt.

$$\mathbf{WACC} = (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C) \qquad \textbf{14.6}$$

This WACC has a straightforward interpretation. It is the overall return the firm must earn on its existing assets to maintain the value of its stock. It is also the required return on any investments by the firm that have essentially the same risks as existing operations. So, if we were evaluating the cash flows from a proposed expansion of our existing operations, this is the discount rate we would use.

If a firm uses preferred stock in its capital structure, then our expression for the WACC needs a simple extension. If we define P/V as the percentage of the firm's financing that comes from preferred stock, then the WACC is:

$$\mathbf{WACC} = (E/V) \times R_E + (P/V) \times R_P + (D/V) \times R_D \times (1 - T_C) \qquad \textbf{14.7}$$

where R_P is the cost of preferred stock.

Calculating the WACC — EXAMPLE 14.4

The B.B. Lean Co. has 1.4 million shares of stock outstanding. The stock currently sells for $20 per share. The firm's debt is publicly traded and was recently quoted at 93 percent of face value. It has a total face value of $5 million, and it is currently priced to yield 11 percent. The risk-free rate is 8 percent, and the market risk premium is 7 percent. You've estimated that Lean has a beta of .74. If the corporate tax rate is 21 percent, what is the WACC of Lean Co.?

We can first determine the cost of equity and the cost of debt. Using the SML, we find that the cost of equity is 8% + .74 × 7% = 13.18%. The total value of the equity is 1.4 million × $20 = $28 million. The pretax cost of debt is the current yield to maturity on the outstanding debt, 11 percent. The debt sells for 93 percent of its face value, so its current market value is .93 × $5 million = $4.65 million. The total market value of the equity and debt together is $28 million + 4.65 million = $32.65 million.

From here, we can calculate the WACC easily enough. The percentage of equity used by Lean to finance its operations is $28 million/$32.65 million = .8576, or 85.76%. Because the weights have to add up to 1, the percentage of debt is 1 − .8576 = .1424, or 14.24%. The WACC is:

$$\begin{aligned}\text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C)\\ &= .8576 \times .1318 + .1424 \times .11 \times (1 - .21)\\ &= .1254, \text{ or } 12.54\%\end{aligned}$$

B.B. Lean has an overall weighted average cost of capital of 12.54 percent.

CALCULATING THE WACC FOR EASTMAN CHEMICAL

In this section, we illustrate how to calculate the WACC for Eastman Chemical Co., a leading international chemical company and maker of plastics such as those used in soft drink containers. It was created in 1993, when its former parent company, Eastman Kodak, split off the division as a separate company. Our goal is to take you through, on a step-by-step basis, the process of finding and using the information needed from online sources. As you will see, there is a fair amount of detail involved, but the necessary information is, for the most part, readily available.

Eastman's Cost of Equity Our first stop is the main screen for Eastman available at finance.yahoo.com (ticker: EMN). As of early 2017, here's what it looked like:

Eastman Chemical Company (EMN) Add to watchlist

NYSE - NYSE Real Time Price. Currency in USD

77.72 -1.35 (-1.71%)

As of 2:01PM EST. Market open.

Summary | Conversations | Statistics | Profile | Financials | Options | Holders | Historical Data | Analysts

Previous Close	79.07	Market Cap	11.41B
Open	78.71	Beta	1.35
Bid	0.00 x	PE Ratio (TTM)	13.09
Ask	0.00 x	EPS (TTM)	5.94
Day's Range	76.99 - 79.23	Earnings Date	Jan 26, 2017
52 Week Range	56.03 - 79.23	Dividend & Yield	2.04 (2.64%)
Volume	730,190	Ex-Dividend Date	N/A
Avg. Volume	1,463,619	1y Target Est	82.24

1D 5D 1M 6M 1Y 2Y 5Y 10Y MAX Interactive chart

Next, we went to the "Statistics" screen. According to this screen, Eastman has 146.75 million shares of stock outstanding. The book value per share is $29.62, but the stock sells for $77.72. Total equity is therefore about $4.347 billion on a book value basis, but it is closer to $11.405 billion on a market value basis.

Balance Sheet	
Total Cash (mrq)	207M
Total Cash Per Share (mrq)	1.41
Total Debt (mrq)	6.68B
Total Debt/Equity (mrq)	148.01
Current Ratio (mrq)	1.32
Book Value Per Share (mrq)	29.62

Stock Price History	
Beta	1.35
52-Week Change [3]	25.49%
S&P500 52-Week Change [3]	17.36%
52 Week High [3]	79.23
52 Week Low [3]	56.03
50-Day Moving Average [3]	76.18
200-Day Moving Average [3]	69.95

Share Statistics	
Avg Vol (3 month) [3]	1.46M
Avg Vol (10 day) [3]	1.33M
Shares Outstanding [5]	146.75M
Float	146M
% Held by Insiders [1]	0.68%
% Held by Institutions [1]	85.50%
Shares Short [3]	2.94M
Short Ratio [3]	1.98
Short % of Float [3]	2.00%
Shares Short (prior month) [3]	2.95M

To estimate Eastman's cost of equity, we will assume a market risk premium of 7 percent, similar to what we calculated in Chapter 12. Eastman's beta on Yahoo! is 1.35, which is higher than the beta of the average stock. To check this number, we went to the well-known Value Line *Investment Survey*, which uses an approach that moderates very large and very small betas. Here, the beta is reported as 1.30, so we will stick with the Yahoo! estimate. According to the Bonds section of finance.yahoo.com, T-bills were paying about .45 percent. Using the CAPM to estimate the cost of equity, we find:

$$R_E = .0045 + 1.35(.07) = .0990, \text{ or } 9.90\%$$

Eastman has paid dividends for only a few years, so calculating the growth rate for the dividend discount model is problematic. However, under the Analysts link at finance .yahoo.com, we found the following:

Growth Estimates	EMN
Current Qtr.	-6.30%
Next Qtr.	4.10%
Current Year	-7.40%
Next Year	8.20%
Next 5 Years (per annum)	5.06%
Past 5 Years (per annum)	11.06%

Analysts estimate the growth in earnings per share for the company will be 5.06 percent for the next five years. For now, we will use this growth rate in the dividend discount model to estimate the cost of equity; the link between earnings growth and dividends is discussed in a later chapter. The estimated cost of equity using the dividend discount model is:

$$R_E = \frac{\$2.04(1 + .0506)}{77.72} + .0506 = .0782, \text{ or } 7.82\%$$

Notice that our two estimates for the cost of equity are not identical. This is essentially always the case. Remember that each method of estimating the cost of equity relies on different assumptions, so different estimates of the cost of equity should not surprise us. If the estimates are different, there are two simple solutions. First, we could ignore one of the estimates. In this case, we would look at each estimate to see if one of them seemed too high or too low to be reasonable. Second, we could average the two estimates. For Eastman, our estimates of 9.90 percent and 7.82 percent are relatively close, so we would average them to get 8.86 percent as the cost of equity.

Eastman's Cost of Debt Eastman has 13 relatively long-term bond issues that account for essentially all of its long-term debt. To calculate the cost of debt, we will have to combine these 13 issues. What we will do is compute a weighted average. We went to www.finra.org/marketdata to find quotes on the bonds. We should note here that finding the yield to maturity for all of a company's outstanding bond issues on a single day is unusual. If you remember our previous discussion of bonds, the bond market is not as liquid as the stock market; on many days, individual bond issues may not trade. To find the book value of the bonds, we went to www.sec.gov and found the 10-Q report dated September 30, 2016, and filed with the SEC on November 4, 2016. The basic information is as follows:

Coupon Rate	Maturity	Book Value (face value, in millions)	Price (% of par)	Yield to Maturity
2.40%	2017	$ 499	100.675	.920%
6.30	2018	166	109.498	1.077
5.50	2019	249	108.301	2.462
2.70	2020	795	101.276	2.245
4.50	2021	249	105.684	2.897
3.60	2022	890	102.866	3.014
1.50	2023	607	90.484	3.168
7.25	2024	244	124.376	3.322
7.625	2024	54	128.187	3.311
3.80	2025	792	101.611	3.565
7.60	2027	222	134.007	3.548
4.80	2042	492	102.564	4.626
4.65	2044	870	97.750	4.797
		$6,129		

To calculate the weighted average cost of debt, we take the percentage of the total debt represented by each issue and multiply by the yield on the issue. We then add to get the overall weighted average debt cost. We use both book values and market values here for comparison. The results of the calculations are as follows:

Coupon Rate	Book Value (face value, in millions)	Percentage of Total	Market Value (in millions)	Percentage of Total	Yield to Maturity	Book Values	Market Values
2.40%	$ 499	.08	$ 502.37	.08	.92%	.07%	.07%
6.30	166	.03	181.77	.03	1.08	.03	.03
5.50	249	.04	269.67	.04	2.46	.10	.11
2.70	795	.13	805.14	.13	2.25	.29	.29
4.50	249	.04	263.15	.04	2.90	.12	.12
3.60	890	.15	915.51	.14	3.01	.44	.44
1.50	607	.10	549.24	.09	3.17	.31	.28
7.25	244	.04	303.48	.05	3.32	.13	.16
7.625	54	.01	69.22	.01	3.31	.03	.04
3.80	792	.13	804.76	.13	3.57	.46	.45
7.60	222	.04	297.50	.05	3.55	.13	.17
4.80	492	.08	504.61	.08	4.63	.37	.37
4.65	875	.14	850.43	.13	4.80	.68	.65
	$6,129	1.00	$6,316.84	1.00		3.17%	3.16%

As these calculations show, Eastman's cost of debt is 3.17 percent on a book value basis and 3.16 percent on a market value basis. For Eastman, whether market values or book values are used makes no difference. The reason is that the market values and book values are similar. This will often be the case and explains why companies frequently use book values for debt in WACC calculations. Also, Eastman has no preferred stock, so we don't need to consider its cost.

Eastman's WACC We now have the various pieces necessary to calculate Eastman's WACC. First, we need to calculate the capital structure weights. On a book value basis, Eastman's equity and debt are worth \$4.347 billion and \$6.129 billion, respectively. The total value is \$10.476 billion, so the equity and debt weights are \$4.347 billion/\$10.476 billion = .41 and \$6.129 billion/\$10.476 billion = .59, respectively. Assuming a tax rate of 21 percent, Eastman's WACC is:

$$\text{WACC} = .41 \times .0886 + .59 \times .0317 \times (1 - .21) = .0514, \text{ or } 5.14\%$$

Using book value capital structure weights (and more decimal points than shown here), we get about 5.14 percent for Eastman's WACC.

If we use market value weights, the WACC will be higher. To see why, notice that on a market value basis, Eastman's equity and debt are worth \$11.405 billion and \$6.317 billion, respectively. The capital structure weights are therefore \$11.405 billion/\$17.722 billion = .64 and \$6.317 billion/\$17.722 billion = .36, so the equity percentage is much higher. With these weights (and more decimal points than shown here), Eastman's WACC is:

$$\text{WACC} = .64 \times .0886 + .36 \times .0316 \times (1 - .21) = .0659, \text{ or } 6.59\%$$

Using market value weights, we get about 6.59 percent for Eastman's WACC, which is noticeably larger than the 5.14 percent WACC we got using book value weights.

As this example illustrates, using book values can lead to trouble, particularly if equity book values are used. Going back to Chapter 3, recall that we discussed the market-to-book

WORK THE WEB

So how does our estimate of the WACC for Eastman Chemical compare to others? One place to find estimates for WACC is www.valuepro.net. We went there and found the following information for Eastman:

Online Valuation for EMN - 1 / 12 / 2017

Intrinsic Stock Value 130.74 [Recalculate] [Value Another Stock]

Excess Return Period (yrs)	10	Depreciation Rate (% of Rev)	4.44
Revenues ($mil)	8588	Investment Rate (% of Rev)	5.8
Growth Rate (%)	11.5	Working Capital (% of Rev)	9.21
Net Oper. Profit Margin (%)	14.68	Short-Term Assets ($mil)	2737
Tax Rate (%)	32.583	Short-Term Liab. ($mil)	1335
Stock Price ($)	71.99	Equity Risk Premium (%)	3
Shares Outstanding (mil)	154.8	Company Beta	1.365
10-Yr Treasury Yield (%)	5	Value Debt Out. ($mil)	4779
Bond Spread Treasury (%)	1.5	Value Pref. Stock Out. ($mil)	0
Preferred Stock Yield (%)	7.5	Company WACC (%)	7.68

As you can see, ValuePro estimates the WACC (cost of capital) for Eastman as 7.68 percent, which is a little over one percent higher than our estimate of 6.59 percent. However, different inputs were used in the computations. For example, ValuePro uses an equity risk premium of only 3 percent. ValuePro also used the historic tax rate, which we chose not to change. Calculating WACC requires the estimation of various inputs, and you must use your best judgment in these estimates.

Questions

1. *Go to www.valuepro.net and look up the current WACC for Eastman Chemical on this website. How has the WACC changed? What are the possible reasons for the change?*
2. *Celgene (CELG) is a biopharmaceutical company. Would you expect the WACC for this company to be higher or lower than the WACC for Eastman Chemical? Why? Go to www.valuepro.net and find the estimated WACC for CELG. Was your assumption correct?*

ratio (the ratio of market value per share to book value per share). This ratio is usually substantially bigger than 1. For Eastman, for example, verify that it's about 2.62; so book values significantly overstate the percentage of Eastman's financing that comes from debt. In addition, if we were computing a WACC for a company that did not have publicly traded stock, we would try to come up with a suitable market-to-book ratio by looking at similar, publicly traded companies, and we would then use this ratio to adjust the book value of the company under consideration. As we have seen, failure to do so can lead to significant underestimation of the WACC.

Our nearby *Work the Web* box explains more about the WACC and related topics.

SOLVING THE WAREHOUSE PROBLEM AND SIMILAR CAPITAL BUDGETING PROBLEMS

Now we can use the WACC to solve the warehouse problem we posed at the beginning of the chapter. However, before we rush to discount the cash flows at the WACC to estimate NPV, we need to make sure we are doing the right thing.

Going back to first principles, we need to find an alternative in the financial markets that is comparable to the warehouse renovation. To be comparable, an alternative must be of the same level of risk as the warehouse project. Projects that have the same risk are said to be in the same risk class.

The WACC for a firm reflects the risk and the target capital structure of the firm's existing assets as a whole. As a result, strictly speaking, the firm's WACC is the appropriate discount rate only if the proposed investment is a replica of the firm's existing operating activities.

In broader terms, whether or not we can use the firm's WACC to value the warehouse project depends on whether the warehouse project is in the same risk class as the firm. We will assume that this project is an integral part of the overall business of the firm. In such cases, it is natural to think that the cost savings will be as risky as the general cash flows of the firm, and the project will be in the same risk class as the overall firm. More generally, projects like the warehouse renovation that are intimately related to the firm's existing operations are often viewed as being in the same risk class as the overall firm.

We can now see what the president should do. Suppose the firm has a target debt-equity ratio of 1/3. From Chapter 3, we know that a debt-equity ratio of $D/E = 1/3$ implies that E/V is .75 and D/V is .25. The cost of debt is 10 percent, and the cost of equity is 20 percent. Assuming a 21 percent tax rate, the WACC will be:

$$
\begin{aligned}
\text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C) \\
&= .75 \times 20\% + .25 \times 10\% \times (1 - .21) \\
&= .1698, \text{ or } 16.98\%
\end{aligned}
$$

Recall that the warehouse project had a cost of \$50 million and expected aftertax cash flows (the cost savings) of \$12 million per year for six years. The NPV (in millions) is:

$$
\text{NPV} = -\$50 + \frac{12}{(1 + \text{WACC})^1} + \cdots + \frac{12}{(1 + \text{WACC})^6}
$$

Because the cash flows are in the form of an ordinary annuity, we can calculate this NPV using 16.65 percent (the WACC) as the discount rate as follows:

$$
\begin{aligned}
\text{NPV} &= -\$50 + 12 \times \frac{1 - [1/(1 + .1698)^6]}{.1698} \\
&= -\$50 + 12 \times 3.5915 \\
&= -\$6.90
\end{aligned}
$$

Should the firm take on the warehouse renovation? The project has a negative NPV using the firm's WACC. This means that the financial markets offer superior projects in the same risk class (namely, the firm itself). The answer is clear: The project should be rejected. For future reference, our discussion of the WACC is summarized in Table 14.1.

TABLE 14.1

Summary of Capital Cost Calculations

I. The Cost of Equity, R_E

A. Dividend growth model approach (from Chapter 8):

$$R_E = D_1/P_0 + g$$

where D_1 is the expected dividend in one period, g is the dividend growth rate, and P_0 is the current stock price.

B. SML approach (from Chapter 13):

$$R_E = R_f + \beta_E \times (R_M - R_f)$$

where R_f is the risk-free rate, R_M is the expected return on the overall market, and β_E is the systematic risk of the equity.

II. The Cost of Debt, R_D

A. For a firm with publicly held debt, the cost of debt can be measured as the yield to maturity on the outstanding debt. The coupon rate is irrelevant. Yield to maturity is covered in Chapter 7.

B. If the firm has no publicly traded debt, then the cost of debt can be measured as the yield to maturity on similarly rated bonds (bond ratings are discussed in Chapter 7).

III. The Weighted Average Cost of Capital, WACC

A. The firm's WACC is the overall required return on the firm as a whole. It is the appropriate discount rate to use for cash flows similar in risk to those of the overall firm.

B. The WACC is calculated as:

$$\text{WACC} = (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C)$$

where T_C is the corporate tax rate, E is the *market* value of the firm's equity, D is the *market* value of the firm's debt, and $V = E + D$. Note that E/V is the percentage of the firm's financing (in market value terms) that is equity, and D/V is the percentage that is debt.

EXAMPLE 14.5 Using the WACC

A firm is considering a project that will result in initial aftertax cash savings of $5 million at the end of the first year. These savings will grow at the rate of 5 percent per year. The firm has a debt-equity ratio of .5, a cost of equity of 29.2 percent, and a cost of debt of 10 percent. The cost-saving proposal is closely related to the firm's core business, so it is viewed as having the same risk as the overall firm. Should the firm take on the project?

Assuming a 21 percent tax rate, the firm should take on this project if it costs less than $30 million. To see this, first note that the PV is:

$$\text{PV} = \frac{\$5 \text{ million}}{\text{WACC} - .05}$$

This is an example of a growing perpetuity as discussed in Chapter 6. The WACC is:

$$\begin{aligned}\text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C) \\ &= 2/3 \times 29.2\% + 1/3 \times 10\% \times (1 - .21) \\ &= 22.10\%\end{aligned}$$

The PV is thus:

$$\text{PV} = \frac{\$5 \text{ million}}{.2210 - .05} = \$29.2 \text{ million}$$

The NPV will be positive only if the cost is less than $29.2 million.

IN THEIR OWN WORDS …

Bennett Stewart on EVA

A firm's weighted average cost of capital has important applications other than the discount rate in capital project evaluations. For instance, it is a key ingredient to measure a firm's true economic profit, or what I like to call EVA, standing for economic value added. Accounting rules dictate that the interest expense a company incurs on its debt financing be deducted from its reported profit, but those same rules ironically forbid deducting a charge for the shareholders' funds a firm uses. In economic terms, equity capital is in fact a very costly financing source, because shareholders bear the risk of being paid last, after all other stakeholders and investors are paid first. But according to accountants, shareholders' equity is free.

This egregious oversight has dire practical consequences. For one thing, it means that the profit figure accountants certify to be correct is inherently at odds with the net present value decision rule. For instance, it is a simple matter for management to inflate its reported earnings and earnings per share in ways that actually harm the shareholders by investing capital in projects that earn less than the overall cost of capital but more than the aftertax cost of borrowing money, which amounts to a trivial hurdle in most cases, a couple percentage points at most. In effect, EPS requires management to vault a mere three-foot hurdle when to satisfy shareholders managers must jump a ten-foot hurdle that includes the cost of equity. A prime example of the way accounting profit leads smart managers to do dumb things was Enron, where former top executives Ken Lay and Jeff Skilling boldly declared in the firm's 2000 annual report that they were "laser-focused on earnings per share," and so they were. Bonuses were funded out of book profit, and project developers were paid for signing up new deals and not generating a decent return on investment. Consequently, Enron's EPS was on the rise while its true economic profit—its EVA—measured after deducting the full cost of capital, was plummeting in the years leading up to the firm's demise—the result of massive misallocations of capital to ill-advised energy and new economy projects. The point is, EVA measures economic profit, the profit that actually discounts to net present value, and the maximization of which is every company's most important financial goal; yet, for all its popularity, EPS is just an accounting contrivance that is wholly unrelated to the maximization of shareholder wealth or sending the right decision signals to management.

Starting in the early 1990s, firms around the world—ranging from Coca-Cola, to Briggs & Stratton, Herman Miller, and Eli Lilly in America, Siemens in Germany, Tata Consulting and the Godrej Group out of India, Brahma Beer in Brazil, and many, many more—began to turn to EVA as a new and better way to measure performance and set goals, make decisions and determine bonuses, and to communicate with investors and to teach business and finance basics to managers and employees. Properly tailored and implemented, EVA is a natural way to bring the cost of capital to life and to turn everyone in a company into a capital conscientious, owner-entrepreneur.

Bennett Stewart is a cofounder of Stern Stewart & Co. and also the CEO of EVA Dimensions, a firm providing EVA data, valuation modeling, and hedge fund management. Stewart pioneered the practical development of EVA as chronicled in his original book, The Quest for Value, *and latest book,* Best-Practice EVA.

PERFORMANCE EVALUATION: ANOTHER USE OF THE WACC

Visit **www.sternstewart.com** for more about EVA.

Performance evaluation is another use of the WACC. Probably the best-known approach in this area is the economic value added (EVA) method developed by Stern Stewart & Co. Companies such as AT&T, Coca-Cola, Quaker Oats, and Briggs & Stratton are among the firms that have been using EVA as a means of evaluating corporate performance. Similar approaches include market value added (MVA) and shareholder value added (SVA).

Although the details differ, the basic idea behind EVA and similar strategies is straightforward. Suppose we have $100 million in capital (debt and equity) tied up in our firm, and our overall WACC is 12 percent. If we multiply these together, we get $12 million. Referring back to Chapter 2, if our cash flow from assets is less than this, we are, on an overall basis, destroying value; if cash flow from assets exceeds $12 million, we are creating value.

In practice, evaluation strategies such as these suffer to a certain extent from problems with implementation. For example, it appears that many companies make extensive use of book values for debt and equity in computing cost of capital. Even so, by focusing on value creation, WACC-based evaluation procedures force employees and management to pay attention to the real bottom line: Increasing share prices.

Concept Questions

14.4a How is the WACC calculated?

14.4b Why do we multiply the cost of debt by $(1 - T_C)$ when we compute the WACC?

14.4c Under what conditions is it correct to use the WACC to determine NPV?

14.5 Divisional and Project Costs of Capital

As we have seen, using the WACC as the discount rate for future cash flows is appropriate only when the proposed investment is similar to the firm's existing activities. This is not as restrictive as it sounds. If we are in the pizza business, for example, and we are thinking of opening a new location, then the WACC is the discount rate to use. The same is true of a retailer thinking of a new store, a manufacturer considering expanding production, or a consumer products company considering expanding its markets.

Despite the usefulness of the WACC as a benchmark, there will clearly be situations in which the cash flows under consideration have risks distinctly different from those of the overall firm. We consider how to cope with this problem next.

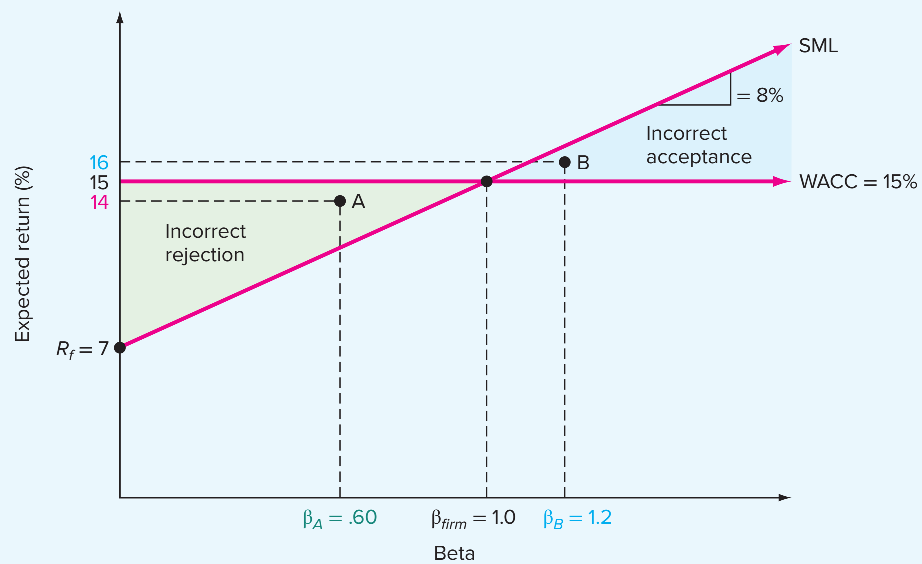
THE SML AND THE WACC

When we are evaluating investments with risks that are substantially different from those of the overall firm, use of the WACC will potentially lead to poor decisions. Figure 14.1 illustrates why.

In Figure 14.1, we have plotted an SML corresponding to a risk-free rate of 7 percent and a market risk premium of 8 percent. To keep things simple, we consider an all-equity company with a beta of 1. As we have indicated, the WACC and the cost of equity are exactly equal to 15 percent for this company because there is no debt.

FIGURE 14.1

The Security Market Line (SML) and the Weighted Average Cost of Capital (WACC)



If a firm uses its WACC to make accept–reject decisions for all types of projects, it will have a tendency toward incorrectly accepting risky projects and incorrectly rejecting less risky projects.

Suppose our firm uses its WACC to evaluate all investments. This means that any investment with a return of greater than 15 percent will be accepted and any investment with a return of less than 15 percent will be rejected. We know from our study of risk and return that a desirable investment is one that plots above the SML. As Figure 14.1 illustrates, using the WACC for all types of projects can result in the firm incorrectly accepting relatively risky projects and incorrectly rejecting relatively safe ones.

For example, consider Point A. This project has a beta of $\beta_A = .60$, as compared to the firm's beta of 1.0. It has an expected return of 14 percent. Is this a desirable investment? The answer is yes because its required return is only:

$$\begin{aligned}\text{Required return} &= R_f + \beta_A \times (R_M - R_f)\\ &= .07 + .60 \times .08\\ &= .118\text{, or } 11.8\%\end{aligned}$$

If we use the WACC as a cutoff, then this project will be rejected because its return is less than 15 percent. This example illustrates that a firm that uses its WACC as a cutoff will tend to reject profitable projects with risks less than those of the overall firm.

At the other extreme, consider Point B. This project has a beta of $\beta_B = 1.2$. It offers a 16 percent return, which exceeds the firm's cost of capital. This is not a good investment, because, given its level of systematic risk, its return is inadequate. Nonetheless, if we use the WACC to evaluate it, it will appear to be attractive. So the second error that will arise if we use the WACC as a cutoff is that we will tend to make unprofitable investments with risks greater than those of the overall firm. As a consequence, through time, a firm that uses its WACC to evaluate all projects will have a tendency to both accept unprofitable investments and become increasingly risky.

DIVISIONAL COST OF CAPITAL

The same type of problem with the WACC can arise in a corporation with more than one line of business. Imagine a corporation that has two divisions: A regulated electric company and an electronics manufacturing operation. The first of these (the electricity operation) has relatively low risk; the second has relatively high risk.

In this case, the firm's overall cost of capital is really a mixture of two different costs of capital, one for each division. If the two divisions were competing for resources, and the firm used a single WACC as a cutoff, which division would tend to be awarded greater funds for investment?

The answer is that the riskier division would tend to have greater returns (ignoring the greater risk), so it would tend to be the "winner." The less glamorous operation might have great profit potential that would end up being ignored. Large corporations in the United States are aware of this problem, and many work to develop separate divisional costs of capital.

THE PURE PLAY APPROACH

We've seen that using the firm's WACC inappropriately can lead to problems. How can we come up with the appropriate discount rates in such circumstances? Because we cannot observe the returns on these investments, there generally is no direct way of coming up with a beta. Instead, what we must do is examine other investments outside the firm that are in the same risk class as the one we are considering, and use the market-required return on these investments as the discount rate. In other words, we will try to determine what the cost of capital is for such investments by trying to locate some similar investments in the marketplace.

Going back to our electricity division, suppose we wanted to come up with a discount rate to use for that division. What we could do is identify several other electric companies that have publicly traded securities. We might find that a typical electric company has a beta of .80, AA-rated debt, and a capital structure that is about 50 percent debt and 50 percent equity. Using this information, we could develop a WACC for a typical electric company and use this as our discount rate.

Alternatively, if we were considering entering a new line of business, we would try to develop the appropriate cost of capital by looking at the market-required returns on companies already in that business. In the language of Wall Street, a company that focuses on a single line of business is called a *pure play*. If you wanted to bet on the price of crude oil by purchasing common stocks, you would try to identify companies that deal exclusively with this product because they would be the most affected by changes in the price of crude oil. Such companies would be called "pure plays on the price of crude oil."

pure play approach
The use of a WACC that is unique to a particular project, based on companies in similar lines of business.

What we try to do here is to find companies that focus as exclusively as possible on the type of project in which we are interested. Our approach, therefore, is called the **pure play approach** to estimating the required return on an investment. To illustrate, suppose McDonald's decides to enter the cell phone and tablet business with a line of electronics called McPhones. The risks involved are quite different from those in the fast-food business. As a result, McDonald's would need to look at companies already in the consumer electronics business to compute a cost of capital for the new division. An obvious pure play candidate would be Apple, which is predominantly in this line of business. Samsung, on the other hand, would not be as good a choice because it sells more product lines, such as televisions and appliances, which likely have a different level of risk.

In Chapter 3, we discussed the subject of identifying similar companies for comparison purposes. The same problems we described there come up here. The most obvious one is that we may not be able to find any suitable companies. In this case, how to objectively determine a discount rate becomes a difficult question. Even so, the important thing is to be aware of the issue so that we at least reduce the possibility of the kinds of mistakes that can arise when the WACC is used as a cutoff on all investments.

THE SUBJECTIVE APPROACH

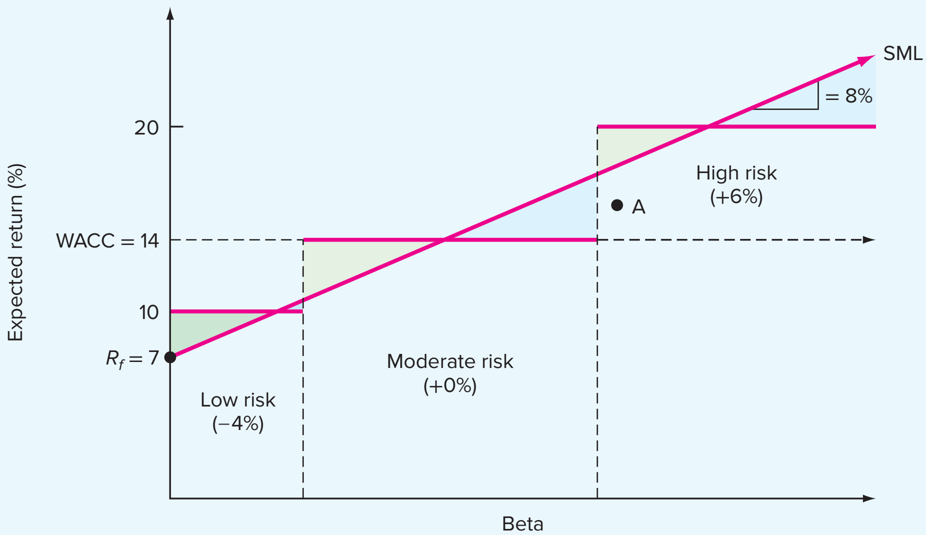
Because of the difficulties that exist in objectively establishing discount rates for individual projects, firms often adopt an approach that involves making subjective adjustments to the overall WACC. To illustrate, suppose a firm has an overall WACC of 14 percent. It places all proposed projects into four categories as follows:

Category	Examples	Adjustment Factor	Discount Rate
High risk	New products	+6%	20%
Moderate risk	Cost savings, expansion of existing lines	+0	14
Low risk	Replacement of existing equipment	−4	10
Mandatory	Pollution control equipment	n/a	n/a

n/a = Not applicable.

The effect of this crude partitioning is to assume that all projects either fall into one of three risk classes or else are mandatory. In the last case, the cost of capital is irrelevant because the project must be taken. With the subjective approach, the firm's WACC may change through time as economic conditions change. As this happens, the discount rates for the different types of projects will also change.

Within each risk class, some projects will presumably have more risk than others, and the danger of making incorrect decisions still exists. Figure 14.2 illustrates this point.



With the subjective approach, the firm places projects into one of several risk classes. The discount rate used to value the project is then determined by adding (for high risk) or subtracting (for low risk) an adjustment factor to or from the firm's WACC. This results in fewer incorrect decisions than if the firm simply used the WACC to make the decisions.

FIGURE 14.2

The Security Market Line (SML) and the Subjective Approach

Comparing Figures 14.1 and 14.2, we see that similar problems exist; but the magnitude of the potential error is less with the subjective approach. The project labeled A would be accepted if the WACC were used, but it is rejected once it is classified as a high-risk investment. What this illustrates is that some risk adjustment, even if it is subjective, is probably better than no risk adjustment.

It would be better, in principle, to objectively determine the required return for each project separately. As a practical matter, it may not be possible to go much beyond subjective adjustments because either the necessary information is unavailable or the cost and effort required are not worthwhile.

Concept Questions

14.5a What are the likely consequences if a firm uses its WACC to evaluate all proposed investments?

14.5b What is the pure play approach to determining the appropriate discount rate? When might it be used?

Company Valuation with the WACC **14.6**

When valuing a company, our approach is the same as the one we used for individual capital projects like the warehouse renovation, but there is one issue we have to deal with. When we look at an entire company, we will often see an interest deduction because the company has borrowed money. But as we have consistently emphasized, interest paid is a financing cost, not an operating cost. However, because interest paid is a tax deductible expense, a company's tax bill is lower than it would have been had the company not used debt financing. We will have much more to say about this in a later chapter.

For now, to calculate cash flow from assets, we need to first calculate what the firm's tax bill would have been if it had not used debt financing. To do that, we take earnings before interest and taxes (EBIT) and multiply it by the firm's tax rate (T_C) to get the firm's "would-have-been" tax bill, which we will call the "adjusted" taxes and label Taxes*:

$$\text{Taxes}^* = \text{EBIT} \times T_C \tag{14.8}$$

Next, we will calculate cash flow from assets the usual way, except we will use the adjusted taxes. We will call this the "adjusted" cash flow from assets, CFA*, which we calculate as:

$$\begin{aligned}\text{CFA}^* &= \text{EBIT} + \text{Depreciation} - \text{Taxes}^* \\ &\quad - \text{Change in NWC} - \text{Capital spending} \\ &= \text{EBIT} + \text{Depreciation} - \text{EBIT} \times T_C \\ &\quad - \text{Change in NWC} - \text{Capital spending}\end{aligned} \tag{14.9}$$

Our adjusted cash flow, CFA*, is often called "free cash flow," but as we mentioned much earlier in our book, that phrase means different things to different people, so we will stick with CFA* to avoid confusion.

Notice that we could simplify our CFA* calculation a bit by writing it as:

$$\begin{aligned}\text{CFA}^* &= \text{EBIT} \times (1 - T_C) + \text{Depreciation} \\ &\quad - \text{Change in NWC} - \text{Capital spending}\end{aligned} \tag{14.10}$$

The term EBIT × $(1 - T_C)$ is what net income would have been if the firm had used no debt, and the sum of the first two terms is our bottom-up definition of operating cash flow from Chapter 10.

At this point, if the firm is growing steadily, we can value it using our growing perpetuity formula (as we did earlier in this chapter). For example, suppose you project CFA* for the coming year as $\text{CFA}_1^* = \$120$ million. You think this amount will grow indefinitely at $g = 5$ percent per year. You've estimated the firm's WACC to be 9 percent, so the value of the firm today (V_0) is:

$$\text{Firm value today} = V_0 = \frac{\text{CFA}_1^*}{\text{WACC} - g} = \frac{\$120}{.09 - .05} = \$3 \text{ billion}$$

In sum, valuing a firm is no different from valuing a project, except for the fact that we have to adjust the taxes to remove the effect of any debt financing.

We can also consider the impact of nonconstant growth (as we did in an earlier chapter on stock valuation using the dividend growth model). In this case, we assume that constant growth begins at Time t in the future. In that case, we can write the value of the firm today as:

$$\begin{aligned}V_0 &= \frac{\text{CFA}_1^*}{1 + \text{WACC}} + \frac{\text{CFA}_2^*}{(1 + \text{WACC})^2} + \frac{\text{CFA}_3^*}{(1 + \text{WACC})^3} + \cdots \\ &\quad + \frac{\text{CFA}_t^* + V_t}{(1 + \text{WACC})^t}\end{aligned} \tag{14.11}$$

Here, V_t is the value of the firm at Time t, which we again calculate using the growing perpetuity formula:

$$V_t = \frac{\text{CFA}_{t+1}^*}{\text{WACC} - g} \tag{14.12}$$

As always, notice that the tricky part is that to get the value at Time t, we have to use the cash flow that occurs at the end of that period at Time $t + 1$. Also, the value of the firm in the future, V_t, is often referred to as the "terminal value."

Valuing a Company

EXAMPLE 14.6

A guest on the popular show *Great White Tank* is attempting to raise money for her new company, Feline Fancy, which makes cat toys. The potential investor wants to value the company, which is privately held. Because of this, she uses the pure play approach to determine that the appropriate WACC for the company is 8 percent. The relevant tax rate is 21 percent.

Feline Fancy currently has $40 million in debt and 3.5 million shares outstanding. Sales this year are expected to be $30 million, and that amount is expected to grow at 15 percent per year for the following four years. After that, sales are expected to grow at 2 percent indefinitely. EBIT this year will be $10 million. EBIT, depreciation, capital spending, and the change in net working capital will grow at the same rate as sales. What value would you assign to Feline Fancy as a whole? What price per share would you assign?

To value the company, we begin by estimating adjusted cash flow from assets (CFA*) for the next five years. The Year 1 values are the projections in millions for next year:

	Year 1	Year 2	Year 3	Year 4	Year 5
EBIT	$10.00	$11.50	$13.23	$15.21	$17.49
Depreciation	1.50	1.73	1.98	2.28	2.62
Taxes*	2.10	2.42	2.78	3.19	3.67
Change in NWC	.80	.92	1.06	1.22	1.40
Capital spending	2.40	2.76	3.17	3.65	4.20
CFA*	$ 6.20	$ 7.13	$ 8.20	$ 9.43	$10.84

Since the adjusted cash flow from assets will grow at 2 percent after Year 5, the terminal value of the company in Year 5 will be:

$$V_5 = \frac{\$10.84(1 + .02)}{.08 - .02} = \$184.35 \text{ million}$$

We can now find the value of the company today by discounting the first five CFA* values and the terminal value back to the present using the WACC. Doing so, we find:

$$V_0 = \frac{\$6.20}{1 + .08} + \frac{\$7.13}{(1 + .08)^2} + \frac{\$8.20}{(1 + .08)^3} + \frac{\$9.43}{(1 + .08)^4} + \frac{\$10.84 + 184.35}{(1 + .08)^5}$$
$$= \$158.14 \text{ million}$$

To find the value of equity, we subtract the $40 million in debt, resulting in a total equity value of $118.14 million. To find the share price, we divide this by the number of shares (3.5 million), which gives us a share price of:

Price per share = $118.14/3.5 = $33.75

Another common way to calculate the terminal value is to use a target ratio, similar to the way we used the PE and price-sales ratios in Chapter 8. For example, suppose the potential investor believes the appropriate price-sales ratio when the company's growth rate slows is three times. Sales in Year 5 are projected at $30 million × 1.15^4 = $52.47 million (notice that we compounded the $30 million forward four years because $30 million is sales by the end of Year 1, not sales from last year). So, the new estimated terminal value is:

$$V_5 = 3 \times \$52.47 \text{ million} = \$157.41 \text{ million}$$

With this new terminal value, the value of the company today will be:

$$V_0 = \frac{\$6.20}{1 + .08} + \frac{\$7.13}{(1 + .08)^2} + \frac{\$8.20}{(1 + .08)^3} + \frac{\$9.43}{(1 + .08)^4} + \frac{\$10.84 + 157.41}{(1 + .08)^5}$$
$$= \$139.80 \text{ million}$$

See for yourself if you don't agree that using this terminal value will result in an estimated per share value of $28.52.

Concept Questions

14.6a Why do we adjust a firm's taxes when we do a firm valuation?

14.6b Why do you think we might prefer to use a ratio when calculating the terminal value when we do a firm valuation?

14.7 Flotation Costs and the Average Cost of Capital

So far, we have not included issue, or flotation, costs in our discussion of the weighted average cost of capital. If a company accepts a new project, it may be required to issue, or float, new bonds and stocks. This means that the firm will incur some costs, which we call *flotation costs*. The nature and magnitude of flotation costs are discussed in some detail in Chapter 15.

Sometimes it is suggested that the firm's WACC should be adjusted upward to reflect flotation costs. This is really not the best approach because, once again, the required return on an investment depends on the risk of the investment, not the source of the funds. This is not to say that flotation costs should be ignored. Because these costs arise as a consequence of the decision to undertake a project, they are relevant cash flows. We briefly discuss how to include them in project analysis.

THE BASIC APPROACH

We start with a simple case. The Spatt Company, an all-equity firm, has a cost of equity of 20 percent. Because this firm is 100 percent equity, its WACC and its cost of equity are the same. Spatt is contemplating a large-scale, \$100 million expansion of its existing operations. The expansion would be funded by selling new stock.

Based on conversations with its investment banker, Spatt believes its flotation costs will run 10 percent of the amount issued. This means that Spatt's proceeds from the equity sale will be only 90 percent of the amount sold. When flotation costs are considered, what is the cost of the expansion?

As we discuss in more detail in Chapter 15, Spatt needs to sell enough equity to raise \$100 million *after* covering the flotation costs. In other words:

$$\$100 \text{ million} = (1 - .10) \times \text{Amount raised}$$
$$\text{Amount raised} = \$100 \text{ million}/.90 = \$111.11 \text{ million}$$

Spatt's flotation costs are \$11.11 million, and the true cost of the expansion is \$111.11 million once we include flotation costs.

Things are only slightly more complicated if the firm uses both debt and equity. Suppose Spatt's target capital structure is 60 percent equity, 40 percent debt. The flotation costs associated with equity are still 10 percent, but the flotation costs for debt are less—say 5 percent.

Earlier, when we had different capital costs for debt and equity, we calculated a weighted average cost of capital using the target capital structure weights. Here we will do much the same thing. We can calculate a weighted average flotation cost, f_A, by multiplying the equity flotation cost, f_E, by the percentage of equity (E/V) and the debt flotation cost, f_D, by the percentage of debt (D/V) and then adding the two together:

14.13

$$\begin{aligned} f_A &= (E/V) \times f_E + (D/V) \times f_D \\ &= .60 \times .10 + .40 \times .05 \\ &= .08, \text{ or } 8\% \end{aligned}$$

The weighted average flotation cost is 8 percent. What this tells us is that for every dollar in outside financing needed for new projects, the firm must actually raise $1/(1 − .08) = $1.087. In our example, the project cost is $100 million when we ignore flotation costs. If we include them, then the true cost is $100 million/(1 − f_A) = $100 million/.92 = $108.7 million.

In taking issue costs into account, the firm must be careful not to use the wrong weights. The firm should use the target weights, even if it can finance the entire cost of the project with either debt or equity. The fact that a firm can finance a specific project with debt or equity is not directly relevant. If a firm has a target debt-equity ratio of 1, for example, but chooses to finance a particular project with all debt, it will have to raise additional equity later on to maintain its target debt-equity ratio. To take this into account, the firm should always use the target weights in calculating the flotation cost.

Calculating the Weighted Average Flotation Cost — EXAMPLE 14.7

The Weinstein Corporation has a target capital structure that is 80 percent equity, 20 percent debt. The flotation costs for equity issues are 20 percent of the amount raised; the flotation costs for debt issues are 6 percent. If Weinstein needs $65 million for a new manufacturing facility, what is the true cost once flotation costs are considered?

We first calculate the weighted average flotation cost, f_A:

$$\begin{aligned} f_A &= (E/V) \times f_E + (D/V) \times f_D \\ &= .80 \times .20 + .20 \times .06 \\ &= .172, \text{ or } 17.2\% \end{aligned}$$

The weighted average flotation cost is 17.2 percent. The project cost is $65 million when we ignore flotation costs. If we include them, then the true cost is $65 million/(1 − f_A) = $65 million/.828 = $78.5 million, again illustrating that flotation costs can be a considerable expense.

FLOTATION COSTS AND NPV

To illustrate how flotation costs can be included in an NPV analysis, suppose the Tripleday Printing Company is currently at its target debt-equity ratio of 100 percent. It is considering building a new $500,000 printing plant in Kansas. This new plant is expected to generate aftertax cash flows of $73,150 per year forever. The tax rate is 21 percent. There are two financing options:

1. A $500,000 new issue of common stock: The issuance costs of the new common stock would be about 10 percent of the amount raised. The required return on the company's new equity is 20 percent.
2. A $500,000 issue of 30-year bonds: The issuance costs of the new debt would be 2 percent of the proceeds. The company can raise new debt at 10 percent.

What is the NPV of the new printing plant?

To begin, because printing is the company's main line of business, we will use the company's weighted average cost of capital to value the new printing plant:

$$\begin{aligned} \text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C) \\ &= .50 \times .20 + .50 \times .10 \times (1 - .21) \\ &= .1395, \text{ or } 13.95\% \end{aligned}$$

Because the cash flows are $73,150 per year forever, the PV of the cash flows at 13.95 percent per year is:

$$\text{PV} = \frac{\$73{,}150}{.1395} = \$524{,}373$$

IN THEIR OWN WORDS ...

Samuel Weaver on Cost of Capital and Hurdle Rates at the Hershey Company

At Hershey, we reevaluate our cost of capital annually or as market conditions warrant. The calculation of the cost of capital essentially involves three different issues, each with a few alternatives:

- *Capital weights*
  book value or market value weights
  current or target capital structure
- *Cost of debt*
  Historical (coupon) interest rates
  Market-based interest rates
- *Cost of equity*
  Dividend growth model
  Capital asset pricing model, or CAPM

At Hershey, we calculate our cost of capital officially based on the projected "target" capital structure at the end of our three-year intermediate planning horizon. This allows management to see the immediate impact of strategic decisions related to the planned composition of Hershey's capital pool. The cost of debt is calculated as the anticipated weighted average aftertax cost of debt in that final plan year based on the coupon rates attached to that debt. The cost of equity is computed via the dividend growth model.

We conducted a survey of the 10 food processing companies that we consider our industry group competitors. The results of this survey indicated that the cost of capital for most of these companies was in the 7 to 10 percent range. Furthermore, without exception, all 10 of these companies employed the CAPM when calculating their cost of equity. Our experience has been that the dividend growth model works better for Hershey. We do pay dividends, and we do experience steady, stable growth in our dividends. This growth is also projected within our strategic plan. Consequently, the dividend growth model is technically applicable and appealing to management because it reflects their best estimate of the future long-term growth rate.

In addition to the calculation already described, the other possible combinations and permutations are calculated as barometers. Unofficially, the cost of capital is calculated using market weights, current marginal interest rates, and the CAPM cost of equity. For the most part, and due to rounding the cost of capital to the nearest whole percentage point, these alternative calculations yield approximately the same results.

From the cost of capital, individual project hurdle rates are developed using a subjectively determined risk premium based on the characteristics of the project. Projects are grouped into separate project categories, such as cost savings, capacity expansion, product line extension, and new products. For example, in general, a new product is more risky than a cost savings project. Consequently, each project category's hurdle rate reflects the level of risk and commensurate required return as perceived by senior management. As a result, capital project hurdle rates range from a slight premium over the cost of capital to the highest hurdle rate of approximately double the cost of capital.

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If we ignore flotation costs, the NPV is:

$$\text{NPV} = \$524{,}373 - 500{,}000 = \$24{,}373$$

With no flotation costs, the project generates an NPV that is greater than zero, so it should be accepted.

What about financing arrangements and issue costs? Because new financing must be raised, the flotation costs are relevant. From the information given, we know that the flotation costs are 2 percent for debt and 10 percent for equity. Because Tripleday uses equal amounts of debt and equity, the weighted average flotation cost, f_A, is:

$$\begin{aligned} f_A = (E/V) \times f_E + (D/V) \times f_D &= .50 \times .10 + .50 \times .02 \\ &= .06, \text{ or } 6\% \end{aligned}$$

Remember, the fact that Tripleday can finance the project with all debt or all equity is irrelevant. Because Tripleday needs \$500,000 to fund the new plant, the true cost, once we include flotation costs, is \$500,000/(1 − f_A) = \$500,000/.94 = \$531,915. Because the PV of the cash flows is \$524,373, the plant has an NPV of \$524,373 − 531,915 = −\$7,542, so it is no longer a good investment.

INTERNAL EQUITY AND FLOTATION COSTS

Our discussion of flotation costs to this point implicitly assumes that firms always have to raise the capital needed for new investments. In reality, most firms rarely sell equity at all. Instead, their internally generated cash flow is sufficient to cover the equity portion of their capital spending. Only the debt portion must be raised externally.

The use of internal equity doesn't change our approach. We now assign a value of zero to the flotation cost of equity because there is no such cost. In our Tripleday example, the weighted average flotation cost would therefore be:

$$\begin{aligned} f_A &= (E/V) \times f_E + (D/V) \times f_D \\ &= .50 \times 0 + .50 \times .02 \\ &= .01, \text{ or } 1\% \end{aligned}$$

Notice that whether equity is generated internally or externally makes a big difference because external equity has a relatively high flotation cost.

Concept Questions

14.7a What are flotation costs?

14.7b How are flotation costs included in an NPV analysis?

Summary and Conclusions 14.8

This chapter has discussed cost of capital. The most important concept is the weighted average cost of capital, or WACC, which we interpreted as the required rate of return on the overall firm. It is also the discount rate appropriate for cash flows that are similar in risk to those of the overall firm. We described how the WACC can be calculated, and we illustrated how it can be used in certain types of analyses.

We also pointed out situations in which it is inappropriate to use the WACC as the discount rate. To handle such cases, we described some alternative approaches to developing discount rates, such as the pure play approach. We also discussed how the flotation costs associated with raising new capital can be included in an NPV analysis.

CONNECT TO FINANCE

Can you answer the following *Connect* Quiz questions?

Section 14.2 A firm has paid dividends of \$1.02, \$1.10, \$1.25, and \$1.35 over the past four years, respectively. What is the average dividend growth rate?

Section 14.3 A semiannual, 7 percent bond matures in 14 years and has a face value of \$1,000. The market quote on this bond is 101.4. What is the aftertax cost of debt if the tax rate is 21 percent?

Section 14.4 Why is the tax rate applied to the cost of debt but not to the cost of equity or preferred stock when computing a firm's weighted average cost of capital?

Section 14.5 What approach to a project's cost of capital entails the use of another firm's cost of capital rather than the use of your own firm's cost of capital?

Section 14.6 What is the flotation cost of equity for a firm that generates sufficient internal cash flows to cover the equity portion of any capital expenditure?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

14.1 **Calculating the Cost of Equity** Suppose stock in Watta Corporation has a beta of .80. The market risk premium is 6 percent, and the risk-free rate is 6 percent. Watta's last dividend was \$1.20 per share, and the dividend is expected to grow at 8 percent indefinitely. The stock currently sells for \$45 per share. What is Watta's cost of equity capital?

14.2 **Calculating the WACC** In addition to the information given in the previous problem, suppose Watta has a target debt-equity ratio of 50 percent. Its cost of debt is 9 percent before taxes. If the tax rate is 21 percent, what is the WACC?

14.3 **Flotation Costs** Suppose in the previous problem Watta is seeking \$30 million for a new project. The necessary funds will have to be raised externally. Watta's flotation costs for selling debt and equity are 2 percent and 16 percent, respectively. If flotation costs are considered, what is the true cost of the new project?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

14.1 We start off with the SML approach. Based on the information given, the expected return on Watta's common stock is:

$$\begin{aligned} R_E &= R_f + \beta_E \times (R_M - R_f) \\ &= .06 + .80 \times .06 \\ &= .1080, \text{ or } 10.80\% \end{aligned}$$

We now use the dividend growth model. The projected dividend is $D_0 \times (1 + g) =$ \$1.20 $\times$ 1.08 = \$1.296, so the expected return using this approach is:

$$\begin{aligned} R_E &= D_1 / P_0 + g \\ &= \$1.296/\$45 + .08 \\ &= .1088, \text{ or } 10.88\% \end{aligned}$$

Because these two estimates, 10.80 percent and 10.88 percent, are fairly close, we will average them. Watta's cost of equity is approximately 10.84 percent.

14.2 Because the target debt-equity ratio is .50, Watta uses \$.50 in debt for every \$1 in equity. In other words, Watta's target capital structure is 1/3 debt and 2/3 equity. The WACC is thus:

$$\begin{aligned}\text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C)\\ &= 2/3 \times .1084 + 1/3 \times .09 \times (1 - .21)\\ &= .0960, \text{ or } 9.60\%\end{aligned}$$

14.3 Because Watta uses both debt and equity to finance its operations, we first need the weighted average flotation cost. As in the previous problem, the percentage of equity financing is 2/3, so the weighted average cost is:

$$\begin{aligned}f_A &= (E/V) \times f_E + (D/V) \times f_D\\ &= 2/3 \times .16 + 1/3 \times .02\\ &= .1133, \text{ or } 11.33\%\end{aligned}$$

If Watta needs \$30 million after flotation costs, then the true cost of the project is \$30 million/$(1 - f_A)$ = \$30 million/.8867 = \$33.83 million.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **WACC** [LO3] On the most basic level, if a firm's WACC is 12 percent, what does this mean?
2. **Book Values versus Market Values** [LO3] In calculating the WACC, if you had to use book values for either debt or equity, which would you choose? Why?
3. **Project Risk** [LO5] If you can borrow all the money you need for a project at 6 percent, doesn't it follow that 6 percent is your cost of capital for the project?
4. **WACC and Taxes** [LO3] Why do we use an aftertax figure for cost of debt but not for cost of equity?
5. **DCF Cost of Equity Estimation** [LO1] What are the advantages of using the DCF model for determining the cost of equity capital? What are the disadvantages? What specific piece of information do you need to find the cost of equity using this model? What are some of the ways in which you could get this estimate?
6. **SML Cost of Equity Estimation** [LO1] What are the advantages of using the SML approach to finding the cost of equity capital? What are the disadvantages? What specific pieces of information are needed to use this method? Are all of these variables observable, or do they need to be estimated? What are some of the ways in which you could get these estimates?
7. **Cost of Debt Estimation** [LO2] How do you determine the appropriate cost of debt for a company? Does it make a difference if the company's debt is privately placed as opposed to being publicly traded? How would you estimate the cost of debt for a firm whose only debt issues are privately held by institutional investors?
8. **Cost of Capital** [LO5] Suppose Tom O'Bedlam, president of Bedlam Products, Inc., has hired you to determine the firm's cost of debt and cost of equity capital.
   a. The stock currently sells for \$50 per share, and the dividend per share will probably be about \$5. Tom argues, "It will cost us \$5 per share to use the stockholders' money this year, so the cost of equity is equal to 10 percent (= \$5/50)." What's wrong with this conclusion?
   b. Based on the most recent financial statements, Bedlam Products's total liabilities are \$8 million. Total interest expense for the coming year will be about

$1 million. Tom therefore reasons, "We owe $8 million, and we will pay $1 million interest. Therefore, our cost of debt is obviously $1 million/8 million = .125, or 12.5%." What's wrong with this conclusion?

c. Based on his own analysis, Tom is recommending that the company increase its use of equity financing because "Debt costs 12.5 percent, but equity costs only 10 percent; thus equity is cheaper." Ignoring all the other issues, what do you think about the conclusion that the cost of equity is less than the cost of debt?

9. **Company Risk versus Project Risk** [LO5] Both Dow Chemical Company, a large natural gas user, and Superior Oil, a major natural gas producer, are thinking of investing in natural gas wells near Houston. Both companies are all equity financed. Dow and Superior are looking at identical projects. They've analyzed their respective investments, which would involve a negative cash flow now and positive expected cash flows in the future. These cash flows would be the same for both firms. No debt would be used to finance the projects. Both companies estimate that their projects would have a net present value of $1 million at an 18 percent discount rate and a −$1.1 million NPV at a 22 percent discount rate. Dow has a beta of 1.25, whereas Superior has a beta of .75. The expected risk premium on the market is 8 percent, and risk-free bonds are yielding 12 percent. Should either company proceed? Should both? Explain.

10. **Divisional Cost of Capital** [LO5] Under what circumstances would it be appropriate for a firm to use different costs of capital for its different operating divisions? If the overall firm WACC were used as the hurdle rate for all divisions, would the riskier divisions or the more conservative divisions tend to get most of the investment projects? Why? If you were to try to estimate the appropriate cost of capital for different divisions, what problems might you encounter? What are two techniques you could use to develop a rough estimate for each division's cost of capital?

QUESTIONS AND PROBLEMS

BASIC
(Questions 1–19)

1. **Calculating Cost of Equity** [LO1] The Drogon Co. just issued a dividend of $2.80 per share on its common stock. The company is expected to maintain a constant 4.5 percent growth rate in its dividends indefinitely. If the stock sells for $58 a share, what is the company's cost of equity?

2. **Calculating Cost of Equity** [LO1] The Rhaegel Corporation's common stock has a beta of 1.07. If the risk-free rate is 3.5 percent and the expected return on the market is 10 percent, what is the company's cost of equity capital?

3. **Calculating Cost of Equity** [LO1] Stock in Daenerys Industries has a beta of 1.05. The market risk premium is 7 percent, and T-bills are currently yielding 3.4 percent. The company's most recent dividend was $2.35 per share, and dividends are expected to grow at an annual rate of 4.1 percent indefinitely. If the stock sells for $43 per share, what is your best estimate of the company's cost of equity?

4. **Estimating the DCF Growth Rate** [LO1] Suppose Stark, Ltd., just issued a dividend of $2.51 per share on its common stock. The company paid dividends of $2.01, $2.17, $2.25, and $2.36 per share in the last four years. If the stock currently sells for $43, what is your best estimate of the company's cost of equity capital using the arithmetic average growth rate in dividends? What if you use the geometric average growth rate?

5. **Calculating Cost of Preferred Stock** [LO1] Holdup Bank has an issue of preferred stock with a stated dividend of $4.25 that just sold for $93 per share. What is the bank's cost of preferred stock?

6. **Calculating Cost of Debt [LO2]** Viserion, Inc., is trying to determine its cost of debt. The firm has a debt issue outstanding with 23 years to maturity that is quoted at 103 percent of face value. The issue makes semiannual payments and has an embedded cost of 6 percent annually. What is the company's pretax cost of debt? If the tax rate is 21 percent, what is the aftertax cost of debt?
7. **Calculating Cost of Debt [LO2]** Jiminy's Cricket Farm issued a 30-year, 6 percent semiannual bond three years ago. The bond currently sells for 93 percent of its face value. The company's tax rate is 22 percent.
   a. What is the pretax cost of debt?
   b. What is the aftertax cost of debt?
   c. Which is more relevant, the pretax or the aftertax cost of debt? Why?
8. **Calculating Cost of Debt [LO2]** For the firm in Problem 7, suppose the book value of the debt issue is $95 million. In addition, the company has a second debt issue on the market, a zero coupon bond with eight years left to maturity; the book value of this issue is $40 million, and the bonds sell for 67 percent of par. What is the company's total book value of debt? The total market value? What is your best estimate of the aftertax cost of debt now?
9. **Calculating WACC [LO3]** Targaryen Corporation has a target capital structure of 70 percent common stock, 5 percent preferred stock, and 25 percent debt. Its cost of equity is 10 percent, the cost of preferred stock is 5 percent, and the pretax cost of debt is 6 percent. The relevant tax rate is 23 percent.
   a. What is the company's WACC?
   b. The company president has approached you about the company's capital structure. He wants to know why the company doesn't use more preferred stock financing because it costs less than debt. What would you tell the president?
10. **Taxes and WACC [LO3]** Lannister Manufacturing has a target debt-equity ratio of .55. Its cost of equity is 11 percent, and its cost of debt is 6 percent. If the tax rate is 21 percent, what is the company's WACC?
11. **Finding the Target Capital Structure [LO3]** Fama's Llamas has a weighted average cost of capital of 7.9 percent. The company's cost of equity is 11 percent, and its pretax cost of debt is 5.8 percent. The tax rate is 25 percent. What is the company's target debt-equity ratio?
12. **Book Value versus Market Value [LO3]** Dinklage Corp. has 7 million shares of common stock outstanding. The current share price is $68, and the book value per share is $8. The company also has two bond issues outstanding. The first bond issue has a face value of $70 million, a coupon rate of 6 percent, and sells for 97 percent of par. The second issue has a face value of $40 million, a coupon rate of 6.5 percent, and sells for 108 percent of par. The first issue matures in 21 years, the second in 6 years. Both bonds make semiannual coupon payments.
    a. What are the company's capital structure weights on a book value basis?
    b. What are the company's capital structure weights on a market value basis?
    c. Which are more relevant, the book or market value weights? Why?
13. **Calculating the WACC [LO3]** In Problem 12, suppose the most recent dividend was $3.25 and the dividend growth rate is 5 percent. Assume that the overall cost of debt is the weighted average of that implied by the two outstanding debt issues. Both bonds make semiannual payments. The tax rate is 21 percent. What is the company's WACC?

14. **WACC [LO3]** Starset, Inc., has a target debt-equity ratio of .85. Its WACC is 9.1 percent, and the tax rate is 23 percent.
    a. If the company's cost of equity is 14 percent, what is its pretax cost of debt?
    b. If instead you know that the aftertax cost of debt is 6.5 percent, what is the cost of equity?

15. **Finding the WACC [LO3]** Given the following information for Watson Power Co., find the WACC. Assume the company's tax rate is 21 percent.

Debt:	15,000 bonds with a 5.8 percent coupon outstanding, $1,000 par value, 25 years to maturity, selling for 108 percent of par; the bonds make semiannual payments.
Common stock:	575,000 shares outstanding, selling for $64 per share; the beta is 1.09.
Preferred stock:	35,000 shares of 2.8 percent preferred stock outstanding, currently selling for $65 per share.
Market:	7 percent market risk premium and 3.2 percent risk-free rate.

16. **Finding the WACC [LO3]** Titan Mining Corporation has 7.5 million shares of common stock outstanding, 250,000 shares of 4.2 percent preferred stock outstanding, and 140,000 bonds with a semiannual coupon of 5.1 percent outstanding, par value $1,000 each. The common stock currently sells for $51 per share and has a beta of 1.15, the preferred stock currently sells for $103 per share, and the bonds have 15 years to maturity and sell for 107 percent of par. The market risk premium is 7.5 percent, T-bills are yielding 2.4 percent, and the company's tax rate is 22 percent.
    a. What is the firm's market value capital structure?
    b. If the company is evaluating a new investment project that has the same risk as the firm's typical project, what rate should the firm use to discount the project's cash flows?

17. **SML and WACC [LO1]** An all-equity firm is considering the following projects:

Project	Beta	IRR
W	.85	8.9%
X	.92	10.8
Y	1.09	12.8
Z	1.35	13.3

The T-bill rate is 4 percent, and the expected return on the market is 11 percent.
    a. Which projects have a higher expected return than the firm's 11 percent cost of capital?
    b. Which projects should be accepted?
    c. Which projects would be incorrectly accepted or rejected if the firm's overall cost of capital were used as a hurdle rate?

18. **Calculating Flotation Costs [LO4]** Suppose your company needs $24 million to build a new assembly line. Your target debt-equity ratio is .75. The flotation cost for new equity is 7 percent, but the flotation cost for debt is only 3 percent. Your boss has decided to fund the project by borrowing money because the flotation costs are lower and the needed funds are relatively small.
    a. What do you think about the rationale behind borrowing the entire amount?
    b. What is your company's weighted average flotation cost, assuming all equity is raised externally?

c. What is the true cost of building the new assembly line after taking flotation costs into account? Does it matter in this case that the entire amount is being raised from debt?

19. Calculating Flotation Costs [LO4] Cully Company needs to raise $80 million to start a new project and will raise the money by selling new bonds. The company will generate no internal equity for the foreseeable future. The company has a target capital structure of 70 percent common stock, 5 percent preferred stock, and 25 percent debt. Flotation costs for issuing new common stock are 7 percent, for new preferred stock, 4 percent, and for new debt, 2 percent. What is the true initial cost figure the company should use when evaluating its project?

INTERMEDIATE
(Questions 20–25)

20. WACC and NPV [LO3, 5] Sommer, Inc., is considering a project that will result in initial aftertax cash savings of $2.3 million at the end of the first year, and these savings will grow at a rate of 2 percent per year indefinitely. The firm has a target debt-equity ratio of .60, a cost of equity of 10 percent, and an aftertax cost of debt of 4.6 percent. The cost-saving proposal is somewhat riskier than the usual project the firm undertakes; management uses the subjective approach and applies an adjustment factor of +3 percent to the cost of capital for such risky projects. Under what circumstances should the company take on the project?

21. Flotation Costs [LO4] Being Human, Inc., recently issued new securities to finance a new TV show. The project cost $35 million, and the company paid $2.2 million in flotation costs. In addition, the equity issued had a flotation cost of 7 percent of the amount raised, whereas the debt issued had a flotation cost of 3 percent of the amount raised. If the company issued new securities in the same proportion as its target capital structure, what is the company's target debt-equity ratio?

22. Calculating the Cost of Debt [LO2] Ying Import has several bond issues outstanding, each making semiannual interest payments. The bonds are listed in the following table. If the corporate tax rate is 22 percent, what is the aftertax cost of the company's debt?

Bond	Coupon Rate	Price Quote	Maturity	Face Value
1	5.00%	103.18	5 years	$45,000,000
2	7.10	112.80	8 years	40,000,000
3	6.30	107.45	$15\frac{1}{2}$ years	50,000,000
4	5.90	102.75	25 years	65,000,000

23. Calculating the Cost of Equity [LO1] Minder Industries stock has a beta of 1.08. The company just paid a dividend of $.65, and the dividends are expected to grow at 4 percent. The expected return on the market is 10.5 percent, and Treasury bills are yielding 3.4 percent. The most recent stock price for the company is $72.

a. Calculate the cost of equity using the DCF method.

b. Calculate the cost of equity using the SML method.

c. Why do you think your estimates in (a) and (b) are so different?

24. Adjusted Cash Flow from Assets [LO3] Pearl Corp. is expected to have an EBIT of $1.8 million next year. Depreciation, the increase in net working capital, and capital spending are expected to be $155,000, $75,000, and $115,000, respectively. All are expected to grow at 18 percent per year for four years. The company currently has $9.5 million in debt and 750,000 shares outstanding. After Year 5, the adjusted cash flow from assets is expected to grow at 3 percent indefinitely. The company's

WACC is 8.5 percent and the tax rate is 21 percent. What is the price per share of the company's stock?

25. **Adjusted Cash Flow from Assets [LO3]** In the previous problem, instead of a perpetual growth rate in adjusted cash flow from assets, you decide to calculate the terminal value of the company with the price-sales ratio. You believe that Year 5 sales will be $16.9 million and the appropriate price-sales ratio is 2.9. What is your new estimate of the current share price?

CHALLENGE
(Questions 26–31)

26. **Adjusted Cash Flow from Assets [LO3]** You have looked at the current financial statements for Reigle Homes, Co. The company has an EBIT of $3.15 million this year. Depreciation, the increase in net working capital, and capital spending were $265,000, $105,000, and $495,000, respectively. You expect that over the next five years, EBIT will grow at 15 percent per year, depreciation and capital spending will grow at 20 percent per year, and NWC will grow at 10 percent per year. The company has $19.5 million in debt and 400,000 shares outstanding. After Year 5, the adjusted cash flow from assets is expected to grow at 3.5 percent indefinitely. The company's WACC is 9.25 percent, and the tax rate is 22 percent. What is the price per share of the company's stock?

27. **Adjusted Cash Flow from Assets [LO3]** In the previous problem, suppose you believe that sales in five years will be $29.2 million and the price-sales ratio will be 2.45. What is the share price now?

28. **Flotation Costs and NPV [LO3, 4]** Photochronograph Corporation (PC) manufactures time series photographic equipment. It is currently at its target debt-equity ratio of .60. It's considering building a new $65 million manufacturing facility. This new plant is expected to generate aftertax cash flows of $9.4 million in perpetuity. The company raises all equity from outside financing. There are three financing options:

    1. *A new issue of common stock*: The flotation costs of the new common stock would be 8 percent of the amount raised. The required return on the company's new equity is 14 percent.
    2. *A new issue of 20-year bonds*: The flotation costs of the new bonds would be 4 percent of the proceeds. If the company issues these new bonds at an annual coupon rate of 8 percent, they will sell at par.
    3. *Increased use of accounts payable financing*: Because this financing is part of the company's ongoing daily business, it has no flotation costs, and the company assigns it a cost that is the same as the overall firm WACC. Management has a target ratio of accounts payable to long-term debt of .15. (Assume there is no difference between the pretax and aftertax accounts payable cost.)

    What is the NPV of the new plant? Assume that PC has a 21 percent tax rate.

29. **Flotation Costs [LO3]** Lucas Corp. has a debt-equity ratio of .65. The company is considering a new plant that will cost $51 million to build. When the company issues new equity, it incurs a flotation cost of 7 percent. The flotation cost on new debt is 2.7 percent. What is the initial cost of the plant if the company raises all equity externally? What if it typically uses 60 percent retained earnings? What if all equity investment is financed through retained earnings?

30. **Project Evaluation [LO3, 4]** This is a comprehensive project evaluation problem bringing together much of what you have learned in this and previous chapters. Suppose you have been hired as a financial consultant to Defense Electronics, Inc. (DEI), a large, publicly traded firm that is the market share leader in radar detection systems (RDSs). The company is looking at setting up a manufacturing plant overseas to produce a new line of RDSs. This will be a five-year project.

The company bought some land three years ago for $2.7 million in anticipation of using it as a toxic dump site for waste chemicals, but it built a piping system to safely discard the chemicals instead. The land was appraised last week for $3.8 million on an aftertax basis. In five years, the aftertax value of the land will be $4.1 million, but the company expects to keep the land for a future project. The company wants to build its new manufacturing plant on this land; the plant and equipment will cost $34 million to build. The following market data on DEI's securities are current:

Debt:	195,000 bonds with a coupon rate of 6.2 percent outstanding, 25 years to maturity, selling for 106 percent of par; the bonds have a $1,000 par value each and make semiannual payments.
Common stock:	8,100,000 shares outstanding, selling for $63 per share; the beta is 1.1.
Preferred stock:	450,000 shares of 4.25 percent preferred stock outstanding, selling for $83 per share.
Market:	7 percent expected market risk premium; 3.1 percent risk- free rate.

DEI uses G.M. Wharton as its lead underwriter. Wharton charges DEI spreads of 7 percent on new common stock issues, 5 percent on new preferred stock issues, and 3 percent on new debt issues. Wharton has included all direct and indirect issuance costs (along with its profit) in setting these spreads. Wharton has recommended to DEI that it raise the funds needed to build the plant by issuing new shares of common stock. DEI's tax rate is 25 percent. The project requires $1,500,000 in initial net working capital investment to get operational. Assume DEI raises all equity for new projects externally.

a. Calculate the project's initial Time 0 cash flow, taking into account all side effects.

b. The new RDS project is somewhat riskier than a typical project for DEI, primarily because the plant is being located overseas. Management has told you to use an adjustment factor of +2 percent to account for this increased riskiness. Calculate the appropriate discount rate to use when evaluating DEI's project.

c. The manufacturing plant has an eight-year tax life, and DEI uses straight-line depreciation to a zero salvage value. At the end of the project (that is, the end of Year 5), the plant and equipment can be scrapped for $4.9 million. What is the aftertax salvage value of this plant and equipment?

d. The company will incur $6.9 million in annual fixed costs. The plan is to manufacture 12,100 RDSs per year and sell them at $11,450 per machine; the variable production costs are $9,500 per RDS. What is the annual operating cash flow (OCF) from this project?

e. DEI's comptroller is primarily interested in the impact of DEI's investments on the bottom line of reported accounting statements. What will you tell her is the accounting break-even quantity of RDSs sold for this project?

f. Finally, DEI's president wants you to throw all your calculations, assumptions, and everything else into the report for the chief financial officer; all he wants to know is what the RDS project's internal rate of return (IRR) and net present value (NPV) are. What will you report?

31. Adjusted Cash Flow from Assets [LO3] Suppose you are looking at a company with no change in capital spending, no change in net working capital, and no depreciation. Since the company is not increasing its assets, EBIT is constant. What is the value of the company?

EXCEL MASTER IT! PROBLEM

You want to calculate the WACC for auto parts retailer AutoZone (AZO). Complete the following steps to construct a spreadsheet that can be updated.

a. Using an input for the ticker symbol, create hyperlinks to the web pages that you will need to find all of the information necessary to calculate the cost of equity. Use a market risk premium of 7 percent when using CAPM.

b. Create hyperlinks to go to the FINRA bond quote website and the SEC EDGAR database and find the information for the company's bonds. Create a table that calculates the cost of debt for the company. Assume the tax rate is 21 percent.

c. Finally, calculate the market value weights for debt and equity. What is the WACC for AutoZone?

MINICASE

Cost of Capital for Swan Motors

You have recently been hired by Swan Motors, Inc. (SMI), in its relatively new treasury management department. SMI was founded eight years ago by Joe Swan. Joe found a method to manufacture a cheaper battery that will hold a larger charge, giving a car powered by the battery a range of 700 miles before requiring a charge. The cars manufactured by SMI are mid-sized and carry a price that allows the company to compete with other mainstream auto manufacturers. The company is privately owned by Joe and his family, and it had sales of $97 million last year.

SMI primarily sells to customers who buy the cars online, although it does have a limited number of company-owned dealerships. The customer selects any customization and makes a deposit of 20 percent of the purchase price. After the order is taken, the car is made to order, typically within 45 days. SMI's growth to date has come from its profits. When the company had sufficient capital, it would expand production. Relatively little formal analysis has been used in its capital budgeting process. Joe has just read about capital budgeting techniques and has come to you for help. For starters, the company has never attempted to determine its cost of capital, and Joe would like you to perform the analysis. Because the company is privately owned, it is difficult to determine the cost of equity for the company. Joe wants you to use the pure play approach to estimate the cost of capital for SMI, and he has chosen Tesla Motors as a representative company. The following questions will lead you through the steps to calculate this estimate.

QUESTIONS

1. Most publicly traded corporations are required to submit quarterly (10-Q) and annual (10-K) reports to the SEC detailing the financial operations of the company over the past quarter or year, respectively. These corporate filings are available on the SEC website at www.sec.gov. Go to the SEC website, follow the "Search for Company Filings" link, and search for SEC filings made by Tesla Motors (TSLA). Find the most recent 10-Q or 10-K, and download the form. Look on the balance sheet to find the book value of debt and the book value of equity.
2. To estimate the cost of equity for TSLA, go to finance.yahoo.com and enter the ticker symbol TSLA. Follow the links to answer the following questions: What is the most recent stock price listed for TSLA? What is the market value of equity, or market capitalization? How many shares of stock does TSLA have outstanding? What is the most recent annual dividend? Can you use the dividend discount model in this case? What is the beta for TSLA? Now go back to finance.yahoo.com and follow the "Bonds" link. What is the yield on three-month Treasury bills? Using the historical market risk premium, what is the cost of equity for TSLA using CAPM?
3. You now need to calculate the cost of debt for TSLA. Go to finra-markets.morningstar.com, enter TSLA as the company, and find the yield to maturity for each of TSLA's bonds. What is the weighted average cost of debt for TSLA using the book value weights and using the market value weights? Does it make a difference in this case if you use book value weights or market value weights?
4. You now have all the necessary information to calculate the weighted average cost of capital for TSLA. Calculate this using book value weights and market value weights, assuming TSLA has a 21 percent tax rate. Which number is more relevant?
5. You used TSLA as a pure play company to estimate the cost of capital for SMI. Are there any potential problems with this approach in this situation?

Raising Capital

Chapter 15

ON MARCH 2, 2017, in one of the most anticipated IPOs of the year, video messaging company Snap, operator of Snapchat, went public. Assisted by investment banks Morgan Stanley, Goldman Sachs, J.P. Morgan, and a host of others, the company offered 145 million shares of stock at a price of $17 per share. The first trade on the New York Stock Exchange was at $24 per share, a 41 percent jump from the initial stock price. The stock quickly rose to $26.05, before closing at $24.48. What made Snap's stock offering particularly unique was that the company sold Class A shares, which had no voting rights, in the IPO. The company also had Class B shares, with one vote per share, and Class C stock, with 10 votes per share. The Class C stock was held entirely by the company's founders. In this chapter, we will examine the process by which companies such as Snap sell stock to the public, the costs of doing so, and the role of investment banks in the process.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Describe the venture capital market and its role in the financing of new, high-risk ventures.

LO2 Explain how securities are sold to the public and the role of investment banks in the process.

LO3 Define initial public offerings and some of the costs of going public.

LO4 Demonstrate how rights are issued to existing shareholders and how to value those rights.

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All firms must, at varying times, obtain capital. To do so, a firm must either borrow the money (debt financing), sell a portion of the firm (equity financing), or both. How a firm raises capital depends a great deal on the size of the firm, its life-cycle stage, and its growth prospects.

In this chapter, we examine some of the ways in which firms actually raise capital. We begin by looking at companies in the early stages of their lives and the importance of venture capital for such firms. We then look at the process of going public and the role of investment banks. Along the way, we discuss many of the issues associated with selling securities to the public and their implications for all types of firms. We close the chapter with a discussion of sources of debt capital.[1]

[1]We are indebted to Jay R. Ritter of the University of Florida and M. Shane Hadden of *The Currency Report* (www.globalcurrencyreport.com) for helpful comments and suggestions for this chapter.

15.1 The Financing Life Cycle of a Firm: Early-Stage Financing and Venture Capital

One day, you and a friend have a great idea for a new computer software product that helps users communicate using the next-generation meganet. Filled with entrepreneurial zeal, you christen the product Megacomm and set about bringing it to market.

Working nights and weekends, you are able to create a prototype of your product. It doesn't actually work, but at least you can show it around to illustrate your idea. To actually develop the product, you need to hire programmers, buy computers, rent office space, and so on. Unfortunately, because you are both college students, your combined assets are not sufficient to fund a pizza party, much less a start-up company. You need what is often referred to as OPM—other people's money.

Your first thought might be to approach a bank for a loan. You would probably discover that banks are generally not interested in making loans to start-up companies with no assets (other than an idea) run by fledgling entrepreneurs with no track record. Instead your search for capital would likely lead you to the **venture capital (VC)** market.

venture capital (VC)
Financing for new, often high-risk, ventures.

VENTURE CAPITAL

The term *venture capital* does not have a precise meaning, but it generally refers to financing for new, often high-risk, ventures. For example, before it went public, Google was VC financed. Individual venture capitalists invest their own money; so-called "angels" are usually individual VC investors, but they tend to specialize in smaller deals. Venture capital firms specialize in pooling funds from various sources and investing them. The underlying sources of funds for such firms include individuals, pension funds, insurance companies, large corporations, and even university endowment funds. The broad term *private equity* is often used to label the rapidly growing area of equity financing for nonpublic companies.[2]

Venture capitalists and venture capital firms recognize that many or even most new ventures will not fly, but the occasional one will. The potential profits are enormous in such cases. To limit their risk, venture capitalists generally provide financing in stages. At each stage, enough money is invested to reach the next milestone or planning stage. For example, the *first-stage financing* might be enough to get a prototype built and a manufacturing plan completed. Based on the results, the *second-stage financing* might be a major investment needed to actually begin manufacturing, marketing, and distribution. There might be many such stages, each of which represents a key step in the process of growing the company.

Venture capital firms often specialize in different stages. Some specialize in very early "seed money," or ground floor, financing. In contrast, financing in the later stages might come from venture capitalists specializing in so-called mezzanine-level financing, where *mezzanine level* refers to the level just above the ground floor.

The fact that financing is available in stages and is contingent on specified goals being met is a powerful motivating force for the firm's founders. Often, the founders receive relatively little in the way of salary and have substantial portions of their personal assets tied up in the business. At each stage of financing, the value of the founders' stake grows and the probability of success rises.

For more on the VC industry, check out **nvca.org**.

In addition to providing financing, venture capitalists often actively participate in running the firm, providing the benefit of experience with previous start-ups as well as general business expertise. This is especially true when the firm's founders have little or no hands-on experience in running a company.

[2]So-called "vulture capitalists" specialize in high-risk investments in established, but financially distressed, firms. Vulgar capitalists invest in firms that have bad taste (OK, we made up this last bit).

SOME VENTURE CAPITAL REALITIES

Although there is a large venture capital market, the truth is that access to venture capital is really very limited. Venture capital companies receive huge numbers of unsolicited proposals, the vast majority of which end up in the circular file unread. Venture capitalists rely heavily on informal networks of lawyers, accountants, bankers, and other venture capitalists to help identify potential investments. As a result, personal contacts are important in gaining access to the venture capital market; it is very much an "introduction" market.

Another simple fact about venture capital is that it is incredibly expensive. In a typical deal, the venture capitalist will demand (and get) 40 percent or more of the equity in the company. Venture capitalists frequently hold voting preferred stock, giving them various priorities in the event that the company is sold or liquidated. The venture capitalist will typically demand (and get) several seats on the company's board of directors and may even appoint one or more members of senior management.

CHOOSING A VENTURE CAPITALIST

Some start-up companies, particularly those headed by experienced, previously successful entrepreneurs, will be in such demand that they will have the luxury of looking beyond the money in choosing a venture capitalist. There are some key considerations in such a case, some of which can be summarized as follows:

The Internet is a tremendous source of venture capital information, both for suppliers and demanders of capital. For example, the site at **www.dealflow.com** prompts you to search the firm's database as either an entrepreneur (capital seeker) or a venture capitalist (capital supplier).

1. *Financial strength is important:* The venture capitalist needs to have the resources and financial reserves for additional financing stages should they become necessary. This doesn't mean that bigger is necessarily better because of our next consideration.
2. *Style is important:* Some venture capitalists will wish to be very much involved in day-to-day operations and decision making, whereas others will be content with monthly reports. Which type is better depends on the firm and also on the venture capitalists' business skills. In addition, a large venture capital firm may be less flexible and more bureaucratic than a smaller "boutique" firm.
3. *References are important:* Has the venture capitalist been successful with similar firms? Of equal importance, how has the venture capitalist dealt with situations that didn't work out?
4. *Contacts are important:* A venture capitalist may be able to help the business in ways other than helping with financing and management by providing introductions to potentially important customers, suppliers, and other industry contacts. Venture capitalist firms frequently specialize in a few particular industries, and such specialization could prove quite valuable.
5. *Exit strategy is important:* Venture capitalists are generally not long-term investors. How and under what circumstances the venture capitalist will "cash out" of the business should be carefully evaluated.

CONCLUSION

If a start-up succeeds, the big payoff frequently comes when the company is sold to another company or goes public. Either way, investment bankers are often involved in the process. We discuss the process of selling securities to the public in the next several sections, paying particular attention to the process of going public.

Concept Questions

15.1a What is venture capital?

15.1b Why is venture capital often provided in stages?

15.2 Selling Securities to the Public: The Basic Procedure

Many rules and regulations surround the process of selling securities. The Securities Act of 1933 is the origin of federal regulations for all new interstate securities issues. The Securities Exchange Act of 1934 is the basis for regulating securities already outstanding. The Securities and Exchange Commission, or SEC, administers both acts.

A series of steps is involved in issuing securities to the public. In general terms, the basic procedure is as follows:

1. Management's first step in issuing any securities to the public is to obtain approval from the board of directors. In some cases, the number of authorized shares of common stock must be increased. This requires a vote of the shareholders.
2. The firm must prepare a **registration statement** and file it with the SEC. The registration statement is required for all public, interstate issues of securities, with two exceptions:
   a. Loans that mature within nine months.
   b. Issues that involve less than $5 million.

registration statement
A statement filed with the SEC that discloses all material information concerning the corporation making a public offering.

The second exception is known as the *small-issues exemption*. In such a case, simplified procedures are used. Under the basic small-issues exemption, issues of less than $5 million are governed by **Regulation A**, for which only a brief offering statement is needed. Normally, a registration statement contains many pages (50 or more) of financial information, including a financial history, details of the existing business, proposed financing, and plans for the future.

Regulation A
An SEC regulation that exempts public issues of less than $5 million from most registration requirements.

3. The SEC examines the registration statement during a waiting period. During this time, the firm may distribute copies of a preliminary **prospectus**. The prospectus contains much of the information in the registration statement, and it is given to potential investors by the firm. The preliminary prospectus is sometimes called a **red herring**, in part because bold red letters are printed on the cover.

prospectus
A legal document describing details of the issuing corporation and the proposed offering to potential investors.

red herring
A preliminary prospectus distributed to prospective investors in a new issue of securities.

A registration statement becomes effective on the 20th day after its filing unless the SEC sends a *letter of comment* suggesting changes. In that case, after the changes are made, the 20-day waiting period starts again. It is important to note that the SEC does not consider the economic merits of the proposed sale; it merely makes sure that various rules and regulations are followed. Also, the SEC generally does not check the accuracy or truthfulness of information in the prospectus.

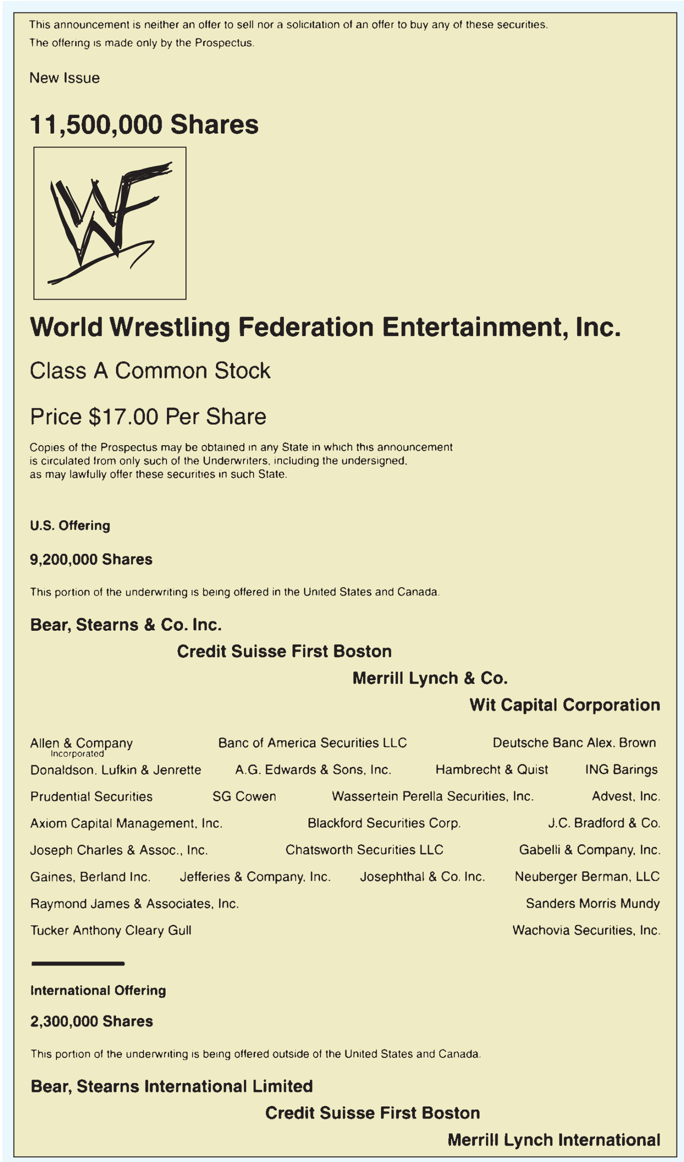
The registration statement does not initially contain the price of the new issue. Usually, a price amendment is filed at or near the end of the waiting period, and the registration becomes effective.

4. The company cannot sell these securities during the waiting period. However, oral offers can be made.
5. On the effective date of the registration statement, a price is determined and a full-fledged selling effort gets under way. A final prospectus must accompany the delivery of securities or confirmation of sale, whichever comes first.

Tombstone advertisements (or *tombstones*) are used by underwriters during and after the waiting period. An example is reproduced in Figure 15.1. The tombstone contains the name of the issuer (the World Wrestling Federation, now known as World Wrestling Entertainment). It provides some information about the issue, and it lists the investment banks (the underwriters) involved with selling the issue. The role of the investment banks in selling securities is discussed more fully in the following sections.

tombstone
An advertisement announcing a public offering.

The investment banks on the tombstone are divided into groups called *brackets* based on their participation in the issue, and the names of the banks are listed alphabetically within each bracket. The brackets are often viewed as a kind of pecking order. In general,



This announcement is neither an offer to sell nor a solicitation of an offer to buy any of these securities.
The offering is made only by the Prospectus.

New Issue

11,500,000 Shares

World Wrestling Federation Entertainment, Inc.

Class A Common Stock

Price $17.00 Per Share

Copies of the Prospectus may be obtained in any State in which this announcement is circulated from only such of the Underwriters, including the undersigned, as may lawfully offer these securities in such State.

U.S. Offering

9,200,000 Shares

This portion of the underwriting is being offered in the United States and Canada.

Bear, Stearns & Co. Inc.
Credit Suisse First Boston
Merrill Lynch & Co.
Wit Capital Corporation

Allen & Company Incorporated   Banc of America Securities LLC   Deutsche Banc Alex. Brown
Donaldson, Lufkin & Jenrette   A.G. Edwards & Sons, Inc.   Hambrecht & Quist   ING Barings
Prudential Securities   SG Cowen   Wasserstein Perella Securities, Inc.   Advest, Inc.
Axiom Capital Management, Inc.   Blackford Securities Corp.   J.C. Bradford & Co.
Joseph Charles & Assoc., Inc.   Chatsworth Securities LLC   Gabelli & Company, Inc.
Gaines, Berland Inc.   Jefferies & Company, Inc.   Josephthal & Co. Inc.   Neuberger Berman, LLC
Raymond James & Associates, Inc.   Sanders Morris Mundy
Tucker Anthony Cleary Gull   Wachovia Securities, Inc.

International Offering

2,300,000 Shares

This portion of the underwriting is being offered outside of the United States and Canada.

Bear, Stearns International Limited
Credit Suisse First Boston
Merrill Lynch International

FIGURE 15.1
An Example of a Tombstone Advertisement

the higher the bracket, the greater is the underwriter's prestige. In recent years, the use of printed tombstones has declined, in part as a cost-saving measure.

CROWDFUNDING

On April 5, 2012, the Jumpstart Our Business Startups ("JOBS") Act was signed into law. A provision of this act allows companies to raise money through *crowdfunding*, which is the practice of raising small amounts of capital from a large number of people, typically via the Internet. Crowdfunding was first used to underwrite the U.S. tour of British rock band Marillion. The JOBS Act allows companies to sell equity by crowdfunding. Originally, the JOBS Act allowed a company to issue up to $1 million in securities in a 12-month period, although this limit was later raised to a maximum of $50 million.

Learn more about crowdfunding at the Crowdfunding Professional Association website, **www.cfpa.org**.

We should make an important distinction about two types of crowdfunding—project crowdfunding and equity crowdfunding. As an example of project crowdfunding, consider the card game Exploding Kittens, which exploded on the crowdfunding website Kickstarter and raised

$8.8 million from about 220,000 backers. During the crowdfunding campaign, the company presold card decks. Every backer was shipped a deck of cards for the game, beginning about six months after the campaign ended. In this case, the backers were purchasers, not investors. This type of crowdfunding has also become a popular way to raise money for charitable causes. In contrast, with equity crowdfunding, the backers receive equity in the company.

Check out two of the more well-known project and charitable crowdfunding websites at **www.kickstarter.com** and **www.gofundme.com**.

In May 2016, Regulation CF (also known as Title III of the JOBS Act) kicked in, which allows small investors access to new crowdfunding "portals." Previously, investors in crowdfunding had to be "accredited." For an individual, this requirement translates to more than $1 million in net worth or more than $200,000 in income for two of the past three years. Regulation CF allows investors with less than $100,000 in income or assets to invest at least $2,000 per year, up to a maximum of $5,000.

To sell securities through Regulation CF, a company must file a form with the SEC. This filing makes the company eligible to list its securities on a crowdfunding portal that is approved by FINRA (the Financial Industry Regulatory Authority), the same agency we mentioned earlier in the textbook for bond price reporting. Crowdfunding portals are already specializing. For example, there are portals that specialize in only accredited investors, all investors, or real estate, to name just a few.

Crowd Expert has a lot more info on equity crowdfunding at **www.crowdexpert.com**.

INITIAL COIN OFFERINGS (ICOs)

In addition to sales of traditional debt and equity, a company can raise funds by selling *tokens*. These tokens often grant the holder the right to use the company's service in the future. For example, a company building a railroad may issue a token that can be used as a train ticket after the railroad is built.

See upcoming ICOs at **tokenmarket.net/ico-calendar**.

Token sales occur on digital currency platforms and can be easily transferred on the platform or converted to U.S. dollars on specialized token exchanges. This liquidity has made tokens a popular means of funding since their introduction in 2015. Tokens are now purchased by both customers and investors who may never use the token for the service being offered.

The initial sale of a token on a digital currency platform is often called an Initial Coin Offering or ICO (to sound like IPO). Many start-up companies are now choosing to raise funding through an ICO rather than the traditional venture capital channels. The most common platform for issuing new tokens is Ethereum, but there are many competitors. In 2017, there were 234 ICOs with a total value of about $3.7 billion.

Token sales are most popular among companies that are building services based on blockchain technology. This technology is at the heart of bitcoin and other cryptocurrencies. A blockchain is a timestamped ledger of transactions that is kept among a network of users without centralized control. It is similar to a traditional database, except that cryptography is used to make it infeasible to change the data once it is added to the chain. Many industries, including finance, are now updating their recordkeeping infrastructure with blockchain technology.

The SEC has some warnings on ICOs at **www.sec.gov/news/public-statement/statement-clayton-2017-12-11**.

Token sales can also serve as an effective marketing tool. This is especially true if the business benefits from network effects as the potential for price appreciation in the tokens attracts new customers. The increase in customers increases the value of the service, which in turn increases the value of the tokens. For example, Civic is building a blockchain-based identity platform, and its currency is used to purchase identity verification services from trusted parties. The company raised $33 million in June 2017 through an ICO of the CVC token. The total value of the tokens at the end of 2017 was $224 million.

To see the market value of tokens at **coinmarketcap.com/**

Concept Questions

15.2a What are the basic procedures involved in selling a new issue?

15.2b What is a registration statement?

15.3 Alternative Issue Methods

When a company decides to issue a new security, it can sell it as a public issue or a private issue. In the case of a public issue, the firm is required to register the issue with the SEC. If the issue is to be sold to fewer than 35 investors, the sale can be carried out privately. In this case, a registration statement is not required.[3]

For equity sales, there are two kinds of public issues: a **general cash offer** and a **rights offer** (or *rights offering*). With a cash offer, securities are offered to the general public. With a rights offer, securities are initially offered only to existing owners. Rights offers are fairly common in other countries, but they are relatively rare in the United States, particularly in recent years. We therefore focus primarily on cash offers in this chapter.

general cash offer
An issue of securities offered for sale to the general public on a cash basis.

rights offer
A public issue of securities in which securities are first offered to existing shareholders. Also called a *rights offering*.

The first public equity issue that is made by a company is referred to as an **initial public offering (IPO)**, or an *unseasoned new issue*. This issue occurs when a company decides to go public. Obviously, all initial public offerings are cash offers. If the firm's existing shareholders wanted to buy the shares, the firm wouldn't have to sell them publicly in the first place.

initial public offering (IPO)
A company's first equity issue made available to the public. Also called an *unseasoned new issue*.

A **seasoned equity offering (SEO)** is a new issue for a company with securities that have been previously issued.[4] A seasoned equity offering of common stock can be made by using a cash offer or a rights offer.

seasoned equity offering (SEO)
A new equity issue of securities by a company that has previously issued securities to the public.

These methods of issuing new securities are shown in Table 15.1. They are discussed in more detail in Sections 15.4 through 15.8.

TABLE 15.1
The Methods of Issuing New Securities

Method	Type	Definition
Public Traditional negotiated cash offer	Firm commitment cash offer	The company negotiates an agreement with an investment banker to underwrite and distribute the new shares. A specified number of shares are bought by underwriters and sold at a higher price.
	Best efforts cash offer	The company has investment bankers sell as many of the new shares as possible at the agreed-upon price. There is no guarantee concerning how much cash will be raised.
	Dutch auction cash offer	The company has investment bankers auction shares to determine the highest offer price obtainable for a given number of shares to be sold.
Privileged subscription	Direct rights offer	The company offers the new stock directly to its existing shareholders.
	Standby rights offer	Like the direct rights offer, this contains a privileged subscription arrangement with existing shareholders. The net proceeds are guaranteed by the underwriters.
Nontraditional cash offer	Shelf cash offer	Qualifying companies can authorize all shares they expect to sell over a two-year period and sell them when needed.
	Competitive firm cash offer	The company can elect to award the underwriting contract through a public auction instead of negotiation.
Private	Direct placement	Securities are sold directly to the purchaser, who, at least until recently, generally could not resell securities for at least two years.

IPO information is widely available. Try IPO Scoop at **www.iposcoop.com**.

[3] A variety of different arrangements can be made for private equity issues. Selling unregistered securities avoids the costs of complying with the Securities Exchange Act of 1934. Regulation significantly restricts the resale of unregistered equity securities. For example, the purchaser may be required to hold the securities for at least one year (or more). Many of the restrictions were significantly eased in 1990 for very large institutional investors. The private placement of bonds is discussed in a later section.

[4] The terms *follow-on offering* and *secondary offering* are also commonly used.

Concept Questions

15.3a What is the difference between a rights offer and a cash offer?

15.3b Why is an initial public offering necessarily a cash offer?

15.4 Underwriters

underwriters
Investment firms that act as intermediaries between a company selling securities and the investing public.

If the public issue of securities is a cash offer, **underwriters** are usually involved. Underwriting is an important line of business for large investment firms such as Morgan Stanley. Underwriters perform services such as the following for corporate issuers:

1. Formulating the method used to issue the securities.
2. Pricing the new securities.
3. Selling the new securities.

syndicate
A group of underwriters formed to share the risk and to help sell an issue.

Typically, the underwriter buys the securities for less than the offering price and accepts the risk of not being able to sell them. Because underwriting involves risk, underwriters usually combine to form an underwriting group called a **syndicate** to share the risk and to help sell the issue.

In a syndicate, one or more managers arrange, or co-manage, the offering. The lead manager typically has the responsibility of dealing with the issuer and pricing the securities. The other underwriters in the syndicate serve primarily to distribute the issue and produce research reports later on. In recent years, it has become fairly common for a syndicate to consist of only a small number of co-managers.

gross spread
Compensation to the underwriter, determined by the difference between the underwriter's buying price and the offering price.

The difference between the underwriter's buying price and the offering price is called the **gross spread**, or underwriting discount. It is the basic compensation received by the underwriter. Sometimes, on smaller deals, the underwriter will get noncash compensation in the form of warrants and stock in addition to the spread.[5]

CHOOSING AN UNDERWRITER

A firm can offer its securities to the highest bidding underwriter on a *competitive offer* basis, or it can negotiate directly with an underwriter. Except for a few large firms, companies usually offer new issues of debt and equity on a *negotiated offer* basis. The exception is public utility holding companies, which are essentially required to use competitive underwriting.

There is evidence that competitive underwriting is cheaper to use than negotiated underwriting. The underlying reasons for the dominance of negotiated underwriting in the United States are the subject of ongoing debate.

TYPES OF UNDERWRITING

Three basic types of underwriting are involved in a cash offer: firm commitment, best efforts, and Dutch auction.

firm commitment underwriting
The type of underwriting in which the underwriter buys the entire issue, assuming full financial responsibility for any unsold shares.

Firm Commitment Underwriting

In **firm commitment underwriting**, the issuer sells the entire issue to the underwriters, who then attempt to resell it. This is the most prevalent type of underwriting in the United States. This is really just a purchase-resale arrangement, and the underwriter's fee is the spread. For a new issue of seasoned equity, the underwriters can look at the market price to determine what the issue should sell for, and more than 95 percent of all such new issues are firm commitments.

If the underwriter cannot sell all of the issue at the agreed-upon offering price, it may have to lower the price on the unsold shares. Nonetheless, with firm commitment

[5] Warrants are options to buy newly issued stock at a fixed price for some fixed period.

underwriting, the issuer receives the agreed-upon amount, and all the risk associated with selling the issue is transferred to the underwriter.

Because the offering price usually isn't set until the underwriters have investigated how receptive the market is to the issue, this risk is usually minimal. Also, because the offering price usually is not set until just before selling commences, the issuer doesn't know precisely what its net proceeds will be until that time.

Learn more about investment banks at Merrill Lynch (www.ml.com).

To determine the offering price, the underwriter will meet with potential buyers, typically large institutional buyers such as mutual funds. Often, the underwriter and company management will do presentations in multiple cities, pitching the stock in what is known as a *road show*. Potential buyers provide information on the price they would be willing to pay and the number of shares they would purchase at a particular price. This process of soliciting information about buyers and the prices and quantities they would demand is known as *bookbuilding*. As we will see, despite the bookbuilding process, underwriters frequently get the price wrong, or so it seems.

Best Efforts Underwriting In **best efforts underwriting**, the underwriter is legally bound to use "best efforts" to sell the securities at the agreed-upon offering price. Beyond this, the underwriter does not guarantee any particular amount of money to the issuer. This form of underwriting has become uncommon in recent years.

Dutch Auction Underwriting With **Dutch auction underwriting**, the underwriter does not set a fixed price for the shares to be sold. Instead, the underwriter conducts an auction in which investors bid for shares. The offer price is determined based on the submitted bids. A Dutch auction is also known by the more descriptive name *uniform price auction*. This approach to selling securities to the public is relatively new in the IPO market and has not been widely used there, but it is very common in the bond markets. For example, it is the sole procedure used by the U.S. Treasury to sell enormous quantities of notes, bonds, and bills to the public.

best efforts underwriting
The type of underwriting in which the underwriter sells as much of the issue as possible, but can return any unsold shares to the issuer without financial responsibility.

Dutch auction underwriting
The type of underwriting in which the offer price is set based on competitive bidding by investors. Also known as a *uniform price auction*.

The best way to understand a Dutch or uniform price auction is to consider a simple example. Suppose the Rial Company wants to sell 400 shares to the public. The company receives five bids as follows:

Bidder	Quantity	Price
A	100 shares	$16
B	100 shares	14
C	200 shares	12
D	100 shares	12
E	200 shares	10

Bidder A is willing to buy 100 shares at $16 each, Bidder B is willing to buy 100 shares at $14, and so on. The Rial Company examines the bids to determine the highest price that will result in all 400 shares being sold. So, for example, at $14, A and B would buy only 200 shares, so that price is too high. Working our way down, all 400 shares won't be sold until we hit a price of $12, so $12 will be the offer price in the IPO. Bidders A through D will receive shares; Bidder E will not.

Learn all about Dutch auction IPOs at www.wrhambrecht.com.

There are two additional important points to observe in our example. First, all the winning bidders will pay $12—even Bidders A and B, who actually bid a higher price. The fact that all successful bidders pay the same price is the reason for the name "uniform price auction." The idea in such an auction is to encourage bidders to bid aggressively by providing some protection against bidding a price that is too high.

Second, notice that at the $12 offer price, there are actually bids for 500 shares, which exceeds the 400 shares Rial wants to sell. There has to be some sort of allocation. How this is done varies a bit; but in the IPO market, the approach has been to compute the ratio of shares offered to shares bid at the offer price or better, which, in our example, is

400/500 = .8, and allocate bidders that percentage of their bids. In other words, Bidders A through D would each receive 80 percent of the shares they bid at a price of $12 per share.

THE AFTERMARKET

The period after a new issue is initially sold to the public is referred to as the *aftermarket*. During this time, the members of the underwriting syndicate generally do not sell securities for less than the offering price.

The principal underwriter is permitted to buy shares if the market price falls below the offering price. The purpose of this would be to support the market and stabilize the price against temporary downward pressure. If the issue remains unsold after a time (for example, 30 days), members can leave the group and sell their shares at whatever price the market will allow.[6]

THE GREEN SHOE PROVISION

Green Shoe provision
A contract provision giving the underwriter the option to purchase additional shares from the issuer at the offering price. Also called the *overallotment option*.

Many underwriting contracts contain a **Green Shoe provision** (sometimes called the *overallotment option*), which gives the members of the underwriting group the option to purchase additional shares from the issuer at the offering price.[7] Essentially all IPOs and SEOs include this provision, but ordinary debt offerings generally do not. The stated reason for the Green Shoe option is to cover excess demand and oversubscriptions. Green Shoe options usually last for 30 days and involve 15 percent of the newly issued shares.

In practice, usually underwriters initially go ahead and sell 115 percent of the shares offered. If the demand for the issue is strong after the offering, the underwriters exercise the Green Shoe option to get the extra 15 percent from the company. If demand for the issue is weak, the underwriters buy the needed shares in the open market, thereby helping to support the price of the issue in the aftermarket.

LOCKUP AGREEMENTS

lockup agreement
The part of the underwriting contract that specifies how long insiders must wait after an IPO before they can sell stock.

Although they are not required by law, almost all underwriting contracts contain so-called **lockup agreements**. Such agreements specify how long insiders must wait after an IPO before they can sell some or all of their stock. Lockup periods have become fairly standardized in recent years at 180 days. Following an IPO, insiders can't cash out until six months have gone by, which ensures that they maintain a significant economic interest in the company going public.

Lockup periods are also important because it is not unusual for the number of locked-up shares to exceed the number of shares held by the public, sometimes by a substantial multiple. On the day the lockup period expires, there is the possibility that a large number of shares will hit the market on the same day and thereby depress values. The evidence suggests that, on average, venture capital-backed companies are particularly likely to experience a loss in value on the lockup expiration day.

THE QUIET PERIOD

Once a firm begins to seriously contemplate an IPO, the SEC requires that a firm and its managing underwriters observe a "quiet period." This means that all communications with the public must be limited to ordinary announcements and other purely factual matters. The quiet period ends 40 calendar days after an IPO (for most IPOs). The SEC's logic is that all relevant information should be contained in the prospectus. An important result of this requirement is that the underwriters' analysts are prohibited from making recommendations

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[6] Occasionally, the price of a security falls dramatically when the underwriter ceases to stabilize the price. In such cases, Wall Street humorists (the ones who didn't buy any of the stock) have referred to the period following the aftermarket as the *aftermath*.

[7] The term *Green Shoe provision* sounds quite exotic, but the origin is relatively mundane. The term comes from the name of the Green Shoe Manufacturing Company, which, in 1963, was the first issuer that granted such an option.

to investors. As soon as the quiet period ends, the managing underwriters typically publish research reports, usually accompanied by a favorable "buy" recommendation.

In 2004, two firms experienced notable quiet period-related problems. Just before the Google (now Alphabet) IPO, an interview with Google cofounders Sergey Brin and Larry Page appeared in *Playboy*. The interview almost caused a postponement of the IPO, but Google was able to amend its prospectus in time. In May 2004, Salesforce.com's IPO was delayed because an interview with CEO Marc Benioff appeared in *The New York Times*. Salesforce.com finally went public two months later.

DIRECT LISTING

While firms usually use underwriters to help their stock become publicly traded, it is not required. If it wishes to do so, and it meets the requirements of the stock exchange, a company can do a **direct listing**. In this case, the firm arranges for its stock to be listed on the exchange without marketing and other help from an underwriter. Direct listings are not common for large firms, but music-streaming giant Spotify, with a valuation well into the billions of dollars, was proposing to do one on the NYSE in 2018. Among other things, a direct listing is much less expensive because there are no underwriting fees and other associated costs. Such fees are discussed in detail in a subsequent section, and they can be substantial.

direct listing
In a direct listing, a firm arranges for its stock to be listed on an exchange without marketing and other help from an underwriter.

Concept Questions

15.4a What do underwriters do?

15.4b What is the Green Shoe provision?

IPOs and Underpricing **15.5**

Determining the correct offering price is the most difficult thing an underwriter must do for an initial public offering. The issuing firm faces a potential cost if the offering price is set too high or too low. If the issue is priced too high, it may be unsuccessful and have to be withdrawn. If the issue is priced below the true market value, the issuer's existing shareholders will experience an opportunity loss when the issuer sells shares for less than they are worth.

Underpricing is fairly common. It obviously helps new shareholders earn a higher return on the shares they buy. The existing shareholders of the issuing firm are not helped by underpricing. To them, it is an indirect cost of issuing new securities. For example, consider the 2017 Snap IPO. Snap sold 145 million shares in the IPO at a price of $17. The stock opened at $24 and rose to a first-day high of $26.05, before closing at $24.48. Based on these numbers, Snap was underpriced by about $7.48 per share, which means the company missed out on an additional $1.085 billion or so "left on the table." In 1999, eToys's 8.2-million-share IPO was underpriced by $57 per share, or almost a half a billion dollars in all. eToys could have used the money: It was bankrupt within two years.

Find out which firms are going public this week at **www.marketwatch.com**.

IPO UNDERPRICING: THE 1999–2000 EXPERIENCE

Table 15.2, along with Figures 15.2 and 15.3, shows that 1999 and 2000 were extraordinary years in the IPO market. Almost 900 companies went public, and the average first-day return across the two years was about 64 percent. During this time, 194 IPOs doubled, or more than doubled, in value on the first day. In contrast, only 39 did so in the preceding 24 years combined. One company, VA Linux, shot up 698 percent!

The dollar amount raised in 1999, $64.91 billion, was a record, followed closely by the $64.88 billion raised in 2000. The underpricing was so severe in 1999 that companies left

TABLE 15.2

Number of Offerings, Average First-Day Return, and Gross Proceeds of Initial Public Offerings: 1960–2016

Year	Number of Offerings*	Average First-Day Return, %†	Gross Proceeds, $ Millions‡
1960	269	17.8	553
1961	435	34.1	1,243
1962	298	−1.6	431
1963	83	3.9	246
1964	97	5.3	380
1965	146	12.7	409
1966	85	7.1	275
1967	100	37.7	641
1968	368	55.9	1,205
1969	780	12.5	2,605
1970	358	−.7	780
1971	391	21.2	1,655
1972	562	7.5	2,724
1973	105	−17.8	330
1974	9	−7.0	51
1975	12	−.2	261
1976	26	1.9	214
1977	15	3.6	128
1978	19	12.6	207
1979	39	8.5	313
1980	75	13.9	934
1981	196	6.2	2,367
1982	80	10.5	1,014
1983	524	8.9	11,370
1984	218	2.8	2,622
1985	218	6.5	4,964
1986	477	6.1	15,938
1987	336	5.7	12,481
1988	129	5.4	3,922
1989	122	7.8	5,308
1990	116	10.4	4,334
1991	293	11.8	16,431
1992	416	10.2	22,750
1993	527	12.7	31,756
1994	411	9.8	17,493
1995	464	21.1	29,511
1996	690	17.3	42,481
1997	486	13.9	32,559
1998	316	20.3	34,465
1999	486	69.7	64,913
2000	382	56.2	64,876
2001	79	14.2	34,241
2002	70	8.6	22,136
2003	68	11.9	10,075

TABLE 15.2 ***(continued)***

Year	Number of Offerings*	Average First-Day Return, %†	Gross Proceeds, $ Millions‡
2004	183	12.3	31,927
2005	168	10.1	28,593
2006	162	11.9	30,648
2007	160	14.0	35,704
2008	21	5.7	22,762
2009	43	10.6	13,307
2010	100	9.2	30,708
2011	82	13.2	27,750
2012	105	17.1	32,074
2013	162	20.9	39,093
2014	224	14.9	46,940
2015	122	18.1	22,020
2016	77	14.4	12,736
1960–69	2,661	21.2	7,988
1970–79	1,536	7.1	6,663
1980–89	2,375	6.9	60,380
1990–99	4,205	21.0	296,693
2000–16	2,208	21.1	505,590
1960–2016	**12,985**	**16.8**	**877,314**

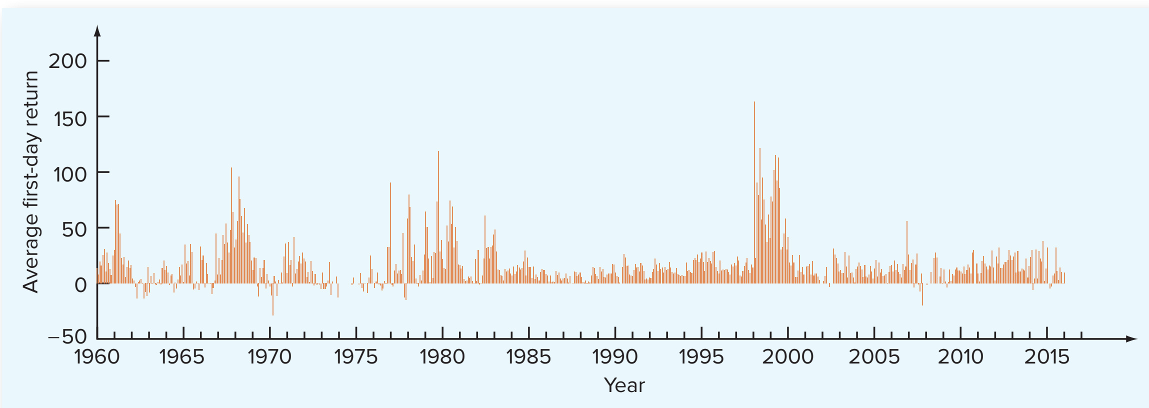
SOURCE: Data from 1960–1974 are taken from Ibbotson, Roger, Sindelar, Jody, and Ritter, Jay R., "The Market's Problems with the Pricing of Initial Public Offerings," *Journal of Applied Corporate Finance* 7, no. 1, Spring 1994, 66–74 (Table 1). Data from 1975–2016 are compiled by Jay R. Ritter using Thomson Financial, Dealogic, and other sources. The 1975–1993 numbers are different from those reported in the 1994 JACF article because the published article included IPOs that did not qualify for listing on Nasdaq, the Amex, or NYSE (mainly penny stocks).

*Beginning in 1975, the number of offerings excludes IPOs with an offer price of less than $5.00, ADRs, small best efforts offers, units, Regulation A offers (small issues, raising less than $1.5 million during the 1980s and $5 million until 2012), real estate investment trusts (REITs), natural resource limited partnerships, and closed-end funds. Banks and S&L IPOs are included. From 2012 and later, Regulation A offerings (issues raising up to $50 million are eligible) are included.

†First-day returns are computed as the percentage return from the offering price to the first closing market price.

‡Gross proceeds exclude overallotment options but include the international tranche, if any. No adjustments for inflation have been made.

FIGURE 15.2 **Average Initial Returns by Month for SEC-Registered Initial Public Offerings: 1960–2016**



SOURCE: Ibbotson, R. G., Sindelar, J. L., and Ritter, J. R., "The Market's Problems with the Pricing of Initial Public Offerings," *Journal of Applied Corporate Finance* 7, no. 1, Spring 1994, as updated by the authors.

WORK THE WEB

So, do the high returns IPOs sometimes earn have you excited? Do you wonder how recent IPOs have performed? You can find out at www.ipomonitor.com. We went to the website and looked in the Best-Worst Performers area. Here is part of what we found:

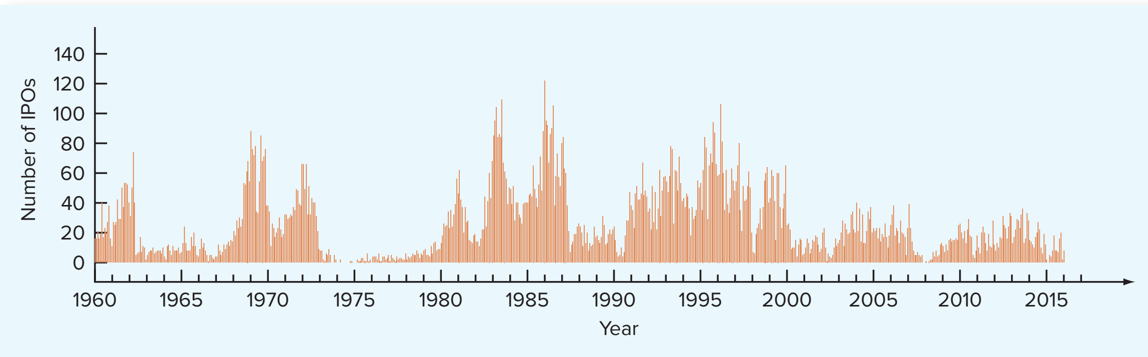
5 Best Performers			
Date	**Company**	**Symbol**	**% Chg.**
2017-01-27	JELD-WEN Holding, Inc.	JELD	+17.6%
2017-01-20	Keane Group, Inc.	FRAC	+16.7%
2017-01-27	REV Group, Inc.	REVG	+14.8%
2017-01-26	AnaptysBio, Inc.	ANAB	+10.8%
2017-01-27	Jounce Therapeutics, Inc.	JNCE	+6.8%

As you can see, in January 2017, JELD-WEN Holding and Keane Group had the largest first-day returns.

Questions

1. *Go to www.ipomonitor.com and find the companies that have had the biggest first-day gains in the most recent quarter. How do those gains compare with the biggest gains shown above? Which companies had the biggest first-day price drop?*
2. *Go to www.ipomonitor.com and find out which companies have filed for an IPO but have yet to start trading.*

FIGURE 15.3 **Number of Offerings by Month for SEC-Registered Initial Public Offerings: 1960–2016**



SOURCE: Ibbotson, R. G., Sindelar, J. L., and Ritter, J. R., "The Market's Problems with the Pricing of Initial Public Offerings," *Journal of Applied Corporate Finance* 7, no. 1, Spring 1994, as updated by the authors.

another $37 billion "on the table," which was substantially more than 1990–1998 combined; and in 2000, the amount was almost $30 billion. In other words, over the two-year period, companies missed out on $67 billion because of underpricing.

October 19, 1999, was one of the more memorable days during this time. The World Wrestling Federation (WWF) (now known as World Wrestling Entertainment, or WWE) and Martha Stewart Omnimedia both went public. When the closing bell rang, it was a

IN THEIR OWN WORDS ...

Jay Ritter on IPO Underpricing around the World

The United States is not the only country in which initial public offerings (IPOs) of common stock are underpriced. The phenomenon exists in every country with a stock market, although the extent of underpricing varies from country to country.

In general, countries with developed capital markets have more moderate underpricing than in emerging markets. During the Internet bubble of 1999–2000, however, underpricing in the developed capital markets increased dramatically. In the United States, for example, the average first-day return during 1999–2000 was 65 percent. Since the bursting of the Internet bubble in mid-2000, the level of underpricing in the United States, Germany, and other developed capital markets has returned to more traditional levels.

The underpricing of Chinese IPOs used to be extreme, but in recent years it has moderated. In the 1990s, Chinese government regulations required that the offer price could not be more than 15 times earnings, even when comparable stocks had a price-earnings ratio of 45. In 2011–2012, the average first-day return was 21 percent. But in 2013, there were no IPOs in China at all, due to a moratorium that the government imposed because it thought that an increase in the supply of shares would depress stock prices.

The following table gives a summary of the average first-day returns on IPOs in a number of countries around the world, with the figures collected from a number of studies by various authors.

Country	Sample Size	Time Period	Avg. Initial Return, %	Country	Sample Size	Time Period	Avg. Initial Return, %
Argentina	26	1991–2013	4.2	Malaysia	474	1980–2013	56.2
Australia	1,562	1976–2011	21.8	Mauritius	40	1989–2005	15.2
Austria	103	1971–2013	6.4	Mexico	123	1987–2002	11.6
Belgium	114	1984–2006	13.5	Morocco	33	2004–2011	33.3
Brazil	275	1979–2011	33.1	Netherlands	181	1982–2006	10.2
Bulgaria	9	2004–2007	36.5	New Zealand	242	1979–2013	18.6
Canada	720	1971–2013	6.5	Nigeria	122	1989–2013	13.1
Chile	81	1982–2013	7.4	Norway	209	1984–2013	8.1
China	2,637	1990–2014	113.5	Pakistan	80	2000–2013	22.1
Cyprus	73	1997–2012	20.3	Philippines	155	1987–2013	18.1
Denmark	164	1984–2011	7.4	Poland	309	1991–2014	12.7
Egypt	62	1990–2010	10.4	Portugal	32	1992–2006	11.9
Finland	168	1971–2013	16.9	Russia	64	1999–2013	3.3
France	697	1983–2010	10.5	Saudi Arabia	80	2003–2011	239.8
Germany	779	1978–2014	23.0	Singapore	609	1973–2013	25.8
Greece	373	1976–2013	50.8	South Africa	316	1980–2013	17.4
Hong Kong	1,486	1980–2013	15.8	Spain	143	1986–2013	10.3
India	2,983	1990–2014	88.0	Sri Lanka	105	1987–2008	33.5
Indonesia	464	1990–2014	24.9	Sweden	405	1980–2015	25.9
Iran	279	1991–2004	22.4	Switzerland	164	1983–2013	27.3
Ireland	38	1991–2013	21.6	Taiwan	1,620	1980–2013	38.1
Israel	348	1990–2006	13.8	Thailand	500	1987–2012	35.1
Italy	312	1985–2013	15.2	Tunisia	38	2001–2014	21.7
Japan	3,313	1970–2014	42.8	Turkey	404	1990–2014	9.6
Jordan	53	1999–2008	149.0	United Kingdom	4,932	1959–2012	16.0
Korea	1,758	1980–2014	58.8	United States	12,819	1960–2015	16.9

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SOURCE: Jay R. Ritter's website.

clear smack-down as Martha Stewart gained 98 percent on the first day compared to 48 percent for the WWF. If you're interested in finding out how IPOs have done recently, check out our nearby *Work the Web* box.

EVIDENCE ON UNDERPRICING

Figure 15.2 provides a more general illustration of the underpricing phenomenon. What is shown is the month-by-month history of underpricing for SEC-registered IPOs.[8] The period covered is 1960 through 2016. Figure 15.3 presents the number of offerings in each month for the same period.

Figure 15.2 shows that underpricing can be quite dramatic, exceeding 100 percent in some months. In such months, the average IPO more than doubled in value, sometimes in a matter of hours. Also, the degree of underpricing varies through time, and periods of severe underpricing ("hot issue" markets) are followed by periods of little underpricing ("cold issue" markets). For example, in the 1960s, the average IPO was underpriced by 21.2 percent. In the 1970s, the average underpricing was much smaller (7.1 percent), and the amount of underpricing was actually very small or even negative for much of that time. Underpricing in the 1980s ran about 6.9 percent. For 1990–1999, IPOs were underpriced by 21 percent on average, and they were underpriced by 21.1 percent in 2000–2016.

From Figure 15.3, it is apparent that the number of IPOs is also highly variable through time. Further, there are pronounced cycles in both the degree of underpricing and the number of IPOs. Comparing Figures 15.2 and 15.3, we see that increases in the number of new offerings tend to follow periods of significant underpricing by roughly six months. This probably occurs because companies decide to go public when they perceive that the market is highly receptive to new issues.

Table 15.2 contains a year-by-year summary of underpricing for the years 1960–2016. As indicated, a grand total of 12,985 companies were included in this analysis. The degree of underpricing averaged 16.8 percent overall for the 57 years examined. Securities were overpriced on average in only 5 of the 57 years. At the other extreme, in 1999, the 486 issues were underpriced, on average, by a remarkable 69.7 percent.

THE PARTIAL ADJUSTMENT PHENOMENON

When a company files its registration statement with the SEC, it will at some point in the process indicate a range of stock prices between which it expects to offer shares. This range is called the "file price range" or words to that effect. A file price range of $10 to $12 is common, but many others exist. For example, when Fitbit first filed its IPO on June 2, 2015, the company indicated a maximum anticipated price of $16.

Just before a company's shares are sold to investors, the final IPO offer price is determined. As shown in Section A of Table 15.3, that price can be above, within, or below the price range originally indicated by the company. Over the period 1980–2016, 48 percent of IPOs were within the file range, with 29 percent below and 23 percent above.

Section B of Table 15.3 illustrates an interesting and very clear pattern. IPO underpricing is much more severe when an offer is priced above the file range. Again over the 1980–2016 period, IPOs that priced above the file range were underpriced by 50 percent, on average, compared to only 3 percent for firms priced below it. The 1999–2000 period again stands out. Issues that "went off" above the file range were underpriced by an average of 121 percent!

This pattern is known as the "partial adjustment" phenomenon. The name refers to the fact that when firms raise their IPO offer prices, they only do so partially, meaning that they don't move the price high enough. In Fitbit's case, for example, the final offer price

[8]The discussion in this section draws on R. G. Ibbotson, J. L. Sindelar, and J. R. Ritter, "The Market's Problems with the Pricing of Initial Public Offerings," *Journal of Applied Corporate Finance* 7, no. 1 (Spring 1994).

TABLE 15.3

IPO Underpricing and File Price Range

A: Percentage of IPOs Relative to File Price Range			
	Below	**Within**	**Above**
1980–1989	30%	57%	13%
1990–1998	27	49	24
1999–2000	18	38	44
2001–2016	36	43	22
1980–2016	29	48	23
B: Average First-Day Returns Relative to File Price Range			
	Below	**Within**	**Above**
1980–1989	0%	6%	20%
1990–1998	4	11	31
1999–2000	8	26	121
2001–2016	3	11	37
1980–2016	3	11	50

was $20, an amount 25 percent higher than the original maximum price: The stock jumped 48 percent on the first day of trading. The Snap IPO we discussed to open the chapter is another good example. The company indicated a preliminary price range of $14–$16, but the final offer price was $17, and the stock soared on the first day of trading.

Why does the partial adjustment phenomenon exist? The answer is unknown. The question is related to the broader question of why IPO underpricing exists, which we consider next.

WHY DOES UNDERPRICING EXIST?

Based on the evidence we've examined, an obvious question is, Why does underpricing continue to exist? As we discuss, there are various explanations; but to date, there is a lack of complete agreement among researchers as to which of these is correct.

We present some pieces of the underpricing puzzle by stressing two important caveats to our preceding discussion. First, the average figures we have examined tend to obscure the fact that much of the apparent underpricing is attributable to the smaller, more highly speculative issues. This point is illustrated in Table 15.4, which shows the extent of underpricing for IPOs over the period from 1980 through 2016. Here, the firms are grouped based on their total sales in the 12 months prior to the IPO.

TABLE 15.4 **Average First-Day Returns, Categorized by Sales, for IPOs: 1980–2016***

	1980–1989		**1990–1998**		**1999–2000**		**2001–2016**	
Annual Sales of Issuing Firms	**Return**	**N**	**Return**	**N**	**Return**	**N**	**Return**	**N**
0 ≤ sales < $10m	10.3%	420	17.2%	741	68.9%	331	9.7%	338
$10m ≤ sales < $20m	8.7	243	18.7	393	81.4	138	13.8	72
$20m ≤ sales < $50m	7.8	500	18.8	791	75.0	155	14.4	213
$50m ≤ sales < $100m	6.3	356	12.9	589	61.8	87	20.8	273
$100m ≤ sales < $200m	5.1	234	11.8	454	35.8	56	17.5	231
$200m ≤ sales	3.4	290	8.7	645	25.0	91	11.9	607
All	7.3	2,043	14.8	3,613	64.5	858	14.0	1,734

*Sales, measured in millions, are for the last 12 months prior to going public. All sales have been converted into dollars of 2003 purchasing power, using the Consumer Price Index. There are 8,248 IPOs, after excluding IPOs with an offer price of less than $5.00 per share, units, REITs, ADRs, closed-end funds, banks and S&Ls, firms not listed on CRSP within six months of the offering, and energy-related limited partnerships. Sales are from Thomson Financial's SDC, Dealogic, EDGAR, and the Graeme Howard-Todd Huxster collection of pre-EDGAR prospectuses. The average first-day return is 17.9 percent.

SOURCE: Professor Jay R. Ritter, University of Florida.

As illustrated in Table 15.4, the underpricing tends to be higher for firms with few to no sales in the previous year. These firms tend to be young firms, and such young firms can be very risky investments. Arguably, they must be significantly underpriced, on average, just to attract investors, and this is one explanation for the underpricing phenomenon.

The second caveat is that relatively few IPO buyers will actually get the initial high average returns observed in IPOs, and many will actually lose money. Although it is true that, on average, IPOs have positive initial returns, a significant fraction of them have price drops. Furthermore, when the price is too low, the issue is often "oversubscribed." This means investors will not be able to buy all of the shares they want, and the underwriters will allocate the shares among investors.

The average investor will find it difficult to get shares in a "successful" offering (one in which the price increases) because there will not be enough shares to go around. On the other hand, an investor blindly submitting orders for IPOs tends to get more shares in issues that go down in price.

To illustrate, consider this tale of two investors. Smith knows very accurately what the Bonanza Corporation is worth when its shares are offered. She is confident that the shares are underpriced. Jones knows only that prices usually rise one month after an IPO. Armed with this information, Jones decides to buy 1,000 shares of every IPO. Does he actually earn an abnormally high return on the initial offering?

The answer is no, and at least one reason is Smith. Knowing about the Bonanza Corporation, Smith invests all her money in its IPO. When the issue is oversubscribed, the underwriters have to somehow allocate the shares between Smith and Jones. The net result is that when an issue is underpriced, Jones doesn't get to buy as much of it as he wanted.

Smith also knows that the Blue Sky Corporation IPO is overpriced. In this case, she avoids its IPO altogether, and Jones ends up with a full 1,000 shares. To summarize this tale, Jones gets fewer shares when more knowledgeable investors swarm to buy an underpriced issue and he gets all he wants when the smart money avoids the issue.

This is an example of a "winner's curse," and it is thought to be another reason why IPOs have such a large average return. When the average investor "wins" and gets the entire allocation, it may be because those who knew better avoided the issue. The only way underwriters can counteract the winner's curse and attract the average investor is to underprice new issues (on average) so that the average investor still makes a profit.

Another reason for underpricing is that the underpricing is a kind of insurance for the investment banks. Conceivably, an investment bank could be sued successfully by angry customers if it consistently overpriced securities. Underpricing guarantees that, at least on average, customers will come out ahead.

A final reason for underpricing is that before the offer price is established, investment banks talk to big institutional investors to gauge the level of interest in the stock and to gather opinions about a suitable price. Underpricing is a way that the bank can reward these investors for truthfully revealing what they think the stock is worth and the number of shares they would like to buy.

Concept Questions

15.5a Why is underpricing a cost to the issuing firm?

15.5b Suppose a stockbroker calls you up out of the blue and offers to sell you "all the shares you want" of a new issue. Do you think the issue will be more or less underpriced than average?

15.6 New Equity Sales and the Value of the Firm

We now turn to a consideration of seasoned offerings, which, as we discussed earlier, are offerings by firms that already have outstanding securities. It seems reasonable to believe that new long-term financing is arranged by firms after positive net present value projects are put together. As a consequence, when the announcement of external financing is made, the firm's market value should go up. Interestingly, this is not what happens. Stock prices tend to decline following the announcement of a new equity issue, although they tend to not change much following a debt announcement. A number of researchers have studied this issue. Plausible reasons for this strange result include the following:

1. *Managerial information*: If management has superior information about the market value of the firm, it may know when the firm is overvalued. If it does, then it will attempt to issue new shares of stock when the market value exceeds the correct value. This will benefit existing shareholders. However, the potential new shareholders are not stupid, and they will anticipate this superior information and discount it in lower market prices at the new-issue date.
2. *Debt usage*: A company's decision to issue new equity may reveal that the company has too much debt or too little liquidity. One version of this argument says that the equity issue is a bad signal to the market. After all, if the new projects are favorable ones, why should the firm let new shareholders in on them? It could just issue debt and let the existing shareholders have all the gain.
3. *Issue costs*: As we discuss next, there are substantial costs associated with selling securities.

The drop in value of the existing stock following the announcement of a new issue is an example of an indirect cost of selling securities. This drop might typically be on the order of 3 percent for an industrial corporation (and somewhat smaller for a public utility); so, for a large company, it can represent a substantial amount of money. In our discussion of the costs of new issues (see Section 15.7), we label this drop the *abnormal return*.

To give a couple of recent examples, in December 2017, biopharmaceutical company Cascadian Therapeutics announced a secondary offering. Its stock fell about 3.4 percent on the day of the announcement. Also in December 2017, power systems company Digital Power announced a secondary offering. Its stock dropped 11.1 percent on the day of the announcement.

Concept Questions

15.6a What are some possible reasons why the price of a stock drops on the announcement of a new equity issue?

15.6b Explain why we might expect a firm with a positive NPV investment to finance it with debt instead of equity.

15.7 The Costs of Issuing Securities

Issuing securities to the public isn't free, and the costs of different methods are important determinants of which is used. These costs associated with *floating* a new issue are generically called *flotation costs*. In this section, we take a closer look at the flotation costs associated with equity sales to the public.

THE COSTS OF SELLING STOCK TO THE PUBLIC

The costs of selling stock are classified in the following list and fall into six categories: (1) the gross spread, (2) other direct expenses, (3) indirect expenses, (4) abnormal returns (discussed previously), (5) underpricing, and (6) the Green Shoe provision.

THE COSTS OF ISSUING SECURITIES

1. *Gross spread*	The gross spread consists of direct fees paid by the issuer to the underwriting syndicate—the difference between the price the issuer receives and the offer price.
2. *Other direct expenses*	These are direct costs, incurred by the issuer, that are not part of the compensation to underwriters. These costs include filing fees, legal fees, and taxes—all reported on the prospectus.
3. *Indirect expenses*	These costs are not reported on the prospectus and include the costs of management time spent working on the new issue.
4. *Abnormal returns*	In a seasoned issue of stock, the price of the existing stock drops on average by 3 percent on the announcement of the issue. This drop is called the *abnormal return*.
5. *Underpricing*	For initial public offerings, losses arise from selling the stock below the true value.
6. *Green Shoe option*	The Green Shoe option gives the underwriters the right to buy additional shares at the offer price to cover overallotments.

Table 15.5 reports direct costs as a percentage of the gross amount raised for IPOs, SEOs, straight (ordinary) bonds, and convertible bonds sold by U.S. companies over the 19-year period from 1990 through 2008. These are direct costs only. Not included are indirect expenses, the cost of the Green Shoe provision, underpricing (for IPOs), and abnormal returns (for SEOs).

As Table 15.5 shows, the direct costs alone can be very large, particularly for smaller issues (less than $10 million). On a smaller IPO, for example, the total direct costs amount to 25.22 percent of the amount raised. This means that if a company sells $10 million in stock, it will net only about $7.5 million; the other $2.5 million goes to cover the underwriter spread and other direct expenses. Typical underwriter spreads on an IPO range from about 5 percent up to 10 percent or so, but for well over half of the IPOs in Table 15.5, the spread is exactly 7 percent; so this is, by far, the most common spread.

Overall, four clear patterns emerge from Table 15.5. First, with the possible exception of straight debt offerings (about which we will have more to say later), there are substantial economies of scale. The underwriter spreads are smaller on larger issues, and the other direct costs fall sharply as a percentage of the amount raised—a reflection of the mostly fixed nature of such costs. Second, the costs associated with selling debt are substantially less than the costs of selling equity. Third, IPOs have higher expenses than SEOs, but the difference is not as great as might originally be guessed. Finally, straight bonds are cheaper to float than convertible bonds.

As we have discussed, the underpricing of IPOs is an additional cost to the issuer. To give a better idea of the total cost of going public, Table 15.6 combines the information in Table 15.5 for IPOs with data on the underpricing experienced by these firms. Overall, across all size groups, the total direct costs amount to about 10 percent of the amount raised, and the underpricing amounts to about 19 percent.

Finally, with regard to debt offerings, there is a general pattern in issue costs that is somewhat obscured in Table 15.5. Recall from Chapter 7 that bonds carry different credit

TABLE 15.5 **Direct Costs as a Percentage of Gross Proceeds for Equity (IPOs and SEOs) and Straight and Convertible Bonds Offered by Domestic Operating Companies: 1990–2008**

	IPOs				SEOs			
Proceeds ($ millions)	Number of Issues	Gross Spread	Other Direct Expense	Total Direct Cost	Number of Issues	Gross Spread	Other Direct Expense	Total Direct Cost
2.00–9.99	1,007	9.40%	15.82%	25.22%	515	8.11%	26.99%	35.11%
10.00–19.99	810	7.39	7.30	14.69	726	6.11	7.76	13.86
20.00–39.99	1,422	6.96	7.06	14.03	1,393	5.44	4.10	9.54
40.00–59.99	880	6.89	2.87	9.77	1,129	5.03	8.93	13.96
60.00–79.99	522	6.79	2.16	8.94	841	4.88	1.98	6.85
80.00–99.99	327	6.71	1.84	8.55	536	4.67	2.05	6.72
100.00–199.99	702	6.39	1.57	7.96	1,372	4.34	.89	5.23
200.00–499.99	440	5.81	1.03	6.84	811	3.72	1.22	4.94
500.00 and up	155	5.01	.49	5.50	264	3.10	.27	3.37
Total/Avg	**6,265**	**7.19**	**3.18**	**10.37**	**7,587**	**5.02**	**2.68**	**7.69**
	Straight Bonds				Convertible Bonds			
2.00–9.99	3,962	1.64%	2.40%	4.03%	14	6.39%	3.43%	9.82
10.00–19.99	3,400	1.50	1.71	3.20	23	5.52	3.09	8.61
20.00–39.99	2,690	1.25	.92	2.17	30	4.63	1.67	6.30
40.00–59.99	3,345	.81	.79	1.59	35	3.49	1.04	4.54
60.00–79.99	891	1.65	.80	2.44	60	2.79	.62	3.41
80.00–99.99	465	1.41	.57	1.98	16	2.30	.62	2.92
100.00–199.99	4,949	1.61	.52	2.14	82	2.66	.42	3.08
200.00–499.99	3,305	1.38	.33	1.71	46	2.65	.33	2.99
500.00 and up	1,261	.61	.15	.76	7	2.16	.13	2.29
Total/Avg	**24,268**	**1.38**	**.61**	**2.00**	**313**	**3.07**	**.85**	**3.92**

SOURCE: Lee, I. et al., "The Costs of Raising Capital," *Journal of Financial Research* 19, Spring 1996, updated by the authors.

TABLE 15.6

Direct and Indirect Costs, in Percentages, of Equity IPOs: 1990–2008

Proceeds ($ millions)	Number of Issues	Gross Spread	Other Direct Expense	Total Direct Cost	Underpricing
2.00–9.99	1,007	9.40%	15.82%	25.22%	20.42%
10.00–19.99	810	7.39	7.30	14.69	10.33
20.00–39.99	1,422	6.96	7.06	14.03	17.03
40.00–59.99	880	6.89	2.87	9.77	28.26
60.00–79.99	522	6.79	2.16	8.94	28.36
80.00–99.99	327	6.71	1.84	8.55	32.92
100.00–199.99	702	6.39	1.57	7.96	21.55
200.00–499.99	440	5.81	1.03	6.84	6.19
500.00 and up	155	5.01	.49	5.50	6.64
Total/Avg	**6,265**	**7.19**	**3.18**	**10.37**	**19.34**

SOURCE: Lee, I. et al., "The Costs of Raising Capital," *Journal of Financial Research* 19, Spring 1996, updated by the authors.

ratings. Higher-rated bonds are said to be investment grade, whereas lower-rated bonds are noninvestment grade. Table 15.7 contains a breakdown of direct costs for bond issues after the investment and noninvestment grades have been separated.

Table 15.7 clarifies two things regarding debt issues. First, there are substantial economies of scale here as well. Second, investment-grade issues have much lower direct costs, particularly for straight bonds.

THE COSTS OF GOING PUBLIC: A CASE STUDY

On July 21, 2016, Impinj, the Seattle-based radio-frequency identification company, went public via an IPO. Impinj issued 4.8 million shares of stock at a price of $14 each. The lead underwriter on the IPO was RBC Capital Markets, assisted by a syndicate of other investment banks. Even though the IPO raised a gross sum of $67.2 million, Impinj only got to keep $62.496 million after expenses. The biggest expense was the 7 percent underwriter spread, which is the usual spread for an offering of that size. Impinj sold each of the 4.8 million shares to the underwriters for $13.02, and the underwriters in turn sold the shares to the public for $14 each.

But wait—there's more. Impinj spent $7,458 in SEC registration fees and $11,609 in FINRA filing fees. The company also spent $125,000 in exchange listing fees, $1.6 million in legal fees, $417,000 on accounting to obtain the necessary audits, $5,000 for a transfer agent to physically transfer the shares and maintain a list of shareholders, $255,000 for printing and engraving expenses, and finally, $261,000 in miscellaneous expenses.

As Impinj's outlays show, an IPO can be a costly undertaking! In the end, Impinj's expenses totaled $7.39 million, of which $4.7 million went to the underwriters and $2.69 million went to other parties. All told, the total direct cost to Impinj was 11.8 percent of the issue proceeds raised by the company.

Concept Questions

15.7a What are the different costs associated with security offerings?

15.7b What lessons do we learn from studying issue costs?

TABLE 15.7 **Average Gross Spreads and Total Direct Costs for Domestic Debt Issues: 1990–2008**

	Convertible Bonds							
	Investment Grade				Junk or Not Rated			
Proceeds ($ millions)	Number of Issues	Gross Spread	Other Direct Expense	Total Direct Cost	Number of Issues	Gross Spread	Other Direct Expense	Total Direct Cost
2.00–9.99	–	–	–	–	14	6.39%	3.43%	9.82%
10.00–19.99	1	14.12%	1.87%	15.98%	23	5.52	3.09	8.61
20.00–39.99	–	–	–	–	30	4.63	1.67	6.30
40.00–59.99	3	1.92	.51	2.43	35	3.49	1.04	4.54
60.00–79.99	6	1.65	.44	2.09	60	2.79	.62	3.41
80.00–99.99	4	.89	.27	1.16	16	2.30	.62	2.92
100.00–199.99	27	2.22	.33	2.55	82	2.66	.42	3.08
200.00–499.99	27	2.03	.19	2.22	46	2.65	.33	2.99
500.00 and up	11	1.94	.13	2.06	7	2.16	.13	2.29
Total/Avg	**79**	**2.15**	**.29**	**2.44**	**313**	**3.31**	**.98**	**4.29**
	Straight Bonds							
	Investment Grade				Junk or Not Rated			
2.00–9.99	2,709	.62%	1.28%	1.90%	1,253	2.77%	2.50%	5.27%
10.00–19.99	2,564	.59	1.17	1.76	836	3.15	1.97	5.12
20.00–39.99	2,400	.63	.74	1.37	290	3.07	1.13	4.20
40.00–59.99	3,146	.40	.52	.92	199	2.93	1.20	4.14
60.00–79.99	792	.58	.38	.96	99	3.12	1.16	4.28
80.00–99.99	385	.66	.29	.96	80	2.73	.93	3.66
100.00–199.99	4,427	.54	.25	.79	522	2.73	.68	3.41
200.00–499.99	3,031	.52	.25	.76	274	2.59	.39	2.98
500.00 and up	1,207	.31	.08	.39	54	2.38	.25	2.63
Total/Avg	**20,661**	**.52**	**.35**	**.87**	**3,607**	**2.76**	**.81**	**3.57**

SOURCE: Lee, I. et al., "The Costs of Raising Capital," *Journal of Financial Research* 19, Spring 1996, updated by the authors.

15.8 Rights

When new shares of common stock are sold to the general public, the proportional ownership of existing shareholders is likely to be reduced. If a preemptive right is contained in the firm's articles of incorporation, the firm must first offer any new issue of common stock to existing shareholders. If the articles of incorporation do not include a preemptive right, the firm has a choice of offering the issue of common stock directly to existing shareholders or to the public.

An issue of common stock offered to existing stockholders is called a *rights offering* (or *offer*, for short) or a *privileged subscription*. In a rights offering, each shareholder is issued rights to buy a specified number of new shares from the firm at a specified price within a specified time, after which the rights are said to *expire*. The terms of the rights offering are evidenced by certificates known as *share warrants* or *rights*. Such rights are often traded on securities exchanges or over the counter.

Rights offerings have some interesting advantages relative to cash offers. For example, they appear to be cheaper for the issuing firm than cash offers. In fact, a firm can do a rights offering without using an underwriter; whereas, as a practical matter, an underwriter is almost a necessity in a cash offer. Despite this, rights offerings are fairly rare in the United States; in many other countries, they are more common than cash offers. Why this is true is a bit of a mystery and the source of much debate; but to our knowledge, no definitive answer exists.

THE MECHANICS OF A RIGHTS OFFERING

To illustrate the various considerations a financial manager faces in a rights offering, we will examine the situation faced by the National Power Company, whose abbreviated initial financial statements are given in Table 15.8.

As indicated in Table 15.8, National Power earns \$2 million after taxes and has 1 million shares outstanding. Earnings per share are \$2, and the stock sells for \$20, or 10 times earnings (that is, the price-earnings ratio is 10). To fund a planned expansion, the company intends to raise \$5 million worth of new equity funds through a rights offering.

TABLE 15.8

National Power Company Financial Statements Before Rights Offering

NATIONAL POWER COMPANY Balance Sheet			
Assets		**Shareholders' Equity**	
Assets	$15,000,000	Common stock	$ 5,000,000
		Retained earnings	10,000,000
Total	$15,000,000	Total	$15,000,000

Income Statement	
Earnings before taxes	$ 2,531,646
Taxes (21%)	531,646
Net income	$ 2,000,000
Shares outstanding	1,000,000
Earnings per share	$ 2
Market price per share	$ 20
Total market value	$20,000,000

To execute a rights offering, the financial management of National Power will have to answer the following questions:

1. What should the price per share be for the new stock?
2. How many shares will have to be sold?
3. How many shares will each shareholder be allowed to buy?

Also, management will probably want to ask this:

4. What is likely to be the effect of the rights offering on the per-share value of the existing stock?

It turns out that the answers to these questions are highly interrelated. We will get to them in just a moment.

The early stages of a rights offering are the same as those for a general cash offer. The difference between a rights offering and a general cash offer lies in how the shares are sold. In a rights offer, National Power's existing shareholders are informed that they own one right for each share of stock they own. National Power will then specify how many rights a shareholder needs to buy one additional share at a specified price.

To take advantage of the rights offering, shareholders have to exercise the rights by filling out a subscription form and sending it, along with payment, to the firm's subscription agent (the subscription agent is usually a bank). Shareholders of National Power will actually have several choices: (1) Exercise their rights and subscribe for some or all of the entitled shares, (2) order some or all of the rights sold, or (3) do nothing and let the rights expire. As we will discuss, this third course of action is inadvisable.

NUMBER OF RIGHTS NEEDED TO PURCHASE A SHARE

National Power wants to raise \$5 million in new equity. Suppose the subscription price is set at \$10 per share. How National Power arrives at that price we will discuss later; but notice that the subscription price is substantially less than the current \$20 per share market price.

At \$10 per share, National Power will have to issue 500,000 new shares. This can be determined by dividing the total amount of funds to be raised by the subscription price:

$$\textbf{Number of new shares} = \frac{\textbf{Funds to be raised}}{\textbf{Subscription price}} \tag{15.1}$$

$$= \frac{\$5{,}000{,}000}{\$10} = 500{,}000 \text{ shares}$$

Because stockholders always get one right for each share of stock they own, 1 million rights will be issued by National Power. To determine how many rights will be needed to buy one new share of stock, we can divide the number of existing outstanding shares of stock by the number of new shares:

$$\begin{array}{c}\textbf{Number of rights needed}\\ \textbf{to buy a share of stock}\end{array} = \frac{\textbf{Old shares}}{\textbf{New shares}} \tag{15.2}$$

$$= \frac{1{,}000{,}000}{500{,}000} = 2 \text{ rights}$$

A shareholder will need to give up two rights plus \$10 to receive a share of new stock. If all the stockholders do this, National Power will raise the required \$5 million.

It should be clear that the subscription price, the number of new shares, and the number of rights needed to buy a new share of stock are interrelated. For example, National Power can lower the subscription price. If it does, then more new shares will have to be issued to raise $5 million in new equity. Several alternatives are worked out here:

Subscription Price	Number of New Shares	Number of Rights Needed to Buy a Share of Stock
$20	250,000	4
10	500,000	2
5	1,000,000	1

THE VALUE OF A RIGHT

Rights clearly have value. In the case of National Power, the right to buy a share of stock worth $20 for $10 is definitely worth something. In fact, if you think about it, a right is essentially a call option, which we will discuss in more detail in later chapters. The most important difference between a right and an ordinary call option is that rights are issued by the firm, so they more closely resemble warrants. In general, the valuation of options, rights, and warrants can be fairly complex, so we defer a full discussion of this subject to a later chapter. However, we can discuss the value of a right just prior to expiration to illustrate some important points.

Suppose a shareholder of National Power owns two shares of stock just before the rights offering is about to expire. This situation is depicted in Table 15.9. Initially, the price of National Power is $20 per share, so the shareholder's total holding is worth $2 \times \$20 = \$40$. The National Power rights offer gives shareholders with two rights the opportunity to purchase one additional share for $10. The additional share does not carry a right.

The stockholder who has two shares will receive two rights. The holding of the shareholder who exercises these rights and buys the new share will increase to three shares. The total investment will be $\$40 + 10 = \$50$ (the $40 initial value plus the $10 paid to the company).

The stockholder now holds three shares, all of which are identical because the new share does not have a right and the rights attached to the old shares have been exercised. Because the total cost of buying these three shares is $\$40 + 10 = \$50$, the price per share must end up at $\$50/3 = \$16.67$ (rounded to two decimal places).

TABLE 15.9

The Value of Rights: The Individual Shareholder

Initial Position	
Number of shares	2
Share price	$20
Value of holding	$40
Terms of Offer	
Subscription price	$10
Number of rights issued	2
Number of rights for a new share	2
After Offer	
Number of shares	3
Value of holding	$50
Share price	$16.67
Value of one right: Old price – New price	$20 – 16.67 = $3.33

Initial Position	
Number of shares	1 million
Share price	\$20
Value of firm	\$20 million
Terms of Offer	
Subscription price	\$10
Number of rights issued	1 million
Number of rights for a new share	2
After Offer	
Number of shares	1.5 million
Share price	\$16.67
Value of firm	\$25 million
Value of one right	\$20 − 16.67 = \$3.33

TABLE 15.10

National Power Company Rights Offering

Table 15.10 summarizes what happens to National Power's stock price. If all shareholders exercise their rights, the number of shares will increase to 1 million + .5 million = 1.5 million. The value of the firm will increase to \$20 million + 5 million = \$25 million. The value of each share will drop to \$25 million/1.5 million = \$16.67 after the rights offering.

The difference between the old share price of \$20 and the new share price of \$16.67 reflects the fact that the old shares carried rights to subscribe to the new issue. The difference must be equal to the value of one right—that is, \$20 − 16.67 = \$3.33.

An investor holding no shares of outstanding National Power stock who wants to subscribe to the new issue can do so by buying some rights. Suppose an outside investor buys two rights. This will cost \$3.33 × 2 = \$6.67 (to account for previous rounding). If the investor exercises the rights at a subscription price of \$10, the total cost will be \$10 + 6.67 = \$16.67. In return for this expenditure, the investor will receive a share of the new stock, which, as we have seen, is worth \$16.67.

Exercising Your Rights: Part 1 — EXAMPLE 15.1

In the National Power example, suppose the subscription price is set at \$8. How many shares will have to be sold? How many rights will you need to buy a new share? What is the value of a right? What will the price per share be after the rights offer?

To raise \$5 million, \$5 million/\$8 = 625,000 shares will need to be sold. There are 1 million shares outstanding, so it will take 1 million/625,000 = 8/5 = 1.6 rights to buy a new share of stock (you can buy five new shares for every eight you own). After the rights offer, there will be 1.625 million shares, worth \$25 million altogether, so the per-share value will be \$25/1.625 = \$15.38. The value of a right in this case is the \$20 original price less the \$15.38 ending price, or \$4.62.

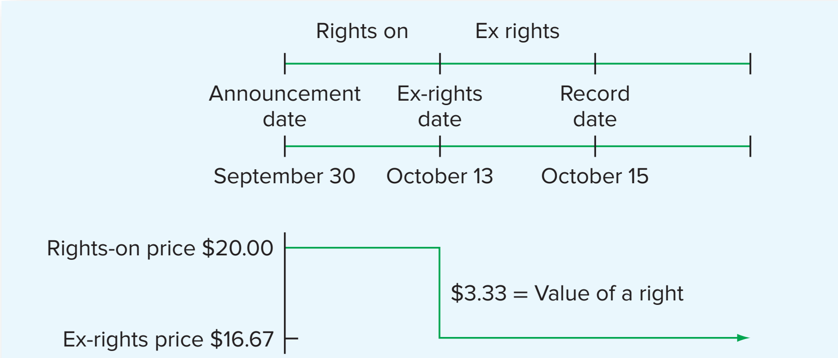
EX RIGHTS

National Power's rights have a substantial value. In addition, the rights offering will have a large impact on the market price of National Power's stock. That price will drop by \$3.33 on the **ex-rights date**.

ex-rights date
The beginning of the period when stock is sold without a recently declared right, normally two trading days before the holder-of-record date.

FIGURE 15.4

Ex-Rights Stock Prices



In a rights offering, there is a date of record, which is the last day on which a shareholder can establish legal ownership. However, stocks are sold ex rights two business days before the record date. Before the ex-rights date, the stock sells rights on, which means that the purchaser receives the rights.

holder-of-record date
The date on which existing shareholders on company records are designated as the recipients of stock rights. Also, the date of record.

The standard procedure for issuing rights involves the firm's setting a **holder-of-record date**. Following stock exchange rules, the stock typically goes ex rights two trading days before the holder-of-record date. If the stock is sold before the ex-rights date—"rights on," "with rights," or "cum rights"—the new owner will receive the rights. After the ex-rights date, an investor who purchases the shares will not receive the rights. This is depicted for National Power in Figure 15.4.

As illustrated, on September 30, National Power announces the terms of the rights offering, stating that the rights will be mailed on, say, November 1 to stockholders of record as of October 15. Because October 13 is the ex-rights date, only shareholders who own the stock on or before October 12 will receive the rights.

EXAMPLE 15.2 Exercising Your Rights: Part II

The Lagrange Point Co. has proposed a rights offering. The stock currently sells for $40 per share. Under the terms of the offer, stockholders will be allowed to buy one new share for every five that they own at a price of $25 per share. What is the value of a right? What is the ex-rights price?

You can buy five rights-on shares for 5 × $40 = $200 and then exercise the rights for another $25. Your total investment is $225, and you end up with six ex-rights shares. The ex-rights price per share is $225/6 = $37.50. The rights are worth $40 − 37.50 = $2.50 apiece.

EXAMPLE 15.3 Right On

In Example 15.2, suppose the rights sell for only $2 instead of the $2.50 we calculated. What can you do?

You can get rich quickly because you have found a money machine. Here's the recipe: Buy five rights for $10. Exercise them and pay $25 to get a new share. Your total investment to get one ex-rights share is 5 × $2 + 25 = $35. Sell the share for $37.50 and pocket the $2.50 difference. Repeat as desired.

THE UNDERWRITING ARRANGEMENTS

Rights offerings are typically arranged using **standby underwriting**. In standby underwriting, the issuer makes a rights offering, and the underwriter makes a firm commitment to "take up" (that is, purchase) the unsubscribed portion of the issue. The underwriter usually gets a **standby fee** and additional amounts based on the securities taken up.

Standby underwriting protects the firm against undersubscription, which can occur if investors throw away rights or if bad news causes the market price of the stock to fall below the subscription price.

In practice, only a small percentage (fewer than 10 percent) of shareholders fail to exercise valuable rights. This failure can probably be attributed to ignorance or vacations. Furthermore, shareholders are usually given an **oversubscription privilege**, which enables them to purchase unsubscribed shares at the subscription price. The oversubscription privilege makes it unlikely that the corporate issuer would have to turn to its underwriter for help.

standby underwriting
The type of underwriting in which the underwriter agrees to purchase the unsubscribed portion of the issue.

standby fee
An amount paid to an underwriter participating in a standby underwriting agreement.

oversubscription privilege
A privilege that allows shareholders to purchase unsubscribed shares in a rights offering at the subscription price.

EFFECTS ON SHAREHOLDERS

Shareholders can exercise their rights or sell them. In either case, the stockholder will neither win nor lose because of the rights offering. The hypothetical holder of two shares of National Power has a portfolio worth \$40. If the shareholder exercises the rights, she or he ends up with three shares worth a total of \$50. In other words, with an expenditure of \$10, the investor's holding increases in value by \$10, which means the shareholder is neither better nor worse off.

On the other hand, if the shareholder sells the two rights for \$3.33 each, he or she would obtain \$3.33 × 2 = \$6.67 and end up with two shares worth \$16.67 and the cash from selling the right:

$$
\begin{aligned}
\text{Shares held} &= 2 \times \$16.67 = \$33.33 \\
\text{Rights sold} &= 2 \times \$3.33 \quad = \underline{\quad 6.67} \\
\text{Total} &= \qquad\qquad\quad \underline{\underline{\$40.00}}
\end{aligned}
$$

The new \$33.33 market value plus \$6.67 in cash is exactly the same as the original holding of \$40. Thus, stockholders cannot lose or gain by exercising or selling rights.

It is obvious that after the rights offering, the new market price of the firm's stock will be lower than the price before the rights offering. As we have seen, stockholders have suffered no loss because of the rights offering. The stock price decline is very much like that in a stock split, a device described in Chapter 17. The lower the subscription price, the greater is the price decline resulting from a rights offering. Because shareholders receive rights equal in value to the price drop, the rights offering does *not* hurt stockholders.

There is one last issue. How do we set the subscription price in a rights offering? If you think about it, you will see that the subscription price really does not matter. It has to be below the market price of the stock for the rights to have value; but beyond this, the price is arbitrary. In principle, it can be as low as we care to make it, as long as it is not zero. In other words, it is impossible to underprice a rights offer.

Concept Questions

15.8a How does a rights offering work?

15.8b What questions must financial managers answer in a rights offering?

15.8c How is the value of a right determined?

15.8d When does a rights offering affect the value of a company's shares?

15.8e Does a rights offering cause share prices to decrease? How are existing shareholders affected by a rights offering?

15.9 Dilution

dilution
Loss in existing shareholders' value in terms of ownership, market value, book value, or EPS.

A subject that comes up quite a bit in discussions involving the selling of securities is **dilution**. Dilution refers to a loss in existing shareholders' value. There are several kinds:

1. Dilution of percentage ownership.
2. Dilution of market value.
3. Dilution of book value and earnings per share.

The differences between these three types can be a little confusing, and there are some common misconceptions about dilution, so we discuss it in this section.

DILUTION OF PROPORTIONATE OWNERSHIP

The first type of dilution can arise whenever a firm sells shares to the general public. For example, Joe Smith owns 5,000 shares of Merit Shoe Company. Merit Shoe currently has 50,000 shares of stock outstanding; each share gets one vote. Joe controls 10 percent (= 5,000/50,000) of the votes and gets 10 percent of the dividends.

If Merit Shoe issues 50,000 new shares of common stock to the public via a general cash offer, Joe's ownership in Merit Shoe may be diluted. If Joe does not participate in the new issue, his ownership will drop to 5 percent (= 5,000/100,000). Notice that the value of Joe's shares is unaffected; he just owns a smaller percentage of the firm.

As this example illustrates, a rights offering ensures Joe Smith an opportunity to maintain his proportionate 10 percent share; therefore, dilution of the ownership of existing shareholders can be avoided by using a rights offering.

DILUTION OF VALUE: BOOK VERSUS MARKET VALUES

We now examine dilution of value by looking at some accounting numbers. We do this to illustrate a fallacy concerning dilution; we do not mean to suggest that accounting value dilution is more important than market value dilution. As we illustrate, quite the reverse is true.

Suppose Upper States Manufacturing (USM) wants to build a new electricity-generating plant to meet future anticipated demands. As shown in Table 15.11, USM currently has

TABLE 15.11

New Issues and Dilution: The Case of Upper States Manufacturing

		After Taking on New Project	
	Initial	With Dilution	With No Dilution
Number of shares	1,000,000	1,400,000	1,400,000
Book value	$10,000,000	$12,000,000	$12,000,000
Book value per share (*B*)	$10	$8.57	$8.57
Market value	$5,000,000	$6,000,000	$8,000,000
Market price (*P*)	$5	$4.29	$5.71
Net income	$1,000,000	$1,200,000	$1,600,000
Return on equity (ROE)	.10	.10	.13
Earnings per share (EPS)	$1	$.86	$1.14
EPS/*P*	.20	.20	.20
P/EPS	5	5	5
P/*B*	.5	.5	.67
Project cost $2,000,000		NPV = −$1,000,000	NPV = $1,000,000

1 million shares outstanding and no debt. Each share is selling for $5, and the company has a $5 million market value. USM's book value is $10 million total, or $10 per share.

USM has experienced a variety of difficulties in the past, including cost overruns, regulatory delays in building a nuclear-powered electricity-generating plant, and below-normal profits. These difficulties are reflected in the fact that USM's market-to-book ratio is $5/$10 = .50 (successful firms rarely have market prices below book values).

Net income for USM is currently $1 million. With 1 million shares, earnings per share are $1, and the return on equity is $1/$10 = .10, or 10%.[9] USM sells for five times earnings (the price-earnings ratio is 5). USM has 200 shareholders, each of whom holds 5,000 shares. The new plant will cost $2 million, so USM will have to issue 400,000 new shares ($5 × 400,000 = $2 million). There will be 1.4 million shares outstanding after the issue.

The ROE on the new plant is expected to be the same as for the company as a whole. In other words, net income is expected to go up by .10 × $2 million = $200,000. Total net income will be $1.2 million. The following will result if the plant is built:

1. With 1.4 million shares outstanding, EPS will be $1.2/1.4 = $.857, down from $1.
2. The proportionate ownership of each old shareholder will drop to 5,000/1.4 million = .0036, or .36 percent from .50 percent.
3. If the stock continues to sell for five times earnings, then the value will drop to 5 × $.857 = $4.29, representing a loss of $.71 per share.
4. The total book value will be the old $10 million plus the new $2 million, for a total of $12 million. Book value per share will fall to $12 million/1.4 million = $8.57.

If we take this example at face value, then dilution of proportionate ownership, accounting dilution, and market value dilution all occur. USM's stockholders appear to suffer significant losses.

A Misconception Our example appears to show that selling stock when the market-to-book ratio is less than 1 is detrimental to stockholders. Some managers claim that the resulting dilution occurs because EPS will go down whenever shares are issued when the market value is less than the book value.

When the market-to-book ratio is less than 1, increasing the number of shares does cause EPS to go down. Such a decline in EPS is accounting dilution, and accounting dilution will always occur under these circumstances.

Is it also true that market value dilution will necessarily occur? The answer is no. There is nothing incorrect about our example, but why the market price has decreased is not obvious. We discuss this next.

The Correct Arguments In this example, the market price falls from $5 per share to $4.29. This is true dilution, but why does it occur? The answer has to do with the new project. USM is going to spend $2 million on the new plant. As shown in Table 15.11, the total market value of the company is going to rise from $5 million to $6 million, an increase of only $1 million. This means that the NPV of the new project is −$1 million. With 1.4 million shares, the loss per share is $1/1.4 = $.71, as we calculated before.

So, true dilution takes place for the shareholders of USM because the NPV of the project is negative, not because the market-to-book ratio is less than 1. This negative NPV causes the market price to drop, and the accounting dilution has nothing to do with it.

[9] Return on equity, or ROE, is equal to earnings per share divided by book value per share, or, equivalently, net income divided by common equity. We discuss this and other financial ratios in some detail in Chapter 3.

Suppose the new project has a positive NPV of $1 million. The total market value rises by $2 million + 1 million = $3 million. As shown in Table 15.11 (third column), the price per share rises to $5.71. Notice that accounting dilution still takes place because the book value per share still falls, but there is no economic consequence of that fact. The market value of the stock rises.

The $.71 increase in share value comes about because of the $1 million NPV, which amounts to an increase in value of about $.71 per share. Also, as shown, if the ratio of price to EPS remains at 5, then EPS must rise to $5.71/5 = $1.14. Total earnings (net income) rises to $1.14 per share × 1.4 million shares = $1.6 million. Finally, ROE will rise to $1.6 million/$12 million = 13.33%.

Concept Questions

15.9a What are the different kinds of dilution?

15.9b Is dilution important?

15.10 Issuing Long-Term Debt

The general procedures followed in a public issue of bonds are the same as those for stocks. The issue must be registered with the SEC, there must be a prospectus, and so on. The registration statement for a public issue of bonds is different from the one for common stock. For bonds, the registration statement must indicate an indenture.

Another important difference is that more than 50 percent of all debt is issued privately. There are two basic forms of direct private long-term financing: Term loans and private placement.

term loans
Direct business loans of typically one to five years.

private placements
Loans (usually long-term) provided directly by a limited number of investors.

Term loans are direct business loans. These loans have maturities of between one and five years. Most term loans are repayable during the life of the loan. The lenders include commercial banks, insurance companies, and other lenders that specialize in corporate finance. **Private placements** are similar to term loans except that the maturity is longer.

The important differences between direct private long-term financing and public issues of debt are these:

1. A direct long-term loan avoids the cost of Securities and Exchange Commission registration.
2. Direct placement is likely to have more restrictive covenants.
3. It is easier to renegotiate a term loan or a private placement in the event of a default. It is harder to renegotiate a public issue because hundreds of holders are usually involved.
4. Life insurance companies and pension funds dominate the private placement segment of the bond market. Commercial banks are significant participants in the term loan market.
5. The costs of distributing bonds are lower in the private market.

The interest rates on term loans and private placements are usually higher than those on an equivalent public issue. This difference reflects the trade-off between a higher interest rate and more flexible arrangements in the event of financial distress, as well as the lower costs associated with private placements.

An additional, and very important, consideration is that the flotation costs associated with selling debt are much less than the comparable costs associated with selling equity.

Concept Questions

15.10a What is the difference between private and public bond issues?

15.10b A private placement is likely to have a higher interest rate than a public issue. Why?

15.11 Shelf Registration

To simplify the procedures for issuing securities, in March 1982, the SEC adopted Rule 415 on a temporary basis, and it was made permanent in November 1983. Rule 415 allows shelf registration. Both debt and equity securities can be shelf registered.

shelf registration
Registration permitted by SEC Rule 415, which allows a company to register all issues it expects to sell within two years at one time, with subsequent sales at any time within those two years.

Shelf registration permits a corporation to register an offering that it reasonably expects to sell within the next two years and then sell the issue whenever it wants during that two-year period. For example, in March 2017, cargo ship operator DryShips announced a shelf registration of $2 billion in securities, including debt, preferred stock, common stock, and warrants. Not all companies can use Rule 415. The primary qualifications are these:

1. The company must be rated investment grade.
2. The firm cannot have defaulted on its debt in the past three years.
3. The aggregate market value of the firm's outstanding stock must be more than $150 million.
4. The firm must not have violated the Securities Act of 1934 in the past three years.

Shelf registration allows firms to use a *dribble* method of new equity issuance. In dribbling, a company registers the issue and hires an underwriter as its selling agent. The company sells shares in "dribs and drabs" from time to time directly via a stock exchange (for example, the NYSE). Companies that have used dribble programs include Wells Fargo & Co., Pacific Gas and Electric Co., and Southern Company.

The rule has been controversial. The following arguments have been constructed against shelf registration:

1. The costs of new issues might go up because underwriters are unable to provide as much current information to potential investors as they would otherwise; therefore, investors may pay less. The expense of selling the issue piece by piece might therefore be higher than that of selling it all at once.
2. Some investment bankers have argued that shelf registration will cause a "market overhang" that will depress market prices. In other words, the possibility that the company may increase the supply of stock at any time will have a negative impact on the current stock price.

Concept Questions

15.11a What is shelf registration?

15.11b What are the arguments against shelf registration?

15.12 Summary and Conclusions

This chapter has looked at how corporate securities are issued. The following are the main points:

1. The costs of issuing securities can be quite large. They are much lower (as a percentage) for larger issues.
2. The direct and indirect costs of going public can be substantial. However, once a firm is public, it can raise additional capital with much greater ease.
3. Rights offerings are cheaper than general cash offers. Even so, most new equity issues in the United States are underwritten general cash offers.

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Can you answer the following *Connect* Quiz questions?

Section 15.1 What stage of venture capital funding is most apt to provide the funding needed to actually commence the manufacturing operations of a firm?

Section 15.2 Smythe Enterprises is issuing securities under Regulation A. Given this, you know that the securities are valued at ______ or less, or are debt securities that mature in less than _____.

Section 15.4 The gross spread is defined as the difference between the ______ and the ______.

Section 15.7 What is referred to as the *abnormal return*?

CHAPTER REVIEW AND SELF-TEST PROBLEMS

15.1 Flotation Costs The L5 Corporation is considering an equity issue to finance a new space station. A total of \$15 million in new equity is needed. If the direct costs are estimated at 7 percent of the amount raised, how large does the issue need to be? What is the dollar amount of the flotation cost?

15.2 Rights Offerings The Hadron Corporation currently has 3 million shares outstanding. The stock sells for \$40 per share. To raise \$20 million for a new particle accelerator, the firm is considering a rights offering at \$25 per share. What is the value of a right in this case? The ex-rights price?

ANSWERS TO CHAPTER REVIEW AND SELF-TEST PROBLEMS

15.1 The firm needs to net \$15 million after paying the 7 percent flotation costs. So the amount raised is given by:

$$\text{Amount raised} \times (1 - .07) = \$15 \text{ million}$$
$$\text{Amount raised} = \$15 \text{ million}/.93 = \$16.129 \text{ million}$$

The total flotation cost is thus \$1.129 million.

15.2 To raise \$20 million at \$25 per share, \$20 million/\$25 = 800,000 shares will have to be sold. Before the offering, the firm is worth 3 million × \$40 = \$120 million. The issue will raise \$20 million, and there will be 3.8 million shares outstanding. The price of an ex-rights share will therefore be \$140 million/3.8 million = \$36.84. The value of a right is thus \$40 − 36.84 = \$3.16.

CONCEPTS REVIEW AND CRITICAL THINKING QUESTIONS

1. **Debt versus Equity Offering Size** [LO2] In the aggregate, debt offerings are much more common than equity offerings and typically much larger as well. Why?
2. **Debt versus Equity Flotation Costs** [LO2] Why are the costs of selling equity so much larger than the costs of selling debt?
3. **Bond Ratings and Flotation Costs** [LO2] Why do noninvestment-grade bonds have much higher direct costs than investment-grade issues?
4. **Underpricing in Debt Offerings** [LO2] Why is underpricing not a great concern with bond offerings?

Use the following information to answer the next three questions. Zipcar, the car-sharing company, went public in April 2011. Assisted by the investment bank Goldman, Sachs & Co., Zipcar sold 9.68 million shares at \$18 each, thereby raising a total of \$174.24 million. By the end of the first day of trading, the stock had zipped to \$28 per share, down from a high of \$31.50. Based on the end-of-day numbers, Zipcar shares were apparently underpriced by about \$10 each, meaning that the company missed out on an additional \$96.8 million.

5. **IPO Pricing** [LO3] The Zipcar IPO was underpriced by about 56 percent. Should Zipcar be upset at Goldman over the underpricing?
6. **IPO Pricing** [LO3] In the previous question, how would it affect your thinking to know that the company was incorporated about 10 years earlier, had only \$186 million in revenues in 2010, and had never earned a profit? Additionally, the viability of the company's business model was still unproven.
7. **IPO Pricing** [LO3] In the previous two questions, how would it affect your thinking to know that in addition to the 9.68 million shares offered in the IPO, Zipcar had an additional 30 million shares outstanding? Of those 30 million shares, 14.1 million shares were owned by four venture capital firms, and 15.5 million shares were owned by the 12 directors and executive officers.
8. **Cash Offer versus Rights Offer** [LO4] Ren-Stimpy International is planning to raise fresh equity capital by selling a large new issue of common stock. Ren-Stimpy is currently a publicly traded corporation, and it is trying to choose between an underwritten cash offer and a rights offering (not underwritten) to current shareholders. Ren-Stimpy management is interested in minimizing the selling costs and has asked you for advice on the choice of issue methods. What is your recommendation and why?
9. **IPO Underpricing** [LO3] In 1980, a certain assistant professor of finance bought 12 initial public offerings of common stock. He held each of these for approximately one month and then sold them. The investment rule he followed was to submit a purchase order for every firm commitment initial public offering of oil and gas exploration companies. There were 22 of these offerings, and he submitted a purchase order for approximately \$1,000 in stock for each of the companies. With 10 of these, no shares were allocated to this assistant professor. With 5 of the 12 offerings that were purchased, fewer than the requested number of shares were allocated.

The year 1980 was very good for oil and gas exploration company owners: On average, for the 22 companies that went public, the stocks were selling for 80 percent above the offering price a month after the initial offering date. The assistant professor looked at his performance record and found that the $8,400 invested in the 12 companies had grown to $10,000, representing a return of only about 20 percent (commissions were negligible). Did he have bad luck, or should he have expected to do worse than the average initial public offering investor? Explain.

10. **IPO Pricing** [LO3] The following material represents the cover page and summary of the prospectus for the initial public offering of the Pest Investigation Control Corporation (PICC), which is going public tomorrow with a firm commitment initial public offering managed by the investment banking firm of Erlanger and Ritter. Answer the following questions:

a. Assume you know nothing about PICC other than the information contained in the prospectus. Based on your knowledge of finance, what is your prediction for

PROSPECTUS PICC

200,000 SHARES
PEST INVESTIGATION CONTROL CORPORATION

Of the shares being offered hereby, all 200,000 are being sold by the Pest Investigation Control Corporation, Inc. ("the Company"). Before the offering there has been no public market for the shares of PICC, and no guarantee can be given that any such market will develop.

These securities have not been approved or disapproved by the SEC nor has the commission passed upon the accuracy or adequacy of this prospectus. Any representation to the contrary is a criminal offense.

	Price to Public	Underwriting Discount	Proceeds to Company*
Per share	$11.00	$1.10	$9.90
Total	$2,200,000	$220,000	$1,980,000

*Before deducting expenses estimated at $27,000 and payable by the Company.

This is an initial public offering. The common shares are being offered, subject to prior sale, when, as, and if delivered to and accepted by the Underwriters and subject to approval of certain legal matters by their Counsel and by Counsel for the Company. The Underwriters reserve the right to withdraw, cancel, or modify such offer and to reject offers in whole or in part.

Erlanger and Ritter, Investment Bankers

July 12, 2018

Prospectus Summary

The Company	The Pest Investigation Control Corporation (PICC) breeds and markets toads and tree frogs as ecologically safe insect-control mechanisms.
The Offering	200,000 shares of common stock, no par value.
Listing	The Company will seek listing on NASDAQ and will trade over the counter.
Shares Outstanding	As of June 30, 2018, 400,000 shares of common stock were outstanding. After the offering, 600,000 shares of common stock will be outstanding.
Use of Proceeds	To finance expansion of inventory and receivables and general working capital, and to pay for country club memberships for certain finance professors.

Selected Financial Information
(amounts in thousands except per-share data)

	Fiscal Year Ended June 30				As of June 30, 2018	
	2016	2017	2018		Actual	As Adjusted for This Offering
Revenues	$60.00	$120.00	$240.00	Working capital	$ 8	$1,961
Net earnings	3.80	15.90	36.10	Total assets	511	2,464
Earnings per share	.01	.04	.09	Stockholders' equity	423	2,376

the price of PICC tomorrow? Provide a short explanation of why you think this will occur.

b. Assume you have several thousand dollars to invest. When you get home from class tonight, you find that your stockbroker, whom you have not talked to for weeks, has called. She has left a message that PICC is going public tomorrow and that she can get you several hundred shares at the offering price if you call her back first thing in the morning. Discuss the merits of this opportunity.

QUESTIONS AND PROBLEMS

connect

BASIC

(Questions 1–8)

1. **Rights Offerings** [LO4] Leah, Inc., is proposing a rights offering. Presently there are 375,000 shares outstanding at $67 each. There will be 50,000 new shares offered at $58 each.
   - **a.** What is the new market value of the company?
   - **b.** How many rights are associated with one of the new shares?
   - **c.** What is the ex-rights price?
   - **d.** What is the value of a right?
   - **e.** Why might a company have a rights offering rather than a general cash offer?
2. **Rights Offerings** [LO4] The Clifford Corporation has announced a rights offer to raise $35 million for a new journal, the *Journal of Financial Excess*. This journal will review potential articles after the author pays a nonrefundable reviewing fee of $5,000 per page. The stock currently sells for $53 per share, and there are 3.9 million shares outstanding.
   - **a.** What is the maximum possible subscription price? What is the minimum?
   - **b.** If the subscription price is set at $47 per share, how many shares must be sold? How many rights will it take to buy one share?
   - **c.** What is the ex-rights price? What is the value of a right?
   - **d.** Show how a shareholder with 1,000 shares before the offering and no desire (or money) to buy additional shares is not harmed by the rights offer.
3. **Rights** [LO4] Red Shoe Co. has concluded that additional equity financing will be needed to expand operations and that the needed funds will be best obtained through a rights offering. It has correctly determined that as a result of the rights offering, the share price will fall from $49 to $47.60 ($49 is the rights-on price; $47.60 is the ex-rights price, also known as the *when-issued* price). The company is seeking $16.5 million in additional funds with a per-share subscription price equal to $34. How many shares are there currently, before the offering? (Assume that the increment to the market value of the equity equals the gross proceeds from the offering.)
4. **IPO Underpricing** [LO3] The Woods Co. and the Spieth Co. have both announced IPOs at $40 per share. One of these is undervalued by $9, and the other is overvalued by $4, but you have no way of knowing which is which. You plan to buy 1,000 shares of each issue. If an issue is underpriced, it will be rationed, and only half your order will be filled. If you *could* get 1,000 shares in Woods and 1,000 shares in Spieth, what would your profit be? What profit do you actually expect? What principle have you illustrated?
5. **Calculating Flotation Costs** [LO3] The Whistling Straits Corporation needs to raise $60 million to finance its expansion into new markets. The company will sell new shares of equity via a general cash offering to raise the needed funds. If the offer price is $21 per share and the company's underwriters charge a spread of 7 percent, how many shares need to be sold?

6. **Calculating Flotation Costs** [LO3] In Problem 5, if the SEC filing fee and associated administrative expenses of the offering are $1.2 million, how many shares need to be sold?

7. **Calculating Flotation Costs** [LO3] The Raven Co. has just gone public. Under a firm commitment agreement, Raven received $21.39 for each of the 20 million shares sold. The initial offering price was $23 per share, and the stock rose to $28.41 per share in the first few minutes of trading. Raven paid $950,000 in direct legal and other costs and $320,000 in indirect costs. What was the flotation cost as a percentage of funds raised?

8. **Price Dilution** [LO3] Nemesis, Inc., has 165,000 shares of stock outstanding. Each share is worth $77, so the company's market value of equity is $12,705,000. Suppose the firm issues 30,000 new shares at the following prices: $77, $73, and $65. What effect will each of these alternative offering prices have on the existing price per share?

INTERMEDIATE (Questions 9–15)

9. **Dilution** [LO3] Wayne, Inc., wishes to expand its facilities. The company currently has 6 million shares outstanding and no debt. The stock sells for $64 per share, but the book value per share is $19. Net income is currently $11.5 million. The new facility will cost $30 million, and it will increase net income by $675,000.
   a. Assuming a constant price-earnings ratio, what will the effect be of issuing new equity to finance the investment? To answer, calculate the new book value per share, the new total earnings, the new EPS, the new stock price, and the new market-to-book ratio. What is going on here?
   b. What would the new net income for the company have to be for the stock price to remain unchanged?

10. **Dilution** [LO3] The Metallica Heavy Metal Mining (MHMM) Corporation wants to diversify its operations. Some recent financial information for the company is shown here:

Stock price	$ 75
Number of shares	64,000
Total assets	$9,400,000
Total liabilities	$4,100,000
Net income	$ 980,000

MHMM is considering an investment that has the same PE ratio as the firm. The cost of the investment is $1.5 million, and it will be financed with a new equity issue. The return on the investment will equal MHMM's current ROE. What will happen to the book value per share, the market value per share, and the EPS? What is the NPV of this investment? Does dilution take place?

11. **Dilution** [LO3] In Problem 10, what would the ROE on the investment have to be if we wanted the price after the offering to be $75 per share? (Assume the PE ratio remains constant.) What is the NPV of this investment? Does any dilution take place?

12. **Rights** [LO4] Bell Hill Mfg. is considering a rights offer. The company has determined that the ex-rights price would be $63. The current price is $68 per share, and there are 26 million shares outstanding. The rights offer would raise a total of $70 million. What is the subscription price?

13. **Value of a Right** [LO4] Show that the value of a right just prior to expiration can be written as:

$$\text{Value of a right} = P_{RO} - P_X = (P_{RO} - P_S)/(N + 1)$$

where P_{RO}, P_S, and P_X stand for the rights-on price, the subscription price, and the ex-rights price, respectively, and N is the number of rights needed to buy one new share at the subscription price.

14. **Selling Rights [LO4]** Prahm Corp. wants to raise $4.7 million via a rights offering. The company currently has 530,000 shares of common stock outstanding that sell for $55 per share. Its underwriter has set a subscription price of $30 per share and will charge the company a spread of 6 percent. If you currently own 5,000 shares of stock in the company and decide not to participate in the rights offering, how much money can you get by selling your rights?

15. **Valuing a Right [LO4]** Knight Inventory Systems, Inc., has announced a rights offer. The company has announced that it will take four rights to buy a new share in the offering at a subscription price of $35. At the close of business the day before the ex-rights day, the company's stock sells for $60 per share. The next morning, you notice that the stock sells for $53 per share and the rights sell for $3 each. Are the stock and the rights correctly priced on the ex-rights day? Describe a transaction in which you could use these prices to create an immediate profit.

MINICASE

S&S Air Goes Public

Mark Sexton and Todd Story have been discussing the future of S&S Air. The company has been experiencing fast growth, and the two see only clear skies in the company's future. However, the fast growth can no longer be funded by internal sources, so Mark and Todd have decided the time is right to take the company public. To this end, they have entered into discussions with the investment bank of Crowe & Mallard. The company has a working relationship with Renata Harper, the underwriter who assisted with the company's previous bond offering. Crowe & Mallard have assisted numerous small companies in the IPO process, so Mark and Todd feel confident with this choice.

Renata begins by telling Mark and Todd about the process. Although Crowe & Mallard charged an underwriter fee of 4 percent on the bond offering, the underwriter fee is 7 percent on all initial stock offerings of the size of S&S Air's offering. Renata tells Mark and Todd that the company can expect to pay about $2.1 million in legal fees and expenses, $12,000 in SEC registration fees, and $15,000 in other filing fees. Additionally, to be listed on the NASDAQ, the company must pay $100,000. There are also transfer agent fees of $6,500 and engraving expenses of $520,000. The company should also expect to pay $110,000 for other expenses associated with the IPO.

Finally, Renata tells Mark and Todd that to file with the SEC, the company must provide three years' audited financial statements. She is unsure about the costs of the audit. Mark tells Renata that the company provides audited financial statements as part of the bond covenant, and the company pays $300,000 per year for the outside auditor.

QUESTIONS

1. At the end of the discussion, Mark asks Renata about the Dutch auction IPO process. What are the differences in the expenses to S&S Air if it uses a Dutch auction IPO versus a traditional IPO? Should the company go public through a Dutch auction or use a traditional underwritten offering?
2. During the discussion of the potential IPO and S&S Air's future, Mark states that he feels the company should raise $85 million. However, Renata points out that if the company needs more cash in the near future, a secondary offering close to the IPO would be problematic. Instead she suggests that the company should raise $95 million in the IPO. How can we calculate the optimal size of the IPO? What are the advantages and disadvantages of increasing the size of the IPO to $95 million?
3. After deliberation, Mark and Todd have decided that the company should use a firm commitment offering with Crowe & Mallard as the lead underwriter. The IPO will be for $85 million. Ignoring underpricing, how much will the IPO cost the company as a percentage of the funds received?
4. Many employees of S&S Air have shares of stock in the company because of an existing employee stock purchase plan. To sell the stock, the employees can tender their shares to be sold in the IPO at the offering price, or the employees can retain their stock and sell it in the secondary market after S&S Air goes public. Todd asks you to advise the employees about which option is best. What would you suggest to the employees?

Chapter

16 Financial Leverage and Capital Structure Policy

NO MATTER HOW YOU you look at it, 2017 was a tough year for brick-and-mortar retailers. In January, women's retailer The Limited announced it was filing for bankruptcy after more than 50 years in business. Then in March, electronics retailer RadioShack filed for bankruptcy. What made RadioShack's bankruptcy unique is that the company had emerged from a previous bankruptcy in 2015. After that bankruptcy, the company was left with 1,200 stores, which were co-branded as Sprint stores, but it quickly failed again. And in September, Toys "R" Us filed for Chapter 11 bankruptcy. The toy retailer had $4.9 billion in debt on its balance sheet at the time of the bankruptcy filing. Overall, more than 19 publicly traded retailers filed for bankruptcy during 2017.

A firm's choice of how much debt it should have relative to equity is known as a *capital structure decision*. Such a choice has many implications for a firm and is far from being a settled issue in either theory or practice. In this chapter, we discuss the basic ideas underlying capital structures and how firms choose them.

A firm's capital structure is really just a reflection of its borrowing policy. Should we borrow a lot of money, or just a little? At first glance, it probably seems that debt is something to be avoided. After all, the more debt a firm has, the greater is the risk of bankruptcy. What we learn is that debt is really a double-edged sword, and, properly used, debt can be enormously beneficial to a firm.

A good understanding of the effects of debt financing is important because the role of debt is so misunderstood, and many firms (and individuals) are far too conservative in their use of debt. Having said this, we can also say that firms sometimes err in the opposite direction, becoming much too heavily indebted, with bankruptcy as the unfortunate consequence. Striking the right balance is what the capital structure issue is all about.

Learning Objectives

After studying this chapter, you should be able to:

LO1 Explain the effect of financial leverage.

LO2 Show the impact of taxes and bankruptcy on capital structure choice.

LO3 Describe the essentials of the bankruptcy process.

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Thus far, we have taken the firm's capital structure as given. Debt-equity ratios don't just drop on firms from the sky, of course, so now it's time to wonder where they come from. Going back to Chapter 1, recall that we refer to decisions about a firm's debt-equity ratio as *capital structure decisions.*[1]

For the most part, a firm can choose any capital structure it wants. If management so desired, a firm could issue some bonds and use the proceeds to buy back some stock, thereby increasing the debt-equity ratio. Alternatively, it could issue stock and use the money to pay off some debt, thereby reducing the debt-equity ratio. Activities such as these, which alter the firm's existing capital structure, are called capital *restructurings*. In general, such restructurings take place whenever the firm substitutes one capital structure for another while leaving the firm's assets unchanged.

Because the assets of a firm are not directly affected by a capital restructuring, we can examine the firm's capital structure decision separately from its other activities. This means that a firm can consider capital restructuring decisions in isolation from its investment decisions. In this chapter, then, we will ignore investment decisions and focus on the long-term financing, or capital structure, question.

What we will see in this chapter is that capital structure decisions can have important implications for the value of the firm and its cost of capital. We will also find that important elements of the capital structure decision are easy to identify, but precise measures of these elements are generally not obtainable. As a result, we are able to give only an incomplete answer to the question of what the best capital structure might be for a particular firm at a particular time.

The Capital Structure Question 16.1

How should a firm go about choosing its debt-equity ratio? Here, as always, we assume that the guiding principle is to choose the course of action that maximizes the value of a share of stock. As we discuss next, when it comes to capital structure decisions, this is essentially the same thing as maximizing the value of the whole firm, and, for convenience, we will tend to frame our discussion in terms of firm value.

FIRM VALUE AND STOCK VALUE: AN EXAMPLE

The following example illustrates that the capital structure that maximizes the value of the firm is the one financial managers should choose for the shareholders, so there is no conflict in our goals. To begin, suppose the market value of the J.J. Sprint Company is $1,000. The company currently has no debt, and J.J. Sprint's 100 shares sell for $10 each. Further suppose that J.J. Sprint restructures itself by borrowing $500 and then paying out the proceeds to shareholders as an extra dividend of $500/100 = $5 per share.

This restructuring will change the capital structure of the firm with no direct effect on the firm's assets. The immediate effect will be to increase debt and decrease equity. What will be the final impact of the restructuring? Table 16.1 illustrates three possible outcomes in addition to the original no-debt case. Notice that in Scenario II, the value of the firm is unchanged at $1,000. In Scenario I, firm value rises to $1,250; it falls by $250, to $750, in Scenario III. We haven't yet said what might lead to these changes. For now, we just take them as possible outcomes to illustrate a point.

Because our goal is to benefit the shareholders, we next examine, in Table 16.2, the net payoffs to the shareholders in these scenarios. We see that, if the value of the firm stays the

[1] It is conventional to refer to decisions regarding debt and equity as *capital structure decisions.* The term *financial structure decisions* would be more accurate, and we use the terms interchangeably.

TABLE 16.1

Possible Firm Values: No Debt versus Debt plus Dividend

	No Debt	Debt plus Dividend I	Debt plus Dividend II	Debt plus Dividend III
Debt	$ 0	$ 500	$ 500	$500
Equity	1,000	750	500	250
Firm value	$1,000	$1,250	$1,000	$750

TABLE 16.2

Possible Payoffs to Shareholders: Debt plus Dividend

	Debt plus Dividend I	Debt plus Dividend II	Debt plus Dividend III
Equity value reduction	−$250	−$500	−$750
Dividends	500	500	500
Net effect	+$250	$ 0	−$250

same, shareholders will experience a capital loss exactly offsetting the extra dividend. This is Scenario II. In Scenario I, the value of the firm increases to $1,250 and the shareholders come out ahead by $250. In other words, the restructuring has an NPV of $250 in this scenario. The NPV in Scenario III is −$250.

The key observation to make here is that the change in the value of the firm is the same as the net effect on the stockholders. Financial managers can try to find the capital structure that maximizes the value of the firm. Put another way, the NPV rule applies to capital structure decisions, and the change in the value of the overall firm is the NPV of a restructuring. J.J. Sprint should borrow $500 if it expects Scenario I. The crucial question in determining a firm's capital structure is, of course, which scenario is likely to occur.

CAPITAL STRUCTURE AND THE COST OF CAPITAL

In Chapter 14, we discussed the concept of the firm's weighted average cost of capital, or WACC. You may recall that the WACC tells us that the firm's overall cost of capital is a weighted average of the costs of the various components of the firm's capital structure. When we described the WACC, we took the firm's capital structure as given. One important issue that we will want to explore in this chapter is what happens to the cost of capital when we vary the amount of debt financing, or the debt-equity ratio.

A primary reason for studying the WACC is that the value of the firm is maximized when the WACC is minimized. To see this, recall that the WACC is the appropriate discount rate for the firm's overall cash flows. Because values and discount rates move in opposite directions, minimizing the WACC will maximize the value of the firm's cash flows.

We will want to choose the firm's capital structure so that the WACC is minimized. For this reason, we will say that one capital structure is better than another if it results in a lower weighted average cost of capital. Further, we say that a particular debt-equity ratio represents the *optimal capital structure* if it results in the lowest possible WACC. This optimal capital structure is sometimes called the firm's *target* capital structure as well.

Concept Questions

16.1a Why should financial managers choose the capital structure that maximizes the value of the firm?

16.1b What is the relationship between the WACC and the value of the firm?

16.1c What is an optimal capital structure?

The Effect of Financial Leverage

16.2

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The previous section described why the capital structure that produces the highest firm value (or the lowest cost of capital) is the one most beneficial to stockholders. In this section, we examine the impact of financial leverage on the payoffs to stockholders. As you may recall, *financial leverage* refers to the extent to which a firm relies on debt. The more debt financing a firm uses in its capital structure, the more financial leverage it employs.

As we describe, financial leverage can dramatically alter the payoffs to shareholders in the firm. Remarkably, financial leverage may not affect the overall cost of capital. If this is true, then a firm's capital structure is irrelevant because changes in capital structure won't affect the value of the firm. We will return to this issue a little later.

THE BASICS OF FINANCIAL LEVERAGE

We start by illustrating how financial leverage works. For now, we ignore the impact of taxes. Also, for ease of presentation, we describe the impact of leverage in terms of its effects on earnings per share, EPS, and return on equity, ROE. These are accounting numbers and, as such, are not our primary concern. Using cash flows instead of these accounting numbers would lead to precisely the same conclusions, but a little more work would be needed. We discuss the impact on market values in a subsequent section.

Financial Leverage, EPS, and ROE: An Example The Trans Am Corporation currently has no debt in its capital structure. The CFO, Ms. Morris, is considering a restructuring that would involve issuing debt and using the proceeds to buy back some of the outstanding equity. Table 16.3 presents both the current and proposed capital structures. As shown, the firm's assets have a market value of $8 million, and there are 400,000 shares outstanding. Because Trans Am is an all-equity firm, the price per share is $20.

The proposed debt issue would raise $4 million; the interest rate would be 10 percent. Because the stock sells for $20 per share, the $4 million in new debt would be used to purchase $4 million/$20 = 200,000 shares, leaving 200,000. After the restructuring, Trans Am would have a capital structure that was 50 percent debt, so the debt-equity ratio would be 1. Notice that, for now, we assume that the stock price will remain at $20.

To investigate the impact of the proposed restructuring, Ms. Morris has prepared Table 16.4, which compares the firm's current capital structure to the proposed capital structure under three scenarios. The scenarios reflect different assumptions about the firm's EBIT. Under the expected scenario, the EBIT is $1 million. In the recession scenario, EBIT falls to $500,000. In the expansion scenario, it rises to $1.5 million.

To illustrate some of the calculations behind the figures in Table 16.4, consider the expansion case. EBIT is $1.5 million. With no debt (the current capital structure) and no taxes, net income is also $1.5 million. In this case, there are 400,000 shares worth $8 million total.

TABLE 16.3

Current and Proposed Capital Structures for the Trans Am Corporation

	Current	Proposed
Assets	$8,000,000	$8,000,000
Debt	$ 0	$4,000,000
Equity	$8,000,000	$4,000,000
Debt-equity ratio	0	1
Share price	$ 20	$ 20
Shares outstanding	400,000	200,000
Interest rate	10%	10%

TABLE 16.4

Capital Structure Scenarios for the Trans Am Corporation

	Recession	Expected	Expansion
Current Capital Structure: No Debt			
EBIT	$500,000	$1,000,000	$1,500,000
Interest	0	0	0
Net income	$500,000	$1,000,000	$1,500,000
ROE	6.25%	12.50%	18.75%
EPS	$ 1.25	$ 2.50	$ 3.75
Proposed Capital Structure: Debt = $4 million			
EBIT	$500,000	$1,000,000	$1,500,000
Interest	400,000	400,000	400,000
Net income	$100,000	$ 600,000	$1,100,000
ROE	2.50%	15.00%	27.50%
EPS	$ .50	$ 3.00	$ 5.50

EPS is $1.5 million/400,000 = $3.75. Also, because accounting return on equity, ROE, is net income divided by total equity, ROE is $1.5 million/$8 million = .1875, or 18.75%.[2]

With $4 million in debt (the proposed capital structure), things are somewhat different. Because the interest rate is 10 percent, the interest bill is $400,000. With EBIT of $1.5 million, interest of $400,000, and no taxes, net income is $1.1 million. Now there are only 200,000 shares worth $4 million total. EPS is therefore $1.1 million/200,000 = $5.50, versus the $3.75 that we calculated in the previous, no-debt, scenario. Furthermore, ROE is $1.1 million/$4 million = .275, or 27.5%. This is well above the 18.75 percent we calculated for the current capital structure.

EPS versus EBIT The impact of leverage is evident when the effect of the restructuring on EPS and ROE is examined. In particular, the variability in both EPS and ROE is much larger under the proposed capital structure. This illustrates how financial leverage acts to magnify gains and losses to shareholders.

In Figure 16.1, we take a closer look at the effect of the proposed restructuring. This figure plots earnings per share, EPS, against earnings before interest and taxes, EBIT, for the current and proposed capital structures. The first line, labeled "No debt," represents the case of no leverage. This line begins at the origin, indicating that EPS would be $0 if EBIT were $0. From there, every $400,000 increase in EBIT increases EPS by $1 (because there are 400,000 shares outstanding).

The second line represents the proposed capital structure. Here, EPS is negative if EBIT is $0. This follows because $400,000 of interest must be paid regardless of the firm's profits. Because there are 200,000 shares in this case, the EPS is −$2 as shown. Similarly, if EBIT were $400,000, EPS would be exactly $0.

The important thing to notice in Figure 16.1 is that the slope of the line in this second case is steeper. In fact, for every $400,000 increase in EBIT, EPS rises by $2, so the line is twice as steep. This tells us that EPS is twice as sensitive to changes in EBIT because of the financial leverage employed.

Another observation to make in Figure 16.1 is that the lines intersect. At that point, EPS is exactly the same for both capital structures. To find this point, note that EPS is equal to EBIT/400,000 in the no-debt case. In the with-debt case, EPS is (EBIT − $400,000)/200,000. If we set these equal to each other, EBIT is:

$$\begin{aligned}\text{EBIT}/400{,}000 &= (\text{EBIT} - \$400{,}000)/200{,}000\\ \text{EBIT} &= 2 \times (\text{EBIT} - \$400{,}000)\\ &= \$800{,}000\end{aligned}$$

[2]ROE is discussed in some detail in Chapter 3.

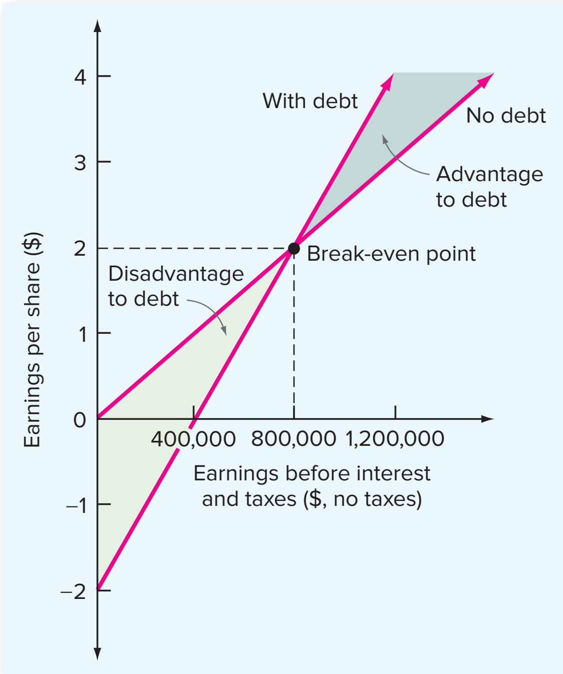

FIGURE 16.1

Financial Leverage: EPS and EBIT for the Trans Am Corporation

When EBIT is \$800,000, EPS is \$2 under either capital structure. This is labeled as the break-even point in Figure 16.1; we could also call it the indifference point. If EBIT is above this level, leverage is beneficial; if it is below this point, it is not.

There is another, more intuitive, way of seeing why the break-even point is \$800,000. Notice that, if the firm has no debt and its EBIT is \$800,000, its net income is also \$800,000. In this case, the ROE is 10 percent. This is precisely the same as the interest rate on the debt, so the firm earns a return that is just sufficient to pay the interest.

Break-Even EBIT

EXAMPLE 16.1

The MPD Corporation has decided in favor of a capital restructuring. Currently, MPD uses no debt financing. Following the restructuring, debt will be \$1 million. The interest rate on the debt will be 9 percent. MPD currently has 200,000 shares outstanding, and the price per share is \$20. If the restructuring is expected to increase EPS, what is the minimum level for EBIT that MPD's management must be expecting? Ignore taxes in answering.

To answer, we calculate the break-even EBIT. At any EBIT above this, the increased financial leverage will increase EPS, so this will tell us the minimum level for EBIT. Under the old capital structure, EPS is EBIT/200,000. Under the new capital structure, the interest expense will be \$1 million × .09 = \$90,000. Furthermore, with the \$1 million proceeds, MPD will repurchase \$1 million/\$20 = 50,000 shares of stock, leaving 150,000 shares outstanding. EPS will be (EBIT – \$90,000)/150,000.

Now that we know how to calculate EPS under both scenarios, we set them equal to each other and solve for the break-even EBIT:

$$\begin{aligned} \text{EBIT}/200{,}000 &= (\text{EBIT} - \$90{,}000)/150{,}000 \\ \text{EBIT} &= 4/3 \times (\text{EBIT} - \$90{,}000) \\ &= \$360{,}000 \end{aligned}$$

Verify that, in either case, EPS is \$1.80 when EBIT is \$360,000. Management at MPD is apparently of the opinion that EPS will exceed \$1.80.

CORPORATE BORROWING AND HOMEMADE LEVERAGE

Based on Tables 16.3 and 16.4 and Figure 16.1, Ms. Morris draws the following conclusions:

1. The effect of financial leverage depends on the company's EBIT. When EBIT is relatively high, leverage is beneficial.
2. Under the expected scenario, leverage increases the returns to shareholders, as measured by both ROE and EPS.
3. Shareholders are exposed to more risk under the proposed capital structure because the EPS and ROE are much more sensitive to changes in EBIT in this case.
4. Because of the impact that financial leverage has on both the expected return to stockholders and the riskiness of the stock, capital structure is an important consideration.

The first three of these conclusions are clearly correct. Does the last conclusion necessarily follow? Surprisingly, the answer is no. As we discuss next, the reason is that shareholders can adjust the amount of financial leverage by borrowing and lending on their own. This use of personal borrowing to alter the degree of financial leverage is called **homemade leverage**.

homemade leverage
The use of personal borrowing to change the overall amount of financial leverage to which the individual is exposed.

We will now illustrate that it actually makes no difference whether or not Trans Am adopts the proposed capital structure, because any stockholder who prefers the proposed capital structure can create it using homemade leverage. To begin, the first part of Table 16.5 shows what will happen to an investor who buys $2,000 worth of Trans Am stock if the proposed capital structure is adopted. This investor purchases 100 shares of stock. From Table 16.4, we know that EPS will be $.50, $3, or $5.50, so the total earnings for 100 shares will be either $50, $300, or $550 under the proposed capital structure.

Now, suppose that Trans Am does not adopt the proposed capital structure. In this case, EPS will be $1.25, $2.50, or $3.75. The second part of Table 16.5 demonstrates how a stockholder who prefers the payoffs under the proposed structure can create them using personal borrowing. To do this, the stockholder borrows $2,000 at 10 percent on his or her own. Our investor uses this amount, along with the original $2,000, to buy 200 shares of stock. As shown, the net payoffs are exactly the same as those for the proposed capital structure.

How did we know to borrow $2,000 to create the right payoffs? We are trying to replicate Trans Am's proposed capital structure at the personal level. The proposed capital structure results in a debt-equity ratio of 1. To replicate this structure at the personal level, the stockholder must borrow enough to create this same debt-equity ratio. Because the stockholder has $2,000 in equity invested, the borrowing of another $2,000 will create a personal debt-equity ratio of 1.

TABLE 16.5
Proposed Capital Structure versus Original Capital Structure with Homemade Leverage

	Recession	Expected	Expansion
Proposed Capital Structure			
EPS	$ .50	$ 3.00	$ 5.50
Earnings for 100 shares	50.00	300.00	550.00
Net cost = 100 shares × $20 = $2,000			
Original Capital Structure and Homemade Leverage			
EPS	$ 1.25	$ 2.50	$ 3.75
Earnings for 200 shares	250.00	500.00	750.00
Less: Interest on $2,000 at 10%	200.00	200.00	200.00
Net earnings	$ 50.00	$300.00	$550.00
Net cost = 200 shares × $20 − Amount borrowed = $4,000 − 2,000 = $2,000			

This example demonstrates that investors can always increase financial leverage themselves to create a different pattern of payoffs. It makes no difference whether Trans Am chooses the proposed capital structure.

Unlevering the Stock

EXAMPLE 16.2

In our Trans Am example, suppose management adopts the proposed capital structure. Further suppose that an investor who owns 100 shares prefers the original capital structure. Show how this investor could "unlever" the stock to re-create the original payoffs.

To create leverage, investors borrow on their own. To undo leverage, investors must lend money. In the case of Trans Am, the corporation borrowed an amount equal to half its value. The investor can unlever the stock by lending money in the same proportion. In this case, the investor sells 50 shares for $1,000 total and then lends the $1,000 at 10 percent. The payoffs are calculated in the following table:

	Recession	Expected	Expansion
EPS (proposed structure)	$ .50	$ 3.00	$ 5.50
Earnings for 50 shares	25.00	150.00	275.00
Plus: Interest on $1,000	100.00	100.00	100.00
Total payoff	$125.00	$250.00	$375.00

These are precisely the payoffs the investor would have experienced under the original capital structure.

Concept Questions

16.2a What is the impact of financial leverage on stockholders?
16.2b What is homemade leverage?
16.2c Why is Trans Am's capital structure irrelevant?

16.3 Capital Structure and the Cost of Equity Capital

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We have seen that there is nothing special about corporate borrowing because investors can borrow or lend on their own. As a result, whichever capital structure Trans Am chooses, the stock price will be the same. Trans Am's capital structure is irrelevant, at least in the simple world we have examined.

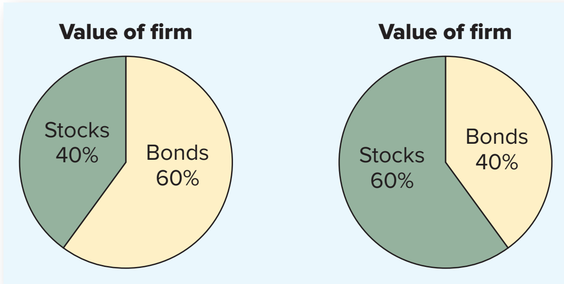
Our Trans Am example is based on a famous argument advanced by two Nobel laureates, Franco Modigliani and Merton Miller, whom we will henceforth call M&M. What we illustrated for the Trans Am Corporation is a special case of **M&M Proposition I**. M&M Proposition I states that it is completely irrelevant how a firm chooses to arrange its finances.

M&M Proposition I
The proposition that the value of the firm is independent of the firm's capital structure.

M&M PROPOSITION I: THE PIE MODEL

One way to illustrate M&M Proposition I is to imagine two firms that are identical on the left side of the balance sheet. Their assets and operations are exactly the same. The right sides are different because the two firms finance their operations differently. In this case, we can view the capital structure question in terms of a "pie" model. Why we choose this

FIGURE 16.2
Two Pie Models of Capital Structure



name is apparent from Figure 16.2. Figure 16.2 gives two possible ways of cutting up the pie between the equity slice, E, and the debt slice, D: 40%–60% and 60%–40%. However, the size of the pie in Figure 16.2 is the same for both firms because the value of the assets is the same. This is precisely what M&M Proposition I states: The size of the pie doesn't depend on how it is sliced.

THE COST OF EQUITY AND FINANCIAL LEVERAGE: M&M PROPOSITION II

Although changing the capital structure of the firm does not change the firm's *total* value, it does cause important changes in the firm's debt and equity. We now examine what happens to a firm financed with debt and equity when the debt-equity ratio is changed. To simplify our analysis, we will continue to ignore taxes.

Based on our discussion in Chapter 14, if we ignore taxes, the weighted average cost of capital, WACC, is:

$$\text{WACC} = (E/V) \times R_E + (D/V) \times R_D$$

where $V = E + D$. We also saw that one way of interpreting the WACC is as the required return on the firm's overall assets. To remind us of this, we will use the symbol R_A to stand for the WACC and write:

$$R_A = (E/V) \times R_E + (D/V) \times R_D$$

If we rearrange this to solve for the cost of equity capital, we see that:

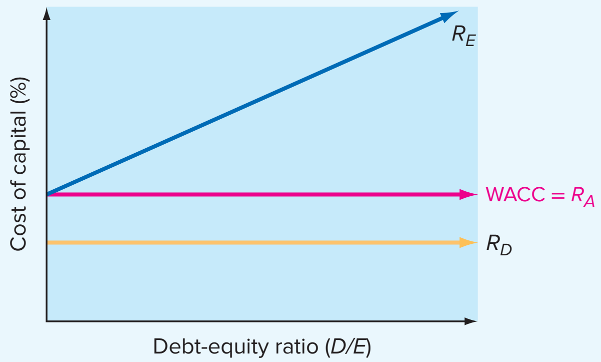
$$\boldsymbol{R_E = R_A + (R_A - R_D) \times (D/E)} \quad \textbf{16.1}$$

M&M Proposition II
The proposition that a firm's cost of equity capital is a positive linear function of the firm's capital structure.

This is the famous **M&M Proposition II**, which tells us that the cost of equity depends on three things: The required rate of return on the firm's assets, R_A; the firm's cost of debt, R_D; and the firm's debt-equity ratio, D/E.

Figure 16.3 summarizes our discussion thus far by plotting the cost of equity capital, R_E, against the debt-equity ratio. As shown, M&M Proposition II indicates that the cost of equity, R_E, is given by a straight line with a slope of $(R_A - R_D)$. The y-intercept corresponds to a firm with a debt-equity ratio of zero, so $R_A = R_E$ in that case. Figure 16.3 shows that as the firm raises its debt-equity ratio, the increase in leverage raises the risk of the equity and therefore the required return or cost of equity (R_E).

Notice in Figure 16.3 that the WACC doesn't depend on the debt-equity ratio; it's the same no matter what the debt-equity ratio is. This is another way of stating M&M Proposition I: The firm's overall cost of capital is unaffected by its capital structure. As illustrated, the fact that the cost of debt is lower than the cost of equity is exactly offset by the increase in the cost of equity from borrowing. In other words, the change in the capital structure weights (E/V and D/V) is exactly offset by the change in the cost of equity (R_E), so the WACC stays the same.



$R_E = R_A + (R_A - R_D) \times (D/E)$ by M&M Proposition II

$R_A = \text{WACC} = \left(\frac{E}{V}\right) \times R_E + \left(\frac{D}{V}\right) \times R_D$

where $V = D + E$

FIGURE 16.3

The Cost of Equity and the WACC: M&M Propositions I and II with No Taxes

The Cost of Equity Capital — EXAMPLE 16.3

The Ricardo Corporation has a weighted average cost of capital (ignoring taxes) of 12 percent. It can borrow at 8 percent. Assuming that Ricardo has a target capital structure of 80 percent equity and 20 percent debt, what is its cost of equity? What is the cost of equity if the target capital structure is 50 percent equity? Calculate the WACC using your answers to verify that it is the same.

According to M&M Proposition II, the cost of equity, R_E, is:

$$R_E = R_A + (R_A - R_D) \times (D/E)$$

In the first case, the debt-equity ratio is .2/.8 = .25, so the cost of the equity is:

$$\begin{aligned} R_E &= .12 + (.12 - .08) \times .25 \\ &= .13, \text{ or } 13\% \end{aligned}$$

In the second case, verify that the debt-equity ratio is 1.0, so the cost of equity is 16 percent.

We can now calculate the WACC assuming that the percentage of equity financing is 80 percent, the cost of equity is 13 percent, and the tax rate is zero:

$$\begin{aligned} \text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \\ &= .80 \times .13 + .20 \times .08 \\ &= .12, \text{ or } 12\% \end{aligned}$$

In the second case, the percentage of equity financing is 50 percent and the cost of equity is 16 percent. The WACC is:

$$\begin{aligned} \text{WACC} &= (E/V) \times R_E + (D/V) \times R_D \\ &= .50 \times .16 + .50 \times .08 \\ &= .12, \text{ or } 12\% \end{aligned}$$

As we have calculated, the WACC is 12 percent in both cases.

IN THEIR OWN WORDS ...

Merton H. Miller on Capital Structure: M&M 30 Years Later

How difficult it is to summarize briefly the contribution of these papers was brought home to me very clearly after Franco Modigliani was awarded the Nobel Prize in Economics, in part—but, of course, only in part—for his work in finance. The television camera crews from our local stations in Chicago immediately descended upon me. "We understand," they said, "that you worked with Modigliani some years back in developing these M&M theorems, and we wonder if you could explain them briefly to our television viewers." "How briefly?" I asked. "Oh, take 10 seconds," was the reply.

Ten seconds to explain the work of a lifetime! Ten seconds to describe two carefully reasoned articles, each running to more than 30 printed pages and each with 60 or so long footnotes! When they saw the look of dismay on my face, they said, "You don't have to go into details. Just give us the main points in simple, common-sense terms."

The main point of the cost-of-capital article was, in principle at least, simple enough to make. It said that in an economist's ideal world, the total market value of all the securities issued by a firm would be governed by the earning power and risk of its underlying real assets and would be independent of how the mix of securities issued to finance it was divided between debt instruments and equity capital. Some corporate treasurers might well think that they could enhance total value by increasing the proportion of debt instruments because yields on debt instruments, given their lower risk, are, by and large, substantially below those on equity capital. But, under the ideal conditions assumed, the added risk to the shareholders from issuing more debt will raise required yields on the equity by just enough to offset the seeming gain from use of low-cost debt.

Such a summary would not only have been too long, but it relied on shorthand terms and concepts that are rich in connotations to economists, but hardly so to the general public. I thought, instead, of an analogy that we ourselves had invoked in the original paper. "Think of the firm," I said, "as a gigantic tub of whole milk. The farmer can sell the whole milk as is. Or he can separate out the cream and sell it at a considerably higher price than the whole milk would bring. (Selling cream is the analog of a firm selling low-yield and hence high-priced debt securities.) But, of course, what the farmer would have left would be skim milk, with low butterfat content, and that would sell for much less than whole milk. Skim milk corresponds to the levered equity. The M&M proposition says that if there were no costs of separation (and, of course, no government dairy support programs), the cream plus the skim milk would bring the same price as the whole milk."

The television people conferred among themselves for a while. They informed me that it was still too long, too complicated, and too academic. "Have you anything simpler?" they asked. I thought of another way in which the M&M proposition is presented that stresses the role of securities as devices for "partitioning" a firm's payoffs among the group of its capital suppliers. "Think of the firm," I said, "as a gigantic pizza, divided into quarters. If, now, you cut each quarter in half into eighths, the M&M proposition says that you will have more pieces, but not more pizza."

Once again whispered conversation. This time, they shut the lights off. They folded up their equipment. They thanked me for my cooperation. They said they would get back to me. But I knew that I had somehow lost my chance to start a new career as a packager of economic wisdom for TV viewers in convenient 10-second sound bites. Some have the talent for it; and some just don't.

The late Merton H. Miller was famous for his pathbreaking work with Franco Modigliani on corporate capital structure, cost of capital, and dividend policy. He received the Nobel Prize in Economics for his contributions shortly after this essay was prepared.

BUSINESS AND FINANCIAL RISK

M&M Proposition II shows that the firm's cost of equity can be broken down into two components. The first component, R_A, is the required return on the firm's assets overall, and it depends on the nature of the firm's operating activities. The risk inherent in a firm's operations is called the **business risk** of the firm's equity. Referring back to Chapter 13, note that this business risk depends on the systematic risk of the firm's assets. The greater a firm's business risk, the greater R_A will be, and, all other things being the same, the greater will be the firm's cost of equity.

business risk
The equity risk that comes from the nature of the firm's operating activities.

The second component in the cost of equity, $(R_A - R_D) \times (D/E)$, is determined by the firm's financial structure. For an all-equity firm, this component is zero. As the firm begins to rely on debt financing, the required return on equity rises. This occurs because the debt financing increases the risks borne by the stockholders. This extra risk that arises from the use of debt financing is called the **financial risk** of the firm's equity.

financial risk
The equity risk that comes from the financial policy (the capital structure) of the firm.

The total systematic risk of the firm's equity has two parts: Business risk and financial risk. The first part (the business risk) depends on the firm's assets and operations and is unaffected by capital structure. Given the firm's business risk (and its cost of debt), the second part (the financial risk) is completely determined by financial policy. As we have illustrated, the firm's cost of equity rises when the firm increases its use of financial leverage because the financial risk of the equity increases while the business risk remains the same.

Concept Questions

16.3a What does M&M Proposition I state?

16.3b What are the three determinants of a firm's cost of equity?

16.3c The total systematic risk of a firm's equity has two parts. What are they?

M&M Propositions I and II with Corporate Taxes 16.4

Debt has two distinguishing features that we have not taken into proper account. First, as we have mentioned in a number of places, interest paid on debt is tax deductible. This is good for the firm, and it may be an added benefit of debt financing. Second, failure to meet debt obligations can result in bankruptcy. This is not good for the firm, and it may be an added cost of debt financing. Because we haven't explicitly considered either of these two features of debt, we realize that we may get a different answer about capital structure once we do. Accordingly, we consider taxes in this section and bankruptcy in the next one.

Our discussion here will assume that all interest paid is tax deductible. In reality, however, the Tax Cuts and Jobs Act of 2017 placed limits on the amount of interest that can be deducted. Specifically, for 2018 through 2021, the net interest deduction is limited to at most 30 percent of EBITDA. After 2021, it drops to 30 percent of EBIT. The term "net interest" means interest paid less interest earned (if any). Also, the limits aren't exactly based on EBITDA and EBIT because of some adjustments, but the differences will be minor in most cases. Importantly, any interest that can't be deducted in a particular year can be carried forward and deducted later. Thus, the tax deductibility isn't lost; it is deferred.

We can start by considering what happens to M&M Propositions I and II when we consider the effect of corporate taxes. To do this, we will examine two firms: Firm U (unlevered) and Firm L (levered). These two firms are identical on the left side of the balance sheet, so their assets and operations are the same.

We assume that EBIT is expected to be \$1,000 every year forever for both firms. The difference between the firms is that Firm L has issued \$1,000 worth of perpetual bonds on which it pays 8 percent interest each year. The interest bill is $.08 \times \$1,000 = \$80$ every year forever. Also, we assume that the corporate tax rate is 21 percent.

For our two firms, U and L, we can now calculate the following:

	Firm U	Firm L
EBIT	\$1,000	\$1,000.00
Interest	0	80.00
Taxable income	\$1,000	\$ 920.00
Taxes (21%)	210	193.20
Net income	\$ 790	\$ 726.80

THE INTEREST TAX SHIELD

To simplify things, we will assume that depreciation is zero. We will also assume that capital spending is zero and that there are no changes in NWC. In this case, cash flow from assets is equal to EBIT − Taxes. For Firms U and L, we have:

Cash Flow from Assets	Firm U	Firm L
EBIT	$1,000	$1,000.00
−Taxes	210	193.20
Total	$ 790	$ 806.80

We immediately see that capital structure is now having some effect because the cash flows from U and L are not the same even though the two firms have identical assets.

To see what's going on, we can compute the cash flow to stockholders and bondholders:

Cash Flow	Firm U	Firm L
To stockholders	$790	$726.80
To bondholders	0	80.00
Total	$790	$806.80

interest tax shield
The tax savings attained by a firm from interest expense.

What we are seeing is that the total cash flow to L is $16.80 more. This occurs because L's tax bill (which is a cash outflow) is $16.80 less. The fact that interest is deductible for tax purposes has generated a tax savings equal to the interest payment ($80) multiplied by the corporate tax rate (21 percent): $80 × .21 = $16.80. We call this tax savings the **interest tax shield**.

TAXES AND M&M PROPOSITION I

Because the debt is perpetual, the same $16.80 shield will be generated every year forever. The aftertax cash flow to L will be the same $790 that U earns plus the $16.80 tax shield. Because L's cash flow is always $16.80 greater, Firm L is worth more than Firm U, the difference being the value of this $16.80 perpetuity.

Because the tax shield is generated by paying interest, it has the same risk as the debt, and 8 percent (the cost of debt) is the appropriate discount rate. The value of the tax shield is:

$$\text{PV} = \frac{\$16.80}{.08} = \frac{.21 \times \$1{,}000 \times .08}{.08} = .21 \times \$1{,}000 = \$210$$

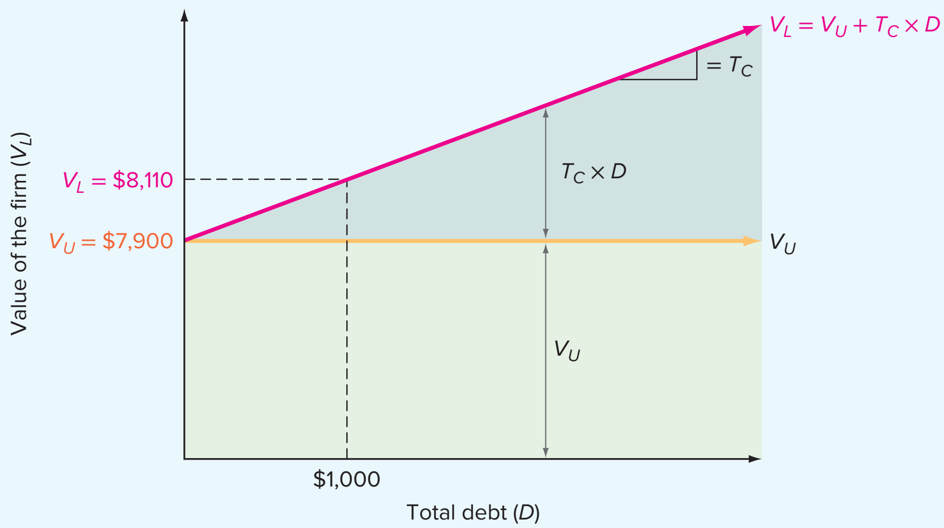
As our example illustrates, the present value of the interest tax shield can be written as:

$$\textbf{Present value of the interest tax shield} = (T_C \times D \times R_D)/R_D = T_C \times D \qquad \textbf{16.2}$$

We have now come up with another famous result, M&M Proposition I with corporate taxes. We have seen that the value of Firm L, V_L, exceeds the value of Firm U, V_U, by the present value of the interest tax shield, $T_C \times D$. M&M Proposition I with taxes states that:

$$V_L = V_U + T_C \times D \qquad \textbf{16.3}$$

The effect of borrowing in this case is illustrated in Figure 16.4. We have plotted the value of the levered firm, V_L, against the amount of debt, D. M&M Proposition I with corporate taxes implies that the relationship is given by a straight line with a slope of T_C and a y-intercept of V_U.



The value of the firm increases as total debt increases because of the interest tax shield. This is the basis of M&M Proposition I with taxes.

FIGURE 16.4

M&M Proposition I with Taxes

In Figure 16.4, we have also drawn a horizontal line representing V_U. As indicated, the distance between the two lines is $T_C \times D$, the present value of the tax shield.

Suppose that the cost of capital for Firm U is 10 percent. We will call this the **unlevered cost of capital**, and we will use the symbol R_U to represent it. We can think of R_U as the cost of capital a firm would have if it had no debt. Firm U's cash flow is $790 every year forever, and, because U has no debt, the appropriate discount rate is $R_U = 10\%$. The value of the unlevered firm, V_U, is:

unlevered cost of capital
The cost of capital for a firm that has no debt.

$$\begin{aligned} V_U &= \frac{\text{EBIT} \times (1 - T_C)}{R_U} \\ &= \frac{\$790}{.10} \\ &= \$7{,}900 \end{aligned}$$

The value of the levered firm, V_L, is:

$$\begin{aligned} V_L &= V_U + T_C \times D \\ &= \$7{,}900 + .21 \times 1{,}000 \\ &= \$8{,}110 \end{aligned}$$

As Figure 16.4 indicates, the value of the firm goes up by $.21 for every $1 in debt. In other words, the NPV *per dollar* of debt is $.21. It is difficult to imagine why any corporation would not borrow to the absolute maximum under these circumstances.

The result of our analysis in this section is the realization that, once we include taxes, capital structure definitely matters. However, we immediately reach the illogical conclusion that the optimal capital structure is 100 percent debt.

TAXES, THE WACC, AND PROPOSITION II

We can also conclude that the best capital structure is 100 percent debt by examining the weighted average cost of capital. From Chapter 14, we know that once we consider the effect of taxes, the WACC is:

$$\text{WACC} = (E/V) \times R_E + (D/V) \times R_D \times (1 - T_C)$$

To calculate this WACC, we need to know the cost of equity. M&M Proposition II with corporate taxes states that the cost of equity is:

$$\boldsymbol{R_E = R_U + (R_U - R_D) \times (D/E) \times (1 - T_C)}$$ 16.4

To illustrate, recall that we saw a moment ago that Firm L is worth $8,110 total. Because the debt is worth $1,000, the equity must be worth $8,110 − 1,000 = $7,110. For Firm L, the cost of equity is:

$$\begin{aligned} R_E &= .10 + (.10 - .08) \times (\$1{,}000/\$7{,}110) \times (1 - .21) \\ &= .1022, \text{ or } 10.22\% \end{aligned}$$

The weighted average cost of capital is:

$$\begin{aligned} \text{WACC} &= (\$7{,}110/\$8{,}110) \times .1022 + (\$1{,}000/\$8{,}110) \times .08 \times (1 - .21) \\ &= .0974, \text{ or } 9.74\% \end{aligned}$$

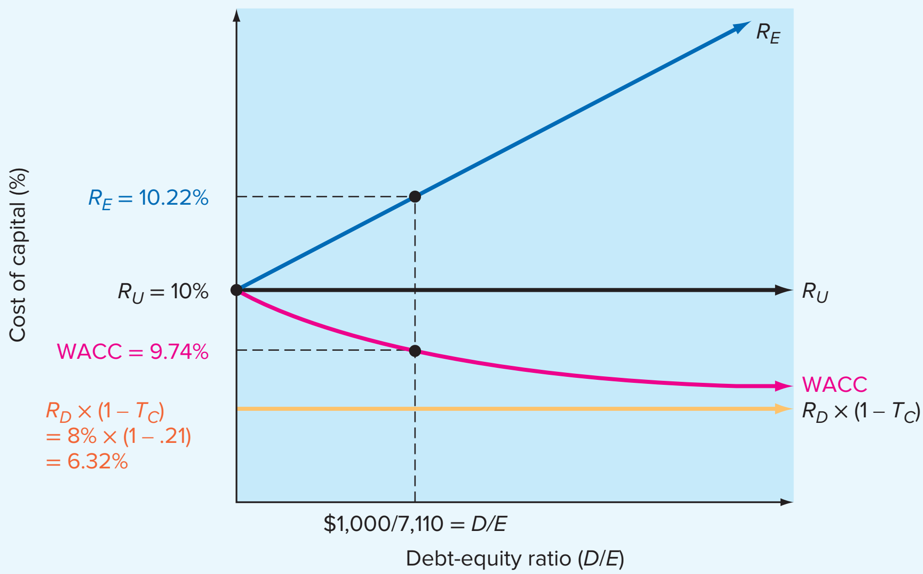
Without debt, the WACC is over 10 percent; with debt, it is 9.74 percent. Therefore, the firm is better off with debt.

CONCLUSION

Figure 16.5 summarizes our discussion concerning the relationship between the cost of equity, the aftertax cost of debt, and the weighted average cost of capital. For reference,

FIGURE 16.5

The Cost of Equity and the WACC: M&M Proposition II with Taxes



M&M Proposition I with taxes implies that a firm's WACC decreases as the firm relies more heavily on debt financing:

$$\text{WACC} = \left(\frac{E}{V}\right) \times R_E + \left(\frac{D}{V}\right) \times R_D \times (1 - T_C)$$

M&M Proposition II with taxes implies that a firm's cost of equity, R_E, rises as the firm relies more heavily on debt financing:
$R_E = R_U + (R_U - R_D) \times (D/E) \times (1 - T_C)$

TABLE 16.6

Modigliani and Miller Summary

I. The No-Tax Case

A. Proposition I: The value of the firm levered (V_L) is equal to the value of the firm unlevered (V_U):

$$V_L = V_U$$

Implications of Proposition I:

1. A firm's capital structure is irrelevant.
2. A firm's weighted average cost of capital (WACC) is the same no matter what mixture of debt and equity is used to finance the firm.

B. Proposition II: The cost of equity, R_E, is:

$$R_E = R_A + (R_A - R_D) \times (D/E)$$

where R_A is the WACC, R_D is the cost of debt, and D/E is the debt-equity ratio.

Implications of Proposition II:

1. The cost of equity rises as the firm increases its use of debt financing.
2. The risk of the equity depends on two things: The riskiness of the firm's operations (*business risk*) and the degree of financial leverage (*financial risk*). Business risk determines R_A; financial risk is determined by D/E.

II. The Tax Case

A. Proposition I with taxes: The value of the firm levered (V_L) is equal to the value of the firm unlevered (V_U) plus the present value of the interest tax shield:

$$V_L = V_U + T_C \times D$$

where T_C is the corporate tax rate and D is the amount of debt.

Implications of Proposition I:

1. Debt financing is highly advantageous, and, in the extreme, a firm's optimal capital structure is 100 percent debt.
2. A firm's weighted average cost of capital (WACC) decreases as the firm relies more heavily on debt financing.

B. Proposition II with taxes: The cost of equity, R_E, is:

$$R_E = R_U + (R_U - R_D) \times (D/E) \times (1 - T_C)$$

where R_U is the *unlevered cost of capital*—that is, the cost of capital for the firm if it has no debt. Unlike the case with Proposition I, the general implications of Proposition II are the same whether or not there are taxes.

we have included R_U, the unlevered cost of capital. In Figure 16.5, we have the debt-equity ratio on the horizontal axis. Notice how the WACC declines as the debt-equity ratio grows. This illustrates again that the more debt the firm uses, the lower is its WACC. Table 16.6 summarizes the key results of our analysis of the M&M propositions for future reference.

The Cost of Equity and the Value of the Firm — EXAMPLE 16.4

This is a comprehensive example that illustrates most of the points we have discussed thus far. You are given the following information for the Format Co.:

$$\text{EBIT} = \$126.58$$
$$T_C = .21$$
$$D = \$500$$
$$R_U = .20$$

The cost of debt capital is 10 percent. What is the value of Format's equity? What is the cost of equity capital for Format? What is the WACC?

This one's easier than it looks. Remember that all the cash flows are perpetuities. The value of the firm if it has no debt, V_U, is:

$$V_U = \frac{\text{EBIT} - \text{Taxes}}{R_U} = \frac{\text{EBIT} \times (1 - T_C)}{R_U}$$
$$= \frac{\$100}{.20}$$
$$= \$500$$

From M&M Proposition I with taxes, we know that the value of the firm with debt is:

$$V_L = V_U + T_C \times D$$
$$= \$500 + .21 \times \$500$$
$$= \$605$$

Because the firm is worth \$605 total and the debt is worth \$500, the equity is worth \$105:

$$E = V_L - D$$
$$= \$605 - 500$$
$$= \$105$$

Based on M&M Proposition II with taxes, the cost of equity is:

$$R_E = R_U + (R_U - R_D) \times (D/E) \times (1 - T_C)$$
$$= .20 + (.20 - .10) \times (\$500/\$105) \times (1 - .21)$$
$$= .5762, \text{ or } 57.62\%$$

Finally, the WACC is:

$$\text{WACC} = (\$105/\$605) \times .5762 + (\$500/\$605) \times .10 \times (1 - .21)$$
$$= .1653, \text{ or } 16.53\%$$

Notice that this is lower than the cost of capital for the firm with no debt (R_U = 20%), so debt financing is advantageous.

Concept Questions

16.4a What is the relationship between the value of an unlevered firm and the value of a levered firm once we consider the effect of corporate taxes?

16.4b If we consider only the effect of taxes, what is the optimal capital structure?

16.5 Bankruptcy Costs

One limiting factor affecting the amount of debt a firm might use comes in the form of *bankruptcy costs*. As the debt-equity ratio rises, so too does the probability that the firm will be unable to pay its bondholders what was promised to them. When this happens, ownership of the firm's assets is ultimately transferred from the stockholders to the bondholders.

In principle, a firm becomes bankrupt when the value of its assets equals the value of its debt. When this occurs, the value of equity is zero, and the stockholders turn over control of the firm to the bondholders. When this takes place, the bondholders hold assets whose value is exactly equal to what is owed on the debt. In a perfect world, there are no costs associated with this transfer of ownership, and the bondholders don't lose anything.

This idealized view of bankruptcy is not, of course, what happens in the real world. Ironically, it is expensive to go bankrupt. As we discuss, the costs associated with bankruptcy may eventually offset the tax-related gains from leverage.

DIRECT BANKRUPTCY COSTS

When the value of a firm's assets equals the value of its debt, then the firm is economically bankrupt in the sense that the equity has no value. However, the formal turning over of the assets to the bondholders is a *legal* process, not an economic one. There are legal and administrative costs to bankruptcy, and it has been remarked that bankruptcies are to lawyers what blood is to sharks.

For example, in September 2008, famed investment bank Lehman Brothers filed for bankruptcy in the largest U.S. bankruptcy to date. The company emerged from bankruptcy in March 2012 as a liquidating trust, with the goal of selling off assets and paying creditors. The direct bankruptcy costs were eye-watering: Lehman spent more than $2.2 billion (that's "billion" with a "b") on lawyers, accountants, consultants, and examiners for its U.S. and European operations. The individual costs submitted by one law firm were equally amazing: The firm requested $200,000 for business meals, $439,000 for computerized and other research, $115,000 for local transportation, and $287,000 for copying charges at 10 cents per page. The other costs of bankruptcy may have been even larger. Some experts estimated that because Lehman rushed into bankruptcy it lost out on $75 billion that it could have earned if the sale of many of its assets had been better planned.

Because of the expenses associated with bankruptcy, bondholders won't get all that they are owed. Some fraction of the firm's assets will "disappear" in the legal process of going bankrupt. These are the legal and administrative expenses associated with the bankruptcy proceeding. We call these costs **direct bankruptcy costs**.

direct bankruptcy costs
The costs that are directly associated with bankruptcy, such as legal and administrative expenses.

These direct bankruptcy costs are a disincentive to debt financing. If a firm goes bankrupt, then, suddenly, a piece of the firm disappears. This amounts to a bankruptcy "tax." So a firm faces a trade-off: Borrowing saves a firm money on its corporate taxes, but the more a firm borrows, the more likely it is that the firm will become bankrupt and have to pay the bankruptcy tax.

INDIRECT BANKRUPTCY COSTS

Because it is expensive to go bankrupt, a firm will spend resources to avoid doing so. When a firm is having significant problems in meeting its debt obligations, we say that it is experiencing financial distress. Some financially distressed firms ultimately file for bankruptcy, but most do not because they are able to recover or otherwise survive.

The costs of avoiding a bankruptcy filing incurred by a financially distressed firm are called **indirect bankruptcy costs**. We use the term **financial distress costs** to refer generically to the direct and indirect costs associated with going bankrupt or avoiding a bankruptcy filing.

indirect bankruptcy costs
The costs of avoiding a bankruptcy filing incurred by a financially distressed firm.

financial distress costs
The direct and indirect costs associated with going bankrupt or experiencing financial distress.

The problems that come up in financial distress are particularly severe, and the financial distress costs are larger, when the stockholders and the bondholders are different groups. Until the firm is legally bankrupt, the stockholders control it. They, of course, will take actions in their own economic interests. Because the stockholders can be wiped out in a legal bankruptcy, they have a very strong incentive to avoid a bankruptcy filing.

The bondholders, on the other hand, are primarily concerned with protecting the value of the firm's assets and will try to take control away from stockholders. They have a strong incentive to seek bankruptcy to protect their interests and keep stockholders from further dissipating the assets of the firm. The net effect of all this fighting is that a long, drawn-out, and potentially quite expensive legal battle gets started.

Meanwhile, as the wheels of justice turn in their ponderous ways, the assets of the firm lose value because management is busy trying to avoid bankruptcy instead of running the business. Normal operations are disrupted, and sales are lost. Valuable employees leave, potentially fruitful programs are dropped to preserve cash, and otherwise profitable investments are not taken.

For example, in 2008, both General Motors and Chrysler were experiencing significant financial difficulty, and many people felt that one or both companies would eventually file for bankruptcy (both later did). As a result of the bad news surrounding them, there was a loss of confidence in the companies' automobiles. A study showed that 75 percent of Americans would not purchase an automobile from a bankrupt company because the company might not honor the warranty, and it might be difficult to obtain replacement parts. This concern resulted in lost potential sales for both companies, which only added to their financial distress.

These are all indirect bankruptcy costs, or costs of financial distress. Whether or not the firm ultimately goes bankrupt, the net effect is a loss of value because the firm chose to use debt in its capital structure. It is this possibility of loss that limits the amount of debt that a firm will choose to use.

Concept Questions

16.5a What are direct bankruptcy costs?

16.5b What are indirect bankruptcy costs?

16.6 Optimal Capital Structure

Our previous two sections have established the basis for determining an optimal capital structure. A firm will borrow because the interest tax shield is valuable. At relatively low debt levels, the probability of bankruptcy and financial distress is low, and the benefit from debt outweighs the cost. At very high debt levels, the possibility of financial distress is a chronic, ongoing problem for the firm, so the benefits from debt financing may be more than offset by the financial distress costs. Based on our discussion, it would appear that an optimal capital structure exists somewhere in between these extremes.

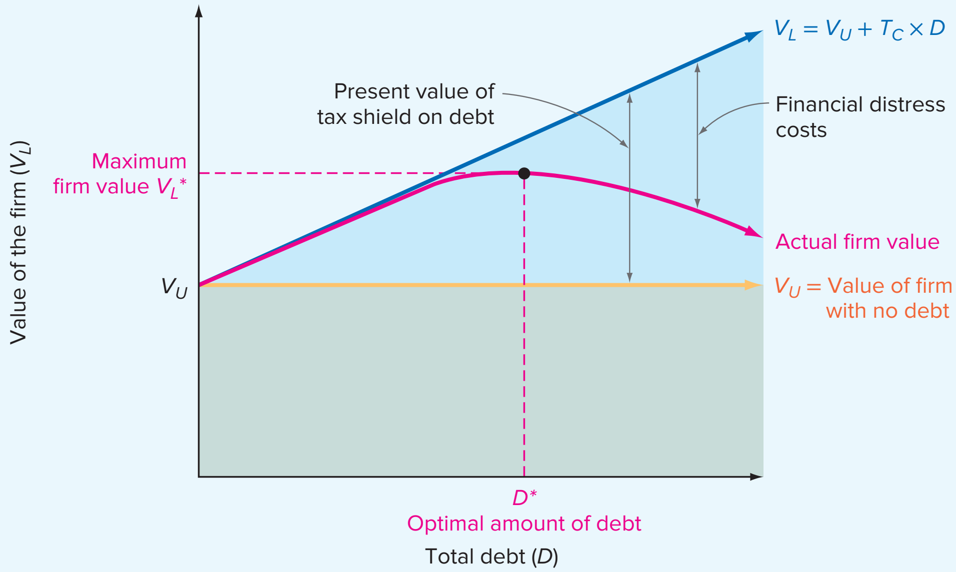
THE STATIC THEORY OF CAPITAL STRUCTURE

static theory of capital structure
The theory that a firm borrows up to the point where the tax benefit from an extra dollar in debt is exactly equal to the cost that comes from the increased probability of financial distress.

The theory of capital structure that we have outlined is called the **static theory of capital structure**. It says that firms borrow up to the point where the tax benefit from an extra dollar in debt is exactly equal to the cost that comes from the increased probability of financial distress. We call this the static theory because it assumes that the firm is fixed in terms of its assets and operations and it considers only possible changes in the debt-equity ratio.

The static theory is illustrated in Figure 16.6, which plots the value of the firm, V_L, against the amount of debt, D. In Figure 16.6, we have drawn lines corresponding to three different stories. The first represents M&M Proposition I with no taxes. This is the horizontal line extending from V_U, and it indicates that the value of the firm is unaffected by its capital structure. The second case, M&M Proposition I with corporate taxes, is represented by the upward-sloping straight line. These two cases are exactly the same as the ones we previously illustrated in Figure 16.4.

FIGURE 16.6 **The Static Theory of Capital Structure: The Optimal Capital Structure and the Value of the Firm**



According to the static theory, the gains from the tax shield on debt is offset by financial distress costs. An optimal capital structure exists that just balances the additional gain from leverage against the added financial distress cost.

The third case in Figure 16.6 illustrates our current discussion: The value of the firm rises to a maximum and then declines beyond that point. This is the picture that we get from our static theory. The maximum value of the firm, V_L*, is reached at D*, so this point represents the optimal amount of borrowing. Put another way, the firm's optimal capital structure is composed of D^*/V_L^* in debt and $(1 - D^*/V_L^*)$ in equity.

The final thing to notice in Figure 16.6 is that the difference between the value of the firm in our static theory and the M&M value of the firm with taxes is the loss in value from the possibility of financial distress. Also, the difference between the static theory value of the firm and the M&M value with no taxes is the gain from leverage, net of distress costs.

OPTIMAL CAPITAL STRUCTURE AND THE COST OF CAPITAL

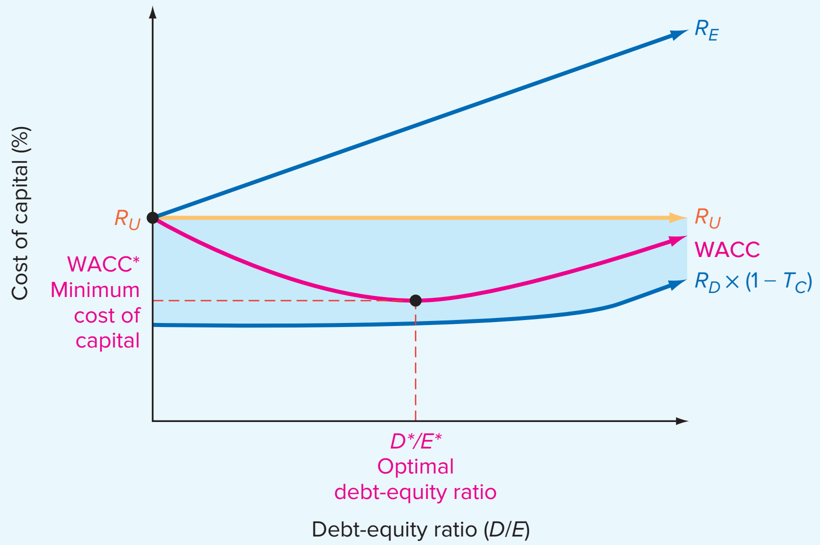
As we discussed earlier, the capital structure that maximizes the value of the firm is also the one that minimizes the cost of capital. Figure 16.7 illustrates the static theory of capital structure in terms of the weighted average cost of capital and the costs of debt and equity. Notice in Figure 16.7 that we have plotted the various capital costs against the debt-equity ratio, D/E.

Figure 16.7 is much the same as Figure 16.5 except that we have added a new line for the WACC. This line, which corresponds to the static theory, declines at first. This occurs because the aftertax cost of debt is cheaper than equity, so, at least initially, the overall cost of capital declines.

At some point, the cost of debt begins to rise, and the fact that debt is cheaper than equity is more than offset by the financial distress costs. From this point, further increases in debt actually increase the WACC. As illustrated, the minimum WACC* occurs at the point D^*/E^*, just as we described before.

FIGURE 16.7

The Static Theory of Capital Structure: The Optimal Capital Structure and the Cost of Capital



According to the static theory, the WACC falls initially because of the tax advantage of debt. Beyond the point D^*/E^*, it begins to rise because of financial distress costs.

OPTIMAL CAPITAL STRUCTURE: A RECAP

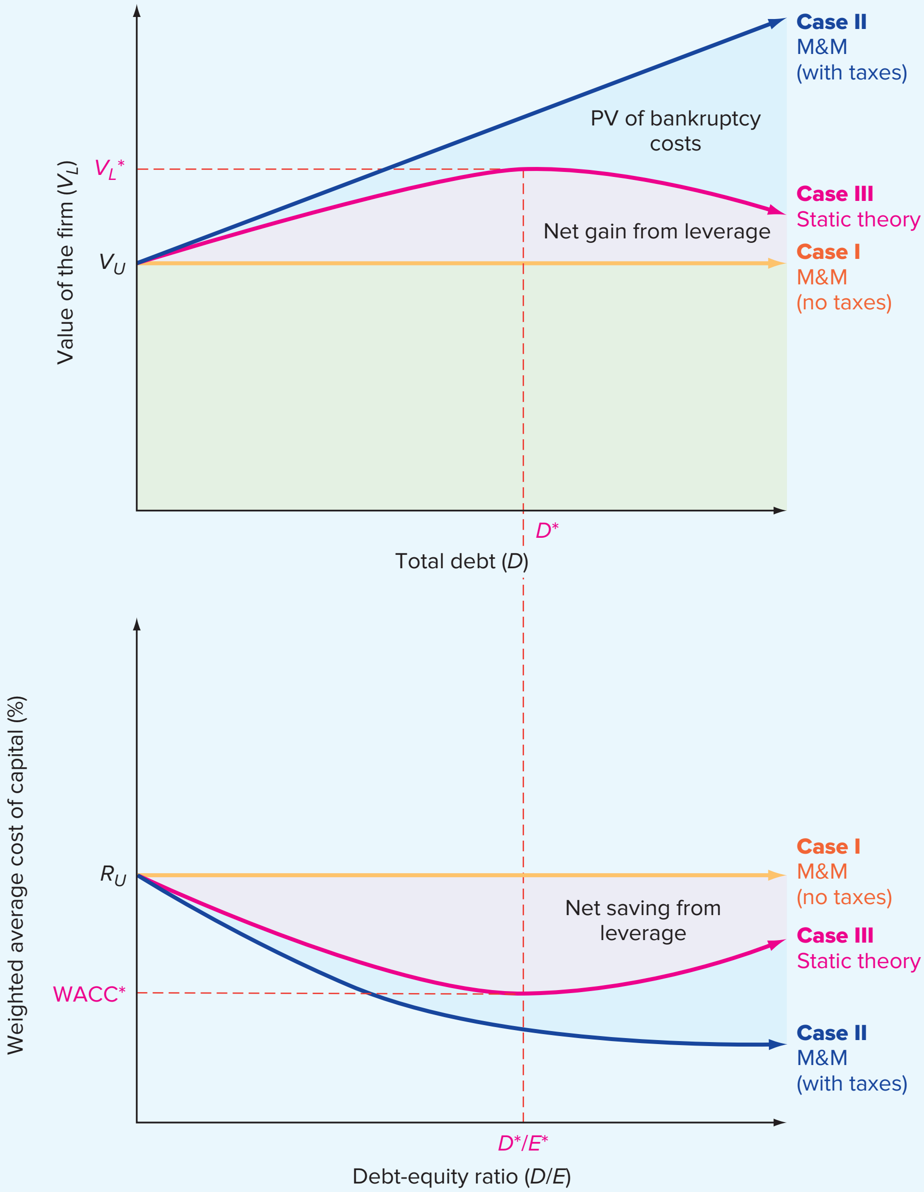
With the help of Figure 16.8, we can recap (no pun intended) our discussion of capital structure and cost of capital. As we have noted, there are essentially three cases. We will use the simplest of the three cases as a starting point and then build up to the static theory of capital structure. Along the way, we will pay particular attention to the connection between capital structure, firm value, and cost of capital.

Figure 16.8 presents the original Modigliani and Miller no-tax, no-bankruptcy argument as Case I. This is the most basic case. In the top part of the figure, we have plotted the value of the firm, V_L, against total debt, D. When there are no taxes, bankruptcy costs, or other real-world imperfections, we know that the total value of the firm is not affected by its debt policy, so V_L is constant. The bottom part of Figure 16.8 tells the same story in terms of the cost of capital. Here, the weighted average cost of capital, WACC, is plotted against the debt-equity ratio, D/E. As with total firm value, the overall cost of capital is not affected by debt policy in this basic case, so the WACC is constant.

Next, we consider what happens to the original M&M argument once taxes are introduced. As Case II illustrates, we now see that the firm's value critically depends on its debt policy. The more the firm borrows, the more it is worth. From our earlier discussion, we know this happens because interest payments are tax deductible, and the gain in firm value is equal to the present value of the interest tax shield.

In the bottom part of Figure 16.8, notice how the WACC declines as the firm uses more and more debt financing. As the firm increases its financial leverage, the cost of equity does increase; but this increase is more than offset by the tax break associated with debt financing. As a result, the firm's overall cost of capital declines.

To finish our story, we include the impact of bankruptcy, or financial distress costs, to get Case III. As shown in the top part of Figure 16.8, the value of the firm will not be as large as we previously indicated. The reason is that the firm's value is reduced by the present value of the potential future bankruptcy costs. These costs grow as the



Case I
With no taxes or bankruptcy costs, the value of the firm and its weighted average cost of capital are not affected by capital structures.

Case II
With corporate taxes and no bankruptcy costs, the value of the firm increases and the weighted average cost of capital decreases as the amount of debt goes up.

Case III
With corporate taxes and bankruptcy costs, the value of the firm, V_L, reaches a maximum at D^*, the point representing the optimal amount of borrowing. At the same time, the weighted average cost of capital, WACC, is minimized at D^*/E^*.

FIGURE 16.8
The Capital Structure Question