

SPECIAL TOPICS IN FINANCIAL MANAGEMENT

P A R T

7

18 *Derivatives and Risk
Management*

19 *Multinational Financial
Management*

20 *Hybrid Financing: Preferred
Stock, Leasing, Warrants,
and Convertibles*

21 *Mergers and Acquisitions*



CHAPTER 18

DERIVATIVES AND RISK MANAGEMENT

Using Derivatives to Manage Risk

Consumer-products giant Procter & Gamble (P&G) has more than 5 billion customers in 160 countries. Its products include such well-known brands as Crest, Tide, Pampers, Folgers, and Charmin. Its products are consumed regularly, and its sales and earnings are fairly immune to changes in the economic cycle, making it a relatively low-risk company. Indeed, *Value Line* estimates that P&G's beta is 0.55, which suggests that its risk is 45 percent below that of an average stock.

Low risk does not mean no risk, and P&G's managers devote considerable time and effort to managing the risks it does face. For example, in a recent annual report management described in detail how the company deals with risks resulting from changes in interest rates, exchange rates, and commodity prices. In each instance, P&G first examines its net exposure to the risk factor, and then it uses derivatives such as options, futures, and swaps to hedge and thus reduce those risks. Here is its statement:

Derivative positions are monitored using techniques including market value, sensitivity analysis, and value-at-risk modeling. The tests for interest rate and currency rate exposures are based on a Monte Carlo simulation value-at-risk model using a one-year horizon and a 95 percent confidence level. The model incorporates the impact of correlation (exposures that tend to move in tandem over time) and diversification from holding multiple currency and interest rate instruments and assumes that financial returns are normally distributed.

It is clear from its annual report that P&G spends a lot of time and energy managing its various risks. However, nothing is completely riskless, and in some instances the steps taken to control risk have actually backfired. Indeed, P&G incurred huge losses in the 1990s on derivative transactions that were supposedly undertaken to reduce risk.

Procter & Gamble

This chapter first discusses the various types of risks that companies face. Then it provides an overview of options, futures, and swaps and describes how companies use these instruments to help minimize their risks.

Source: Procter & Gamble's 2004 Annual Report, p. 42.

Putting Things In Perspective

In this chapter, we discuss risk management, a topic of increasing importance to financial managers. The term *risk management* can mean many things, but in business it involves identifying events that could have adverse financial consequences and then taking actions to prevent and/or minimize the damage caused by these events. Years ago, corporate risk managers dealt primarily with insurance—they made sure the firm was adequately insured against fire, theft, and other casualties and that it had adequate liability coverage. More recently, the scope of risk management has been broadened to include such things as controlling the costs of key inputs like petroleum by purchasing oil futures or protecting against changes in interest rates or exchange rates through dealings in the interest rate or foreign exchange markets. In addition, risk managers try to ensure that actions designed to hedge against risk are not actually increasing risk.

18.1 REASONS TO MANAGE RISK

We know that investors dislike risk. We also know that most investors hold well-diversified portfolios, so at least in theory the only “relevant risk” is systematic risk. Therefore, if you asked corporate executives what type of risk they were concerned about, you might expect the answer to be, “beta.” However, this is almost certainly not the answer you would get. The most likely answer, if you asked a CEO to define risk, is something like this: “Risk is the possibility that our future earnings and free cash flows will be significantly lower than we expect.” For example, consider Plastics Inc., which manufactures dashboards, interior door panels, and other plastic components used by auto companies. Petroleum is the key feedstock for plastic and thus makes up a large percentage of its costs. Plastics has a three-year contract with an auto company to deliver 500,000 door panels each year, at a price of \$60 each. When the company signed this contract, oil sold for \$59 per barrel, and oil was expected to stay at that level for the next three years. If oil prices fall, Plastics will have higher than expected profits and free cash flows, but if oil prices rise, profits will fall. Plastics’ value depends on its profits and free cash flows, so a change in the price of oil will cause stockholders to earn either more or less than they anticipated.

Now suppose Plastics announces that it plans to lock in a three-year supply of oil at a guaranteed price of \$59 per barrel, and the cost of the guarantee is

zero. Would that cause its stock price to rise? At first glance, it seems that the answer should be yes, but maybe that's not correct. Recall that the long-run value of a stock depends on the present value of its expected future free cash flows, discounted at the weighted average cost of capital (WACC). Locking in the cost of oil will cause an increase in Plastics' stock price if and only if (1) it causes the expected future free cash flows to increase or (2) it causes the WACC to decline.

Consider first the free cash flows. Before the announcement of guaranteed oil costs, investors had formed an estimate of the expected future free cash flows, based on an expected oil price of \$59 per barrel. Therefore, while locking in the cost of oil at \$59 per barrel will lower the riskiness of the expected future free cash flows, it will not change the *size* of these cash flows because investors already expected a price of \$59 per barrel.

Now what about the WACC? It will change only if locking in the cost of oil causes a change in the cost of debt or equity or the target capital structure. Assuming the foreseeable increases in the price of oil were not enough to cause bankruptcy, Plastics' cost of debt should not change, and neither should its target capital structure. Regarding the cost of equity, recall from Chapter 8 that most investors hold well-diversified portfolios, which means that the cost of equity should depend only on systematic risk. Moreover, even though an increase in oil prices would have a negative effect on Plastics' stock price, it would not have a negative effect on all stocks. Indeed, oil producers should have higher than expected returns and stock prices. Assuming that Plastics' investors hold well-diversified portfolios, including stocks of oil-producing companies, there would not appear to be much reason to expect its cost of equity to decrease. The bottom line is this: If Plastics' expected future cash flows and WACC will not change significantly due to an elimination of the risk of oil price increases, then neither should the value of its stock.

We discuss futures contracts and hedging in detail in the next section, but for now let's assume that Plastics has *not* locked in oil prices. Therefore, if oil prices increase, its stock price will fall. However, its stockholders know this, so they can build portfolios that contain oil futures whose values will rise or fall with oil prices and thus offset changes in the price of Plastics' stock. By choosing the correct amount of futures contracts, investors can thus "hedge" their portfolios and completely eliminate the risk due to changes in oil prices. There will be a cost to hedging, but that cost to large, sophisticated investors should be about the same as the cost to Plastics. If stockholders can hedge away oil price risk themselves, why should they pay a higher price for Plastics' stock just because the company itself hedged away the risk?

This discussion suggests that unless something else is going on, it doesn't make sense for firms to hedge risk. At the same time, a 1995 survey reported that 59 percent of firms with market values greater than \$250 million engage in risk management, and that percentage is surely much higher today.¹ One explanation is that corporate managers frequently hedge risk even though it does little to increase corporate value. The other (perhaps more likely) explanation is that hedging creates other benefits that ultimately lead to either higher cash flows and/or a lower WACC. Here are some of the reasons that have been suggested for why it might make sense for companies to manage risks:

1. *Debt capacity.* Risk management can reduce the volatility of cash flows, and this decreases the probability of bankruptcy. As we discussed in Chapter 14,

¹ See Gordon M. Bodnar, Gregory S. Hayt, and Richard C. Marston, "1995 Wharton Survey of Derivative Usage by U.S. Non-Financial Firms," *Financial Management*, Winter 1996, pp. 113–133.

firms with lower operating risks can use more debt, and this can lead to higher stock prices due to the interest tax savings.

2. *Maintaining the optimal capital budget over time.* Recall from Chapters 10, 13, and 14 that firms are reluctant to raise external equity due to high flotation costs and market pressure. This means that the capital budget must generally be financed with debt plus internally generated funds, mainly retained earnings and depreciation. In years when internal cash flows are low, they may be too small to support the optimal capital budget, causing firms to either slow investment below the optimal rate or else incur the high costs associated with external equity. By smoothing out the cash flows, risk management can alleviate this problem.
3. *Financial distress.* Financial distress—which can range from worrying stockholders to higher interest rates on debt to customer defections to bankruptcy—is associated with having cash flows fall below expected levels. Risk management can reduce the likelihood of low cash flows, hence of financial distress.
4. *Comparative advantages in hedging.* Many investors cannot implement a homemade hedging program as efficiently as can a company. First, firms generally have lower transactions costs due to a larger volume of hedging activities. Second, there is the problem of asymmetric information—managers know more about the firm’s risk exposure than outside investors, hence managers can create more effective hedges. And third, effective risk management requires specialized skills and knowledge that firms are more likely to have.
5. *Borrowing costs.* As discussed later in the chapter, firms can sometimes reduce input costs, especially the interest rate on debt, through the use of derivative instruments called “swaps.” Any such cost reduction adds value to the firm.
6. *Tax effects.* Companies with volatile earnings pay more taxes than more stable companies due to the treatment of tax credits and the rules governing corporate loss carry-forwards and carry-backs. Moreover, if volatile earnings lead to bankruptcy, then tax loss carry-forwards are generally lost. Therefore, our tax system encourages risk management to stabilize earnings.²
7. *Compensation systems.* Many compensation systems establish “floors” and “ceilings” on bonuses or else reward managers for meeting targets. To illustrate, suppose a firm’s compensation system calls for a manager to receive no bonus if net income is below \$1 million, a bonus of \$10,000 if income is between \$1 million and \$2 million, and one of \$20,000 if income is \$2 million or more. Moreover, the manager will receive an additional \$10,000 if actual income is at least 90 percent of the forecasted level, which is \$1 million. Now consider the following two situations. First, if income is stable at \$2 million each year, the manager receives a \$30,000 bonus each year, for a two-year total of \$60,000. However, if income is zero the first year and \$4 million the second, the manager receives no bonus the first year and \$30,000 the second, for a two-year total of \$30,000. So, even though the company has the same total income (\$4 million) over the two years, the manager’s bonus is higher if earnings are stable. So, even if hedging does not add much value for stockholders, it may still be beneficial to managers.

Perhaps the most important aspect of risk management involves derivative securities. The next section explains **derivatives**, which are securities whose values are determined by the market price of some other asset. Derivatives include *options*, whose values depend on the price of some underlying asset; *interest rate*

Derivatives

Securities whose values are determined by the market price or interest rate of some other asset.

² See Clifford W. Smith and René Stulz, “The Determinants of Firms’ Hedging Policies,” *The Journal of Financial and Quantitative Analysis*, December 1985, pp. 395–406.

and exchange rate futures and swaps, whose values depend on interest rate and exchange rate levels; and commodity futures, whose values depend on commodity prices.



Explain why finance theory, combined with well-diversified investors and “homemade hedging,” might suggest that risk management should not add much value to a company.

List and explain some reasons companies might actually employ risk management techniques.



The Chicago Board of Trade has an excellent Web site at <http://www.cbot.com>. Make sure to check out the wealth of information on the history and operations of the exchange by clicking on “About CBOT.”

18.2 BACKGROUND ON DERIVATIVES

A historical perspective is useful when studying derivatives. One of the first formal markets for derivatives was the futures market for wheat. Farmers were concerned about the price they would receive for their wheat when they sold it in the fall, and millers were concerned about the price they would have to pay. The risks faced by both parties could be reduced if they could establish a price earlier in the year. Accordingly, mill agents would go out to the wheat belt and make contracts with farmers that called for the farmers to deliver grain at a pre-determined price. Both parties benefited from the transaction in the sense that their risks were reduced. The farmers could concentrate on growing their crop without worrying about the price of grain, and the millers could concentrate on their milling operations. Thus, *hedging with futures* lowered aggregate risk in the economy.

These early futures dealings were between two parties who arranged transactions between themselves. Soon, though, middlemen came into the picture, and trading in futures was established. The Chicago Board of Trade was an early marketplace for this dealing, and *futures dealers* helped make a market in futures contracts. Thus, farmers could sell futures on the exchange, and millers could buy them there. This improved the efficiency and lowered the cost of hedging operations.

Quickly, a third group—*speculators*—entered the scene. As we will see in the next section, most derivatives, including futures, are highly leveraged, meaning that a small change in the value of the underlying asset will produce a large change in the price of the derivative. This leverage appealed to speculators. At first blush, one might think that the appearance of speculators would increase risk, but this is not true. Speculators add capital and players to the market, and this tends to stabilize the market. Of course, derivatives markets are inherently volatile due to the leverage involved, hence risk to the speculators themselves is high. Still, their bearing that risk makes the derivatives markets more stable for the hedgers.

Natural hedges, defined as situations in which aggregate risk can be reduced by derivatives transactions between two parties (called *counterparties*), exist for many commodities, foreign currencies, interest rates on securities with different maturities, and even common stocks where portfolio managers want to “hedge their bets.” Natural hedges occur when futures are traded between cotton farmers and cotton mills, copper mines and copper fabricators, importers and foreign manufacturers for currency exchange rates, electric utilities and coal miners, and oil producers and oil users. In all such situations, hedging reduces aggregate risk and thus benefits the economy.

Hedging can also be done in situations where no natural hedge exists. Here one party wants to reduce some type of risk, and another party agrees to sell a

Natural Hedges

Situations in which aggregate risk can be reduced by derivatives transactions between two parties known as counterparties.

GLOBAL PERSPECTIVES

Barings and Sumitomo Suffer Large Losses in the Derivatives Market

Barings, a conservative English bank with a long, impressive history dating back to its financing of the Louisiana Purchase in the 19th century, collapsed in 1995 when one of its traders lost \$1.4 billion in derivatives trades. Nicholas Leeson, a 28-year-old trader in Barings' Singapore office, had speculated in Japanese stock index and interest rate futures without his superiors' knowledge. A lack of internal controls at the bank allowed him to accumulate large losses without being detected. Leeson's losses caught many by surprise, and they provided ammunition to those who argue that trading in derivatives should be more highly regulated if not sharply curtailed.

Most argue that the blame goes beyond Leeson—that both the bank and the exchanges were at fault for failing to provide sufficient oversight. For misreporting his trades, Leeson was sentenced to a 6½-year term in a Singapore prison. What remained of Barings was ultimately sold to a Dutch banking concern.

Many analysts, including those who argued that the Barings episode was just an unsettling but isolated

incident, were startled by a similar case a year and a half after the Barings debacle. In June 1996, Japan's Sumitomo Corporation disclosed that its well-respected chief copper trader, Yasuo Hamanaka, had been conducting unauthorized speculative trades for more than a decade. The cumulative loss on these trades was \$2.6 billion.

These two events illustrate both the dangers of derivatives and the importance of internal controls. While it is unsettling to learn that the actions of a single, relatively low-level employee can suddenly cripple a giant corporation, these losses should be placed in perspective. The overwhelming majority of firms that use derivatives have been successful in enhancing performance and/or reducing risk. For this reason, most analysts argue that it would be a huge mistake to use the rare instances where fraud occurred to limit a market that has, for the most part, been a resounding success. However, given the volume of business in this market, we can in the future expect to see other problems similar to those encountered by Barings and Sumitomo.

contract that protects the first party from that specific event or situation. Insurance is an obvious example of this type of hedge. Note, though, that with nonsymmetric hedges, risks are generally *transferred* rather than *eliminated*. Even here, though, insurance companies can reduce certain types of risk through diversification.

The derivatives markets have grown more rapidly than any other major market in recent years, for a number of reasons. First, analytical techniques such as the Black-Scholes Option Pricing Model, which is discussed in Section 18.5, have been developed to help establish "fair" prices, and having a better basis for pricing hedges makes the counterparties more comfortable with deals. Second, computers and electronic communications make it much easier for counterparties to deal with one another. Third, globalization has greatly increased the importance of currency markets and the need for reducing the exchange rate risks brought on by global trade. Recent trends and developments are sure to continue if not accelerate, so the use of derivatives for risk management is bound to grow.

Note, though, that derivatives do have a potential downside. These instruments are highly leveraged, so small miscalculations can lead to huge losses. Also, they are complicated, hence not well understood by most people. This makes mistakes more likely than with less complex instruments, and it makes it harder for a firm's top management to exercise proper control over derivatives transactions. One 28-year-old, relatively low-level employee, operating in the Far East, entered into transactions that led to the bankruptcy of Britain's oldest bank (Barings Bank), the institution that held the accounts of the Queen of England. (See the Global Perspectives box entitled "Barings and Sumitomo Suffer Large

Losses in the Derivatives Market.”) Just prior to the problems at Barings, Orange County, California, went bankrupt due to its treasurer’s speculation in derivatives, and Procter & Gamble got into a nasty fight with Bankers Trust over derivative-related losses. A few years later in 1998, the high-profile hedge fund, Long Term Capital Management LP, nearly collapsed because of bad bets made in the derivatives market. More recently, it has been argued that extensive derivative positions enabled Enron to hide some of its losses and to hide debt that had been incurred on some of its unprofitable businesses.

The P&G, Orange County, Barings Bank, Long Term Capital Management, and Enron affairs make the headlines, causing some people to argue that derivatives should be regulated out of existence to “protect the public.” However, derivatives are used far more often to hedge risks than in harmful speculations, but these beneficial transactions never make the headlines. So, while the horror stories point out the need for top managers to exercise control over the personnel who deal with derivatives, they certainly do not justify the elimination of derivatives. In the balance of this chapter, we discuss how firms can manage risks, and how derivatives are used in risk management.



What is a “natural hedge”? Give some examples of natural hedges.

How does a nonsymmetric hedge differ from a natural hedge? Name an example of a nonsymmetric hedge.

List three reasons the derivatives markets have grown more rapidly than any other major market in recent years.

18.3 OPTIONS

Option

A contract that gives its holder the right to buy (or sell) an asset at a predetermined price within a specified period of time.

An **option** is a contract that gives its holder the right to buy (or sell) an asset at some predetermined price within a specified period of time. Financial managers should understand option theory both for risk management and also because such an understanding will help them structure warrant and convertible financings, discussed in Chapter 20.

Option Types and Markets

There are many types of options and option markets.³ To illustrate how options work, suppose you owned 100 shares of IBM, which on Wednesday, August 24, 2005, sold for \$81.84 per share. You could sell to someone the right to buy your 100 shares at any time during the next five months at a price of, say, \$85 per share. The \$85 is called the **strike**, or **exercise price**. Such options exist, and they are traded on a number of exchanges, with the Chicago Board Options Exchange (CBOE) being the oldest and the largest. This type of option is defined as a **call option**, because the purchaser has a “call” on 100 shares of stock. The seller of an option is called the option *writer*. An investor who “writes” call options against stock held in his or her portfolio is said to be selling *covered options*. Options sold without the stock to back them up are called *naked options*. When the exercise price exceeds the current stock price, a call option is said to be *out-of-the-money*. When the exercise price is below the current price of the stock, the option is *in-the-money*.

Strike (Exercise) Price

The price that must be paid for a share of common stock when an option is exercised.

Call Option

An option to buy, or “call,” a share of stock at a certain price within a specified period.

³ For an in-depth treatment of options, see Don M. Chance, *An Introduction to Derivatives and Risk Management* (Mason, OH: Thomson/South-Western, 2004).

Table 18-1 is a listing of selected options quotations (calls and puts) for IBM obtained from the *MSN Money Web site* on August 24, 2005. As we see in the first column, IBM's closing stock price was \$81.84. This implies that the first two call options listed were selling in-the-money, while the third option with an \$85 strike price was trading out-of-the-money. Taking a closer look, we see that IBM's September \$85 call option sold at the end of the day for \$0.30. Thus, for $\$0.30(100) = \30 you could buy options that would give you the right to purchase 100 shares of IBM stock at a price of \$85 per share until September 17, 2005.⁴ If the stock price stayed below \$85 during that period, you would lose your \$30, but if it rose to \$95, your \$30 investment would increase in value to $(\$95 - \$85)(100) = \$1,000$ in less than 30 days. That translates into a very healthy annualized return. Incidentally, if the stock price did go up, you would not actually exercise your options and buy the stock—rather, you would sell the options, which would then have a value of \$1,000 versus the \$30 you paid, to another option buyer or back to the original seller.

You can also buy an option that gives you the right to *sell* a stock at a specified price within some future period—this is called a **put option**. For example, suppose you think IBM's stock price is likely to decline from its current level of \$81.84 sometime during the next five months. Table 18-1 provides data on IBM's put options. You could buy a five-month put option (the January put option) for \$110.00 ($\1.10×100) that would give you the right to sell 100 shares (that you would not necessarily own) at a price of \$75 per share (\$75 is the strike price). Suppose you bought this 100-share contract for \$110.00 and then IBM's stock fell to \$70. You could buy a share of stock for \$70 and exercise your put option by selling the stock for \$75. Your profit from exercising the option would be $(\$75 - \$70)(100) = \$500$. After subtracting the \$110.00 you paid for the option, your profit (before taxes and commissions) would be \$390.00.

In addition to options on individual stocks, options are also available on several stock indexes such as the NYSE Index, Dow Jones Industrials, the S&P 100, and the S&P 500—just to name a few. Index options permit one to hedge (or bet) on a rise or fall in the general market as well as on individual stocks.

Option trading is one of the hottest financial activities in the United States. The leverage involved makes it possible for speculators with just a few dollars to make a fortune almost overnight. Also, investors with sizable portfolios can sell options against their stocks and earn the value of the option (less brokerage commissions), even if the stock's price remains constant. Most importantly,



You can obtain information for a specific company's call and put options at <http://moneycentral.msn.com/investor/options>. Just type the firm's ticker symbol and select go. Shaded options are "in-the-money."

Put Option

An option to sell a share of stock at a certain price within a specified period.

TABLE 18-1 Selected IBM Options Quotations, August 24, 2005

Closing Price	Strike Price	CALLS—LAST QUOTE			PUTS—LAST QUOTE		
		Sept.	Oct.	Jan.	Sept.	Oct.	Jan.
81.84	75	7.30	8.20	9.00	0.10	0.40	1.10
81.84	80	2.70	4.00	5.50	0.50	1.30	2.40
81.84	85	0.30	1.15	2.75	3.40	3.80	4.80

Note: Table created from data for August 24, 2005, from *MSN Money Web site*, <http://moneycentral.msn.com/investor/options>.

⁴ Actually, the *expiration date*, which is the last date that the option can be exercised, is the Friday before the third Saturday of the exercise month. Also, note that option contracts are generally written in 100-share multiples.

though, options can be used to create *hedges* that protect the value of an individual stock or portfolio. We will discuss hedging strategies in more detail later in the chapter.⁵

Long-term Equity Anticipation Security (LEAPS)

A long-term option that is listed on the exchanges and tied to both individual stocks and to stock indexes.

Conventional options are generally written for six months or less, but another type of option called a **Long-term Equity Anticipation Security (LEAPS)** is also traded. Like conventional options, LEAPS are listed on exchanges and are tied both to individual stocks and to stock indexes. The major difference is that LEAPS are long-term options, having maturities of up to 2½ years. One-year LEAPS cost about twice as much as the matching three-month option, but because of their much longer time to expiration, LEAPS provide buyers with more potential for gains and offer better long-term protection for a portfolio.

Corporations on whose stocks options are written have nothing to do with the option market. Corporations do not raise money in the option market, nor do they have any direct transactions in it. Moreover, option holders do not vote for corporate directors or receive dividends. There have been studies by the SEC and others as to whether option trading stabilizes or destabilizes the stock market, and whether this activity helps or hinders corporations seeking to raise new capital. The studies have not been conclusive, but option trading is here to stay, and many regard it as the most exciting game in town.

Factors That Affect the Value of a Call Option

A study of Table 18-1 provides some insights into call option valuation. First, we see that there are at least three factors that affect a call option's value: (1) The higher the stock's market price in relation to the strike price, the higher will be the call option price. Thus, IBM's \$85 September call option sells for \$0.30, whereas IBM's \$75 September option sells for \$7.30. This difference arises because IBM's current stock price is \$81.84. (2) The higher the strike price, the lower the call option price. Thus, all of IBM's call options shown, regardless of exercise month, decline as the strike price increases. (3) The longer the option period, the higher the option price. This occurs because the longer the time before expiration, the greater the chance that the stock price will climb substantially above the exercise price. Thus, option prices increase as the expiration date is lengthened. As shown in Table 18-1, the January 2006 options are all higher in price than either the September or October options. Other factors that affect option values, especially the volatility of the underlying stock, are discussed in later sections.

Exercise Value versus Option Price

How is the actual price of a call option determined in the market? In Section 18.5, we present a widely used model (the Black-Scholes model) for pricing call options, but first it is useful to establish some basic concepts. To begin, we define a call option's exercise value as follows:

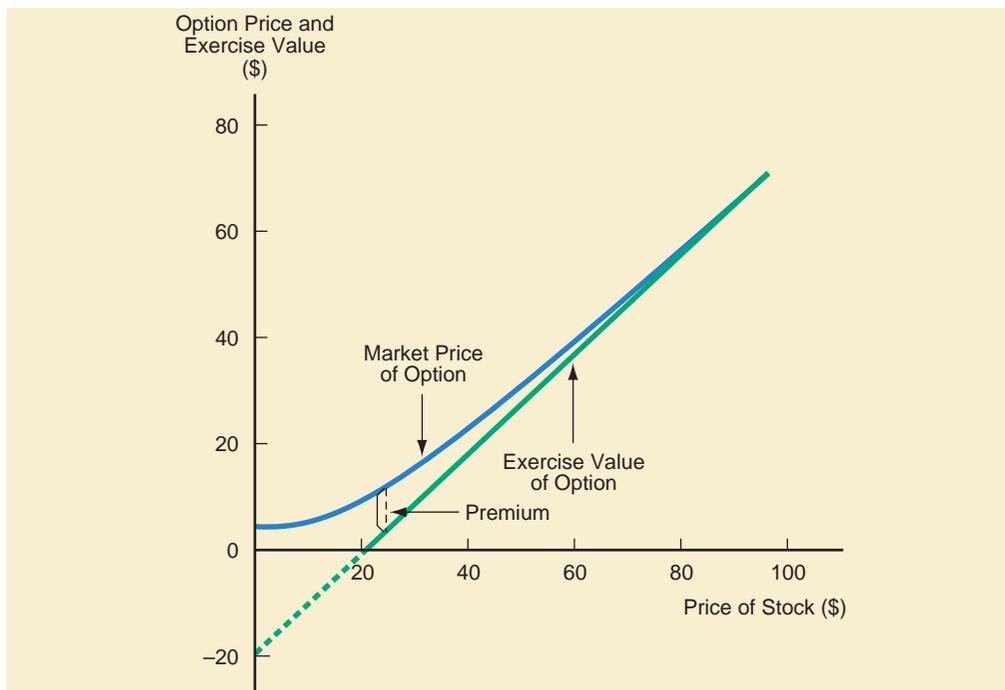
$$\text{Exercise value} = \text{Current price of the stock} - \text{Strike price} \quad (18-1)$$

⁵ It should be noted that insiders who trade illegally generally buy options rather than stock because the leverage inherent in options increases the profit potential. Note, though, that it is illegal to use insider information for personal gain, and an insider using such information would be taking advantage of the option seller. Insider trading, in addition to being unfair and essentially equivalent to stealing, hurts the economy: Investors lose confidence in the capital markets and raise their required returns because of an increased element of risk, and this raises the cost of capital and thus reduces the level of real investment.

The exercise value is what the option would be worth if you had to exercise it immediately. For example, if a stock sells for \$50 and its option has a strike price of \$20, then you could buy the stock for \$20 by exercising the option. You would own a stock worth \$50, but you would have to pay only \$20. Therefore, the option would be worth \$30 if you had to exercise it immediately. Note that the calculated exercise value of a call option could be negative, but realistically the minimum “true” value of an option is zero, because no one would exercise an out-of-the-money option. Note also that an option’s exercise value is only a first approximation value—it merely provides a starting point for finding the actual value of the option.

Now consider Figure 18-1, which presents some data on Space Technology Inc. (STI), a company that recently went public and whose stock price has fluctuated widely during its short history. The third column in the tabular data shows the exercise values for STI’s call option when the stock was selling at different prices; the fourth column gives the actual market prices for the option; and the

FIGURE 18-1 *Space Technology Inc.: Option Price and Exercise Value*



Price of Stock (1)	Strike Price (2)	Exercise Value of Option (1) – (2) = (3)	Market Price of Option (4)	Premium (4) – (3) = (5)
\$20.00	\$20.00	\$ 0.00	\$ 9.00	\$9.00
21.00	20.00	1.00	9.75	8.75
22.00	20.00	2.00	10.50	8.50
35.00	20.00	15.00	21.00	6.00
42.00	20.00	22.00	26.00	4.00
50.00	20.00	30.00	32.00	2.00
73.00	20.00	53.00	54.00	1.00
98.00	20.00	78.00	78.50	0.50

fifth column shows the premium of the actual option price over its exercise value. At any stock price below \$20, the exercise value is set at zero, but above \$20, each \$1 increase in the price of the stock brings with it a \$1 increase in the option's exercise value. Note, however, that the actual market price of the call option lies above the exercise value at each price of the common stock, although the premium declines as the price of the stock increases above the strike price. For example, when the stock sold for \$20 and the option had a zero exercise value, its actual price, and the premium, was \$9. Then, as the price of the stock rose, the *exercise value's increase* matched the stock's increase dollar for dollar, but the *market price* of the option climbed less rapidly, causing the premium to decline. The premium was \$9 when the stock sold for \$20 a share, but it had declined to \$1 by the time the stock price had risen to \$73 a share. Beyond that point, the premium virtually disappeared.

Why does this pattern exist? Why should a call option ever sell for more than its exercise value, and why does the premium decline as the price of the stock increases? The answer lies in part in the speculative appeal of options—they enable someone to gain a high degree of personal leverage when buying securities. To illustrate, suppose STI's option sold for exactly its exercise value. Now suppose you were thinking of investing in the company's common stock at a time when it was selling for \$21 a share. If you bought a share and the price rose to \$42, you would have made a 100 percent capital gain. However, had you bought the option at its exercise value (\$1 when the stock was selling for \$21), your capital gain would have been $\$22 - \$1 = \$21$ on a \$1 investment, or 2,100 percent! At the same time, your total loss potential with the option would be only \$1 versus a potential loss of \$21 if you purchased the stock. The huge capital gains potential, combined with the loss limitation, is clearly worth something—the exact amount it is worth to investors is the amount of the premium. Note, however, that buying the option is riskier than buying STI's stock, because there is a higher probability of losing money on the option. If STI's stock price fell to \$20, you would have a 4.76 percent loss if you bought the stock (ignoring transactions costs), but you would have a 100 percent loss on the option investment.

Why does the premium decline as the price of the stock rises? Part of the answer is that both the leverage effect and the loss protection feature decline at high stock prices. For example, if you were thinking of buying STI stock when its price was \$73 a share, the exercise value of the option would be \$53. If the stock price doubled to \$146, you would have a 100 percent gain on the stock. Now note that the exercise value of the option would go from \$53 to \$126, for a percentage gain of 138 percent versus 2,100 percent in the earlier case. Note also that the potential loss per dollar of potential gain on the option is much greater when the option is selling at high prices. These two factors, the declining leverage impact and the increasing danger of larger losses, help explain why the premium diminishes as the price of the common stock rises.

In addition to the stock price and the exercise price, the price of an option depends on three other factors: (1) the option's term to maturity, (2) the variability of the stock price, and (3) the risk-free rate. We will explain precisely how these factors affect call option prices later, but for now, note these points:

1. The longer a call option has to run, the greater its value and the larger its premium. If an option expires at 4 p.m. today, there is not much chance that the stock price will go up very much, so the option must sell at close to its exercise value, and its premium must be small. On the other hand, if the expiration date is a year away, the stock price could rise sharply, pulling the option's value up with it.

2. An option on an extremely volatile stock is worth more than one on a very stable stock. If the stock price rarely moves, then there is only a small chance of a large gain. However, if the stock price is highly volatile, the option could easily become very valuable. At the same time, losses on options are limited—you can make an unlimited amount, but you can only lose what you paid for the option. Therefore, a large decline in a stock's price does not have a corresponding bad effect on option holders. As a result of the unlimited upside but limited downside, the more volatile a stock, the higher the value of its options.
3. The effect of the risk-free rate on a call option isn't as obvious. The expected growth rate of a firm's stock price increases as interest rates increase, but the present value of future cash flows decreases. The first effect tends to increase the call option's price, while the second tends to decrease it. As it turns out, the first effect dominates the second one, so the price of a call option always increases as the risk-free rate increases. We illustrate this fact later in Table 18-2 in Section 18.5.

Because of Points 1 and 2, in a graph such as Figure 18-1 the longer an option's life, the higher its market price line would be above the exercise value line. Similarly, the more volatile the price of the underlying stock, the higher is the market price line. We will see precisely how these factors, and also the discount rate, affect option values when we discuss the Black-Scholes option pricing model.



What is an option? A call option? A put option?

Define a call option's exercise value. Why is the actual market price of a call option usually above its exercise value?

What are some factors that affect a call option's value?

Underwater Technology stock is currently trading at \$30 a share. A call option on the stock with a \$25 strike price currently sells for \$12. What are the exercise value and the premium of the call option? (\$5.00; \$7.00)

18.4 INTRODUCTION TO OPTION PRICING MODELS⁶

In the next section, we discuss a widely used but complex option pricing model, the Black-Scholes model. First, though, we go through a simple example to illustrate basic principles. To begin, note that all option pricing models are based on the concept of a **riskless hedge**. Here an investor buys a stock and simultaneously sells a call option on that stock. If the stock's price goes up, the investor will earn a profit on the stock, but the holder of the option will exercise it, and that will cost the investor money. Conversely, if the stock goes down, the investor will lose on his or her investment in the stock, but gain from the option (which will expire worthless if the stock price declines). As we demonstrate, it is possible to set things up such that the investor will end up with a riskless position—regardless of what the stock does, the value of the investor's portfolio will remain constant. Thus, a riskless investment will have been created.

Riskless Hedge

A hedge in which an investor buys a stock and simultaneously sells a call option on that stock and ends up with a riskless position.

⁶ This section and the following one on the Black-Scholes model are relatively technical, and they can be omitted without loss of continuity.

Expensing Executive Stock Options

In Chapter 1, we noted that many companies give senior managers stock options as part of their compensation packages. One reason for doing so is that options give managers a strong incentive to increase their companies' stock prices. Another benefit is that options are a substitute for salaries, which reduces cash requirements. Reducing the need for cash payments is particularly important for young, startup companies where cash for salaries is generally in short supply. However, options are not free to the issuing company—they have a very real cost because they lead to an increase in the number of shares outstanding, which in turn reduces the company's earnings per share.

In the past, there was another important reason companies liked to issue stock options. Cash paid as salaries must be reported as salary expense on the income statement, thus lowering reported profits. By contrast, until recently, stock options, even though they may have a true value in the millions of dollars, did not have to be reported on the income statement, and thus did not reduce reported profits.^a While some companies such as Microsoft, Cisco, Citigroup, and GE took steps to voluntarily expense their executive stock options, many other companies resisted.

Companies had been reluctant to expense options for two reasons. First, managers generally dislike any action that reduces reported profits because their own salaries, bonuses, and future options are generally based on reported profits. Recent studies indicate that expensing options would reduce the

reported profits of an average S&P 500 company by about 15 percent, and for some companies the reduction would be more than 50 percent. Second, companies weren't sure exactly how to value them. The Black-Scholes model is used most frequently, but it has limitations. In particular, some executive stock options are worth less than the valuations implied by Black-Scholes because grantees must wait several years before they can exercise their options.

Despite their reluctance, accountants and corporate managers faced intense pressure from investors who argued that it is better to be approximately correct than exactly wrong (that is, expense options using Black-Scholes for an approximate valuation rather than not expensing them and getting an obviously incorrect result). Responding to this pressure, the Financial Accounting Standards Board (FASB) recently put in place new guidelines that require public companies to deduct as an expense the value of their stock options granted each year. Some critics have complained that the new guidelines still give companies too much discretion in deciding how to value these options, but many contend that this is at least a step in the right direction.

^a Although options were not reported as an expense on firms' income statements, they had to be reported in the notes to the financial statements.

Sources: Elizabeth MacDonald, "A Volatile Brew: Easing the Impact of Strict New Stock Option Rules," *Forbes*, August 15, 2005, pp. 70–71; and Anthony Bianco, "The Angry Market," *BusinessWeek*, July 29, 2002, pp. 32–51.

If an investment is riskless, it must, in equilibrium, yield the risk-free rate. If it offered a higher return, arbitrageurs would buy it and in the process push the return down, and vice versa if it offered less than the risk-free rate.

Given the price of the stock, its potential volatility, the option's exercise price, the life of the option, and the risk-free rate, there is but one price for the option if it is to meet the equilibrium condition, namely, that a portfolio that consists of the stock and the call option will earn the risk-free rate. We value an illustrative option below, and then we use the Black-Scholes model to value options under more realistic conditions.

1. *Assumptions of the example.* The stock of Western Cellular, a manufacturer of cell phones, sells for \$40 per share. Options exist that permit the holder to buy one share of Western at an exercise price of \$35. These options will expire at the end of one year, at which time Western's stock will be selling at one of two prices, either \$30 or \$50. Also, the risk-free rate is 8 percent. Based on these assumptions, we must find the value of the options.

2. *Find the range of values at expiration.* When the option expires at the end of the year, Western's stock will sell for either \$30 or \$50, and here is the situation with regard to the value of the options:

Ending Stock Price	–	Strike Price Value	=	Ending Option Value	
\$30.00	–	\$35.00	=	\$ 0.00	(The option will be worthless. It cannot have a negative value.)
<u>50.00</u>	–	35.00	=	<u>15.00</u>	
Range <u>\$20.00</u>				<u>\$15.00</u>	

3. *Equalize the range of payoffs for the stock and the option.* As shown above, the ranges of payoffs for the stock and the option are \$20 and \$15. To construct the riskless portfolio, we need to equalize these ranges. We do so by buying 0.75 share and selling one option (or 75 shares and 100 options) to produce the following situation, where the range for both the stock and the option is \$15:

Ending Stock Price	×	0.75	=	Ending Value of Stock	Ending Value of Option
\$30.00	×	0.75	=	\$22.50	\$ 0.00
<u>50.00</u>	×	0.75	=	<u>37.50</u>	<u>15.00</u>
Range <u>\$20.00</u>				<u>\$15.00</u>	<u>\$15.00</u>

4. *Create a riskless hedged investment.* We can now create a riskless investment portfolio by buying 0.75 share of Western's stock and selling one call option. Here is the situation:

Ending Stock Price	×	0.75	=	Ending Value of Stock in the Portfolio	+	Ending Value of Option in the Portfolio	=	Ending Total Value of the Portfolio
\$30.00	×	0.75	=	\$22.50	+	\$ 0.00	=	\$22.50
50.00	×	0.75	=	37.50	+	–15.00	=	22.50

The stock in the portfolio will have a value of either \$22.50 or \$37.50, depending on what happens to the price of the stock. The call option that was sold will have no effect on the value of the portfolio if Western's price falls to \$30, because it will then not be exercised—it will expire worthless. However, if the stock price ends at \$50, the holder of the option will exercise it, paying the \$35 exercise price for stock that would cost \$50 on the open market, so in that case, the option would have a cost of \$15 to the holder of the portfolio.

Now note that the value of the portfolio is \$22.50 regardless of whether Western's stock goes up or down. So, the portfolio is riskless. A hedge has been created that protects against both increases or decreases in the price of the stock.

5. *Pricing the call option.* To this point, we have not mentioned the price of the call option that was sold to create the riskless hedge. How much should it sell for? Obviously, the seller would like to get a high price, but the buyer would want a low price. What is the *fair*, or *equilibrium*, price? To find this price, we proceed as follows:
- a. The value of the portfolio will be \$22.50 at the end of the year, regardless of what happens to the price of the stock. This \$22.50 is riskless.
 - b. The risk-free rate is 8 percent, so the present value of the riskless \$22.50 year-end value is shown below.

$$PV = \$22.50/1.08 = \$20.83$$

- c. Because Western's stock is currently selling for \$40, and because the portfolio contains 0.75 share, the cost of the stock in the portfolio is shown below.

$$0.75(\$40) = \$30.00$$

- d. If you paid \$30 for the stock, and if the present value of the portfolio is \$20.83, the option would have to sell for at least \$9.17.

$$\begin{aligned}\text{Price of option} &= \text{Cost of stock} - \text{PV of portfolio} \\ &= \$30 - \$20.83 = \$9.17\end{aligned}$$

If this option sold at a price higher than \$9.17, other investors could create riskless portfolios as described above and earn more than the risk-free rate. Investors would create such portfolios—and options—until their price fell to \$9.17, at which point the market would be in equilibrium. Conversely, if the options sold for less than \$9.17, investors would refuse to create them, and the resulting supply shortage would drive the price up to \$9.17. Thus, investors (or arbitrageurs) would buy and sell in the market until the options were priced at their equilibrium level.

Clearly, this example is overly simplistic—Western's stock price could be almost anything after one year, and you could not purchase 0.75 share of stock (but you could do so in effect by buying 75 shares and selling 100 options). Still, the example does illustrate that investors can, in principle, create riskless portfolios by buying stocks and selling call options against those stocks, and the return on such portfolios should be the risk-free rate. If call options are not priced to reflect this condition, arbitrageurs will actively trade stocks and options until option prices reflect equilibrium conditions. In the next section, we discuss the Black-Scholes Option Pricing Model, which is based on the general premise we developed here—the creation of a riskless portfolio—but which is applicable to “real-world” option pricing because it allows for a complete range of ending stock prices.



Describe how a risk-free portfolio can be created using stocks and options.

How can such a portfolio be used to help estimate a call option's value?

18.5 THE BLACK-SCHOLES OPTION PRICING MODEL (OPM)

The *Black-Scholes Option Pricing Model (OPM)*, developed in 1973, helped give rise to the rapid growth in options trading.⁷ This model, which has even been programmed into the permanent memories of some hand-held calculators, is widely used by option traders.

OPM Assumptions and Equations

In deriving their option pricing model, Fischer Black and Myron Scholes made the following assumptions:

⁷ See Fischer Black and Myron Scholes, “The Pricing of Options and Corporate Liabilities,” *Journal of Political Economy*, May/June 1973, pp. 637–659.

1. The stock underlying the call option provides no dividends or other distributions during the life of the option.
2. There are no transactions costs for buying or selling either the stock or the option.
3. The short-term, risk-free interest rate is known and is constant during the life of the option.
4. Any purchaser of a security may borrow any fraction of the purchase price at the short-term, risk-free interest rate.
5. Short selling is permitted, and the short seller will receive immediately the full cash proceeds of today's price for a security sold short.⁸
6. The call option can be exercised only on its expiration date.
7. Trading in all securities takes place continuously, and the stock price moves randomly.

The derivation of the Black-Scholes model rests on the concept of a riskless hedge such as the one we set up in the last section. By buying shares of a stock and simultaneously selling call options on that stock, an investor can create a risk-free investment position, where gains on the stock will exactly offset losses on the option. This riskless hedged position must earn a rate of return equal to the risk-free rate. Otherwise, an arbitrage opportunity would exist, and people trying to take advantage of this opportunity would drive the price of the option to the equilibrium level as specified by the Black-Scholes model.

The Black-Scholes model consists of the following three equations.

$$V = P[N(d_1)] - Xe^{-r_{RF}t}[N(d_2)] \quad (18-2)$$

$$d_1 = \frac{\ln(P/X) + [r_{RF} + (\sigma^2/2)]t}{\sigma\sqrt{t}} \quad (18-3)$$

$$d_2 = d_1 - \sigma\sqrt{t} \quad (18-4)$$

Here

V = current value of the call option.
 P = current price of the underlying stock.
 $N(d_i)$ = probability that a deviation less than d_i will occur in a standard normal distribution. Thus, $N(d_1)$ and $N(d_2)$ represent areas under a standard normal distribution function.
 X = exercise, or strike, price of the option.
 $e \approx 2.7183$.
 r_{RF} = risk-free interest rate.
 t = time until the option expires (the option period).
 $\ln(P/X)$ = natural logarithm of P/X .
 σ^2 = variance of the rate of return on the stock.

Note that the value of the option is a function of the variables we discussed earlier: (1) P , the stock's price; (2) t , the option's time to expiration; (3) X , the strike price; (4) σ^2 , the variance of the underlying stock; and (5) r_{RF} , the risk-free rate.

⁸ Suppose an investor (or speculator) does not now own any IBM stock. If the investor anticipates a rise in the stock price and consequently buys IBM stock, he or she is said to have *gone long* in IBM. On the other hand, if the investor thinks IBM's stock is likely to fall, he or she could *go short*, or *sell IBM short*. Since the short seller has no IBM stock, he or she would have to borrow the shares sold short from a broker. If the stock price falls, the short seller could, later on, buy shares on the open market and pay back the ones borrowed from the broker. The short seller's profit, before commissions and taxes, would be the difference between the price received from the short sale and the price paid later to purchase the replacement stock.



Robert's Online Option Pricer can be accessed at <http://www.intrepid.com/~robertl/option-pricer1.html>.

The site is designed to provide a financial service over the Internet to small investors for option pricing, giving anyone a means to price option trades without having to buy expensive software and hardware.

We do not derive the Black-Scholes model—the derivation involves some extremely complicated mathematics that go far beyond the scope of this text. However, it is not difficult to use the model. Under the assumptions set forth previously, if the option price is different from the one found by Equation 18-2, this would provide the opportunity for arbitrage profits, which would force the option price back to the value indicated by the model.⁹ As we noted earlier, the Black-Scholes model is widely used by traders, so actual option prices conform reasonably well to values derived from the model.

In essence, the first term of Equation 18-2, $P[N(d_1)]$, can be thought of as the expected present value of the terminal stock price, while the second term, $Xe^{-r_{RF}t}[N(d_2)]$, can be thought of as the present value of the exercise price. However, rather than try to figure out exactly what the equations mean, it is more productive to insert some numbers to see how changes in the inputs affect the value of an option.

OPM Illustration

The current stock price, P , the exercise price, X , and the time to maturity, t , can be obtained from a newspaper such as *The Wall Street Journal* or on leading financial Web sites such as *Yahoo! Finance* or *MSN Money*. The risk-free rate, r_{RF} , is the yield on a Treasury bill with a maturity equal to the option expiration date. The annualized variance of stock returns, σ^2 , can be estimated by multiplying the variance of the percentage change in daily stock prices for the past year [that is, the variance of $(P_t - P_{t-1})/P_{t-1}$] by 365 days.

Assume that the following information has been obtained:

$$\begin{aligned} P &= \$21. \\ X &= \$21. \\ t &= 0.36 \text{ year.} \\ r_{RF} &= 5\% = 0.05. \\ \sigma^2 &= 0.09. \text{ Note that } \sigma^2 = 0.09, \text{ then } \sigma = \sqrt{0.09} = 0.3. \end{aligned}$$

Given this information, we can now use the OPM by solving Equations 18-2, 18-3, and 18-4. Since d_1 and d_2 are required inputs for Equation 18-2, we solve Equations 18-3 and 18-4 first:

$$\begin{aligned} d_1 &= \frac{\ln(\$21/\$21) + [0.05 + (0.09/2)](0.36)}{0.3(0.6)} \\ &= \frac{0 + 0.0342}{0.18} = 0.19 \end{aligned}$$

$$d_2 = d_1 - 0.3\sqrt{0.36} = 0.19 - 0.18 = 0.01$$

Note that $N(d_1) = N(0.19)$ and $N(d_2) = N(0.01)$ represent areas under a standard normal distribution function. From Appendix C at the end of the book, we see that the value $d_1 = 0.19$ implies a probability of $0.0753 + 0.5000 = 0.5753$, so $N(d_1) = 0.5753$. Similarly, $N(d_2) = 0.504$. We can use those values to solve Equation 18-2:

$$\begin{aligned} V &= \$21[N(d_1)] - \$21e^{-(0.05)(0.36)}[N(d_2)] \\ &= \$21[N(0.19)] - \$21(0.98216)[N(0.01)] \\ &= \$21(0.5753) - \$20.625(0.504) \\ &= \$12.081 - \$10.395 = \$1.686 \end{aligned}$$

⁹ *Programmed trading*, in which stocks are bought and options are sold, or vice versa, is an example of arbitrage between stocks and options.

TABLE 18-2 Effects of OPM Factors on the Value of a Call Option

Case	INPUT FACTORS					OUTPUT
	P	X	t	r_{RF}	σ^2	V
Base case	\$21	\$21	0.36	5%	0.09	\$1.686
Increase P by \$4	25	21	0.36	5	0.09	4.672
Increase X by \$4	21	25	0.36	5	0.09	0.434
Increase t to 0.5	21	21	0.50	5	0.09	2.023
Increase r_{RF} to 8%	21	21	0.36	8	0.09	1.802
Increase σ^2 to 0.16	21	21	0.36	5	0.16	2.181

Thus, the value of the option, under the assumed conditions, is \$1.686. Suppose the actual option price were \$2.25. Arbitrageurs could simultaneously sell the option, buy the underlying stock, and earn a riskless profit. Such trading would occur until the price of the option was driven down to \$1.686. The reverse would occur if the option sold for less than \$1.686. Thus, investors would be unwilling to pay more than \$1.686 for the option, and they could not buy it for less, so \$1.686 is the *equilibrium value* of the option.

To see how the five OPM factors affect the value of the option, consider Table 18-2. Here the top row shows the base-case input values that were used above to illustrate the OPM and the resulting option value, $V = \$1.686$. In each of the subsequent rows, the boldfaced factor is increased, while the other four are held constant at their base-case levels. The resulting value of the call option is given in the last column. Now let's consider the effects of the changes:

1. *Current stock price.* If the current stock price, P , increases from \$21 to \$25, the option value increases from \$1.686 to \$4.672. Thus, the value of the option increases as the stock price increases, but by less than the stock price increase, \$2.986 versus \$4.00. Note, though, that the percentage increase in the option value, $(\$4.672 - \$1.686)/\$1.686 = 177\%$, far exceeds the percentage increase in the stock price, $(\$25 - \$21)/\$21 = 19\%$.
2. *Exercise price.* If the exercise price, X , increases from \$21 to \$25, the value of the option declines. Again, the decrease in the option value is less than the exercise price increase, but the percentage change in the option value (in absolute value terms), $(\$0.434 - \$1.686)/\$1.686 = -74\%$, exceeds the percentage change in the exercise price, $(\$25 - \$21)/\$21 = 19\%$.
3. *Option period.* As the time to expiration increases from $t = 0.36$ year to $t = 0.50$ year, the value of the option increases from \$1.686 to \$2.023. This occurs because the value of the option depends on the chances for an increase in the price of the underlying stock, and the longer the option has before its expiration, the higher the stock price may climb.
4. *Risk-free rate.* As the risk-free rate increases from 5 to 8 percent, the value of the option increases slightly, from \$1.686 to \$1.802. Equations 18-2, 18-3, and 18-4 suggest that the principal effect of an increase in r_{RF} is to reduce the present value of the exercise price, $Xe^{-r_{RF}t}$, hence to increase the current value of the option.¹⁰ The risk-free rate also plays a role in determining the

¹⁰ At this point, you may be wondering why the first term in Equation 18-2, $P[N(d_1)]$, is not discounted. In fact, it has been, because the current stock price, P , already represents the present value of the expected stock price at expiration. In other words, P is a discounted value, and the discount rate used in the market to determine today's stock price includes the risk-free rate. Thus, Equation 18-2 can be thought of as the present value of the end-of-option-period spread between the stock price and the strike price, adjusted for the probability that the stock price will be higher than the strike price.

values of the normal distribution functions $N(d_1)$ and $N(d_2)$, but this effect is of secondary importance. Indeed, option prices in general are not very sensitive to interest rate changes, at least not to changes within the ranges normally encountered.

5. *Variance.* As the variance increases from the base case 0.09 to 0.16, the value of the option increases from \$1.686 to \$2.181. Therefore, the riskier the underlying security, the more valuable the option. This result is logical. First, if you bought an option to buy a stock that sells at its exercise price, and if $\sigma^2 = 0$, then there would be a zero probability of the stock increasing, hence a zero probability of making money on the option. On the other hand, if you bought an option on a high-variance stock, there would be a fairly high probability that the stock price would go way up, hence that you would make a large profit on the option. Of course, a high-variance stock could go way down, but as an option holder, your losses would be limited to the price paid for the option—only the right-hand side of the stock's probability distribution counts. Put another way, an increase in the price of the stock helps option holders more than a decrease hurts them, so the greater the variance, the greater is the value of the option. This makes options on risky stocks more valuable than those on safer, low-variance stocks.

Myron Scholes and Robert Merton were awarded the 1972 Nobel Prize in Economics, and Fischer Black would have been a co-recipient had he still been living.¹¹ Their work provided analytical tools and methodologies that are widely used to solve many types of financial problems, not just option pricing. Indeed, the entire field of modern risk management is based primarily on their contributions. This concludes our discussion of options and option pricing theory. The next section discusses some other types of derivative securities.



What is the purpose of the Black-Scholes Option Pricing Model?

Explain what a “riskless hedge” is and how the riskless hedge concept is used in the Black-Scholes OPM.

Describe the effect of a change in each of the following factors on the value of a call option:

- (1) Stock price.
- (2) Exercise price.
- (3) Option life.
- (4) Risk-free rate.
- (5) Stock price variance; that is, riskiness of stock.

What is the value of a call option with these data: $P = \$25$; $X = \$25$; $r_{RF} = 8\%$; $t = 0.5$ (6 months); $\sigma^2 = 0.09$; $N(d_1) = 0.61586$; and $N(d_2) = 0.53287$? (**\$2.60**)

Forward Contract

A contract under which one party agrees to buy a commodity at a specific price on a specific future date and the other party agrees to make the sale. Physical delivery occurs.

18.6 FORWARD AND FUTURES CONTRACTS

Forward contracts are agreements where one party agrees to buy a commodity at a specific price on a specific future date and the other party agrees to make the sale. *Goods are actually delivered under forward contracts.* Unless both parties

¹¹ See Robert C. Merton, “Theory of Rational Option Pricing,” *Bell Journal of Economics and Management Science*, Vol. 4 (1973), pp. 141–183.

are financially strong, there is a danger that one party will default on the contract, especially if the price of the commodity changes markedly after the agreement is reached.

A **futures contract** is similar to a forward contract, but with three key differences: (1) Futures contracts are “marked to market” on a daily basis, meaning that gains and losses are noted and money must be put up to cover losses. This greatly reduces the risk of default that exists with forward contracts. (2) With futures, physical delivery of the underlying asset is virtually never taken—the two parties simply settle up with cash for the difference between the contracted price and the actual price on the expiration date. (3) Futures contracts are generally standardized instruments that are traded on exchanges, whereas forward contracts are generally tailor-made, are negotiated between two parties, and are not traded after they have been signed.

Futures and forward contracts were originally used for commodities such as wheat, where farmers would sell forward contracts to millers, enabling both parties to lock in prices and thus reduce their risk exposure. Commodities contracts are still important, but today more trading is done in foreign exchange and interest rate futures. To illustrate how foreign exchange contracts are used, suppose GE arranges to buy electric motors from a German manufacturer on terms that call for GE to pay 1 million euros in 180 days. GE would not want to give up the free trade credit, but if the euro appreciated against the dollar during the next six months, the dollar cost of the million euros would rise. GE could hedge the transaction by buying a forward contract under which it agreed to buy the million euros in 180 days at a fixed dollar price. This would lock in the dollar cost of the motors. This transaction would probably be conducted through a money center bank, which would try to find a German company (a “counterparty”) that needed dollars in six months. Alternatively, GE could buy a futures contract on an exchange.

Interest rate futures represent another huge and growing market. For example, suppose Simonset Corporation decides to build a new plant at a cost of \$20 million. It plans to finance the project with 15-year bonds that would carry an 8 percent interest rate if they were issued today. However, the company will not need the money for about six months. Simonset could go ahead and sell 15-year bonds now, locking in the 8 percent rate, but it would have the money before it was needed, so it would have to invest in short-term securities that would yield less than 8 percent. However, if Simonset waits six months to sell the bond issue, interest rates might be higher than they are today, in which case the firm would have to pay higher interest costs on the bonds, perhaps to the point of making it unprofitable to build the plant.

One solution to Simonset’s dilemma involves *interest rate futures*, which are based on a hypothetical 15-year Treasury bond with a 6 percent semiannual coupon. If interest rates in the economy rise, the value of the hypothetical T-bond will fall, and vice versa. In our example, Simonset is worried about an increase in interest rates. Should rates rise, the hypothetical Treasury bond’s value would decline. Therefore, Simonset could sell T-bond futures for delivery in six months to hedge its position. If interest rates rise, Simonset will have to pay more when it issues its own bonds. However, it will make a profit on its futures position because it will have pre-sold the bonds at a higher price than it will have to pay to cover (repurchase) them. Of course, if interest rates decline, Simonset will lose on its futures position, but this will be offset by the fact that it will get to pay a lower interest rate when it issues its bonds.

In 2005, futures contracts were available on more than 30 real and financial assets traded on 14 U.S. exchanges, the largest of which are the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME). Futures contracts are divided into two classes, **commodity futures** and **financial futures**. Commodity

Futures Contract

Standardized contracts that are traded on exchanges and are “marked to market” daily, but where physical delivery of the underlying asset is virtually never taken.

Commodity Futures

A contract that is used to hedge against price changes for input materials.

Financial Futures

A contract that is used to hedge against fluctuating interest rates, stock prices, and exchange rates.

TABLE 18-3 Interest Rate Futures

TREASURY BONDS (CBT)—\$100,000; PTS. 32nds OF 100%								
Delivery Month (1)	Open (2)	High (3)	Low (4)	Settle (5)	Change (6)	LIFETIME		Open Interest (9)
						High (7)	Low (8)	
Sept	116-07	116-24	116-00	116-17	9	119-23	108-15	563,857
Dec	115-28	116-12	115-22	116-05	9	119-07	108-23	55,147
Mar06	115-30	115-30	115-28	115-29	9	118-19	113-03	207
June	115-21	115-21	115-21	115-25	9	115-21	115-05	2

Est vol 242,706; vol Mon 271,374; open int 619,213, +3,204.

Source: *The Wall Street Journal*, August 24, 2005, p. B9.

futures, which cover oil, various grains, oilseeds, livestock, meats, fibers, metals, and wood, were first traded in the United States in the mid-1800s. Financial futures, which were first traded in 1975, include Treasury bills, notes, bonds, certificates of deposit, eurodollar deposits, foreign currencies, and stock indexes.

To illustrate how futures contracts work, consider the CBOT's contract on Treasury bonds. The basic contract is for \$100,000 of a hypothetical 6 percent coupon, semiannual payment Treasury bond with 15 years to maturity. Table 18-3 shows an extract from the Treasury bond futures table that appeared in the August 24, 2005, issue of *The Wall Street Journal*.

The first column gives the delivery month; the next three columns give the opening, high, and low prices for that contract on that day. The opening price for the September future, 116-07, means 116 plus $\frac{7}{32}$, or 116.21875 percent of par. Column 5 gives the settlement price, which is typically the price at the close of trading. Column 6 reports the change in the settlement price from the preceding day—the September contract rose $\frac{9}{32}$. Columns 7 and 8 give the lifetime-of-contract highs and lows. Finally, Column 9 shows the “open interest,” which is the number of contracts outstanding.

To illustrate, we focus on the Treasury bonds for December delivery. The settlement price was 116-05, or 116 plus $\frac{5}{32}$ percent of the \$100,000 contract value. Thus, the price at which one could buy \$100,000 face value of 6 percent, 15-year Treasury bonds to be delivered in December was 116.15625 percent of par, or $1.1615625(\$100,000) = \$116,156.25$. The contract price increased by $\frac{9}{32}$ of 1 percent of \$100,000, or by \$281.25, from the previous day, so if you had bought the contract yesterday, you would have gained \$281.25. Over its life, the contract's price has ranged from 108.71875 to 119.21875 percent of par, and there were 55,147 contracts outstanding, representing a total value of about \$6.41 billion.

Note that the contract increased by $\frac{9}{32}$ of a percent on this particular day. Why would the value of the bond futures contract increase? Since bond prices increase when interest rates fall, we know that interest rates fell on that day. Moreover, we can calculate the implied rates inherent in the futures contracts. (*The Wall Street Journal* formerly provided the implied yields, but now we must calculate them.) Recall that the contract relates to a hypothetical 15-year, semiannual payment, 6 percent coupon bond. The closing price (settlement price) was $116\frac{5}{32}$, or 116.15625 percent of par. Using a financial calculator, we can solve for r_d in the following equation:

$$\sum_{t=1}^{30} \frac{\$30}{(1 + r_d/2)^t} + \frac{\$1,000}{(1 + r_d/2)^{30}} = \$1,161.5625$$

The solution value for the six-month rate is 2.25326 percent, which is equivalent to a nominal annual rate of 4.50652 percent, or 4.51 percent. Because the price of the bond rose by $\frac{9}{32}$ that day, we could find the previous day's closing (settlement) price and its implied interest rate, which would turn out to be 4.53 percent. Therefore, interest rates fell by 2 basis points, which was enough to increase the value of the contract by \$281.25.

Thus, the futures contract for December delivery of this hypothetical bond sold for \$116,156.25 for 100 bonds with a par value of \$100,000, which translates to a yield to maturity of about 4.5 percent. This yield reflects investors' beliefs about what the interest rate level will be in December. The spot yield on T-bonds was about 4.4 percent at the time, so the marginal trader in the futures market was predicting about a 10-basis-point increase in yields over the next four months. That prediction could, of course, turn out to be incorrect.

Now suppose that two months later interest rates in the futures market had fallen from the earlier levels, say, from 4.5 to 4.0 percent. Falling interest rates mean rising bond prices, and we could calculate that the December contract would then be worth about \$122,396.46. Thus, the contract's value would have increased by $\$122,396.46 - \$116,156.25 = \$6,240.21$.

When futures contracts are purchased, the purchaser does not have to put up the full amount of the purchase price; rather, the purchaser is required to post an initial *margin*, which for CBT Treasury bond contracts is \$1,553 per \$100,000 contract. However, investors are required to maintain a certain value in the margin account, called a *maintenance margin*. The maintenance margin for CBT Treasury bond contracts is \$1,150 per \$100,000 contract. If the value of the contract declines, then the owner may be required to add additional funds to the margin account, and the more the contract value falls, the more money must be added. The value of the contract is checked at the end of every working day, and margin account adjustments are made at that time. This is called "marking to market." If an investor purchased our illustrative contract and then sold it later for \$122,396.46, he or she would have made a profit of \$6,240.21 on a \$1,553 investment, or a return of about 402 percent in only two months. It is clear, therefore, that futures contracts offer a considerable amount of leverage. Of course, if interest rates had risen, then the value of the contract would have declined, and the investor could easily have lost his or her \$1,553, or more. Futures contracts are never settled by delivery of the securities involved. Rather, the transaction is completed by reversing the trade, which amounts to selling the contract back to the original seller.¹² The actual gains and losses on the contract are realized when the futures contract is closed.

Our examples show that forward contracts and futures can be used to hedge, or reduce, risks. Later on, in Section 18.9, we describe in more detail how futures can be used to hedge various types of risk. It has been estimated that more than 95 percent of all futures transactions are indeed designed as hedges, with banks and futures dealers serving as middlemen between hedging counterparties. Interest rate and exchange rate futures can, of course, be used for speculative as well as hedging purposes. We can buy a T-bond contract on \$100,000 of bonds with only \$1,553 down, in which case a small change in interest rates will result in a very large gain or loss. Still, the primary motivation behind the vast majority of these transactions is to hedge risks, not to create them.

¹² The buyers and sellers of most financial futures contracts do not actually trade with one another—each trader's contractual obligation is with a futures exchange. This feature helps to guarantee the fiscal integrity of the trade. Incidentally, commodities futures traded on the exchanges are settled in the same way as financial futures, but in the case of commodities much of the contracting is done off the exchange, between farmers and processors, as *forward contracts*, in which case actual deliveries occur.

Futures contracts and options are similar to one another—so similar that people often confuse the two. Therefore, it is useful to compare the two instruments. A *futures contract* is a definite agreement on the part of one party to buy something on a specific date and at a specific price, and the other party agrees to sell on the same terms. No matter how low or how high the price goes, the two parties must settle the contract at the agreed-upon price. An *option*, on the other hand, gives someone the right to buy (call) or sell (put) an asset, but the holder of the option does not have to complete the transaction. Note also that options exist both for individual stocks and for “bundles” of stocks such as those in the S&P and *Value Line* indexes, but generally not for commodities. Futures, on the other hand, are used for commodities, debt securities, and stock indexes. The two types of instruments can be used for the same purposes. One is not necessarily better or worse than another—they are simply different.



What is a forward contract?

What is a futures contract? What are the key differences between forward and futures contracts?

What is the difference between the initial margin and the maintenance margin on a futures contract?

Suppose you buy a March futures contract on a hypothetical 15-year, 6 percent semiannual coupon bond with a settlement price today of $109\frac{9}{32}$. You post the initial margin required for this transaction (\$1,553 per \$100,000 contract). What nominal yield to maturity is implied by the settlement price? If interest rates fall to 4.5 percent, what return would you earn on one futures contract? If interest rates rose to 5.5 percent, what is the return on one futures contract? (5.11%, 448%, -271.66%)

18.7 OTHER TYPES OF DERIVATIVES

Options, forwards, and futures are among the most important classes of derivative securities, but there are other types of derivatives, including swaps, structured notes, inverse floaters, and a host of other “exotic” contracts.

Swaps

Swap

Two parties agree to exchange obligations to make specified payment streams.

A **swap** is just what the name implies—two parties agree to swap something, generally obligations to make specified payment streams. Most swaps today involve either interest payments or currencies. To illustrate an interest rate swap, suppose Company S has a 20-year, \$100 million floating-rate bond outstanding, while Company F has a \$100 million, 20-year, fixed-rate issue outstanding. Thus, each company has an obligation to make a stream of interest payments, but one payment stream is fixed while the other will vary as interest rates change in the future.

Now suppose Company S has stable cash flows, and it wants to lock in its cost of debt. Company F has cash flows that fluctuate with the economy, rising when the economy is strong and falling when it is weak. Recognizing that interest rates also move up and down with the economy, Company F has concluded that it would be better off with variable rate debt. If the companies swapped their payment obligations, an *interest rate swap* would occur. Company S would

now have to make fixed payments, which is consistent with its stable cash inflows, and Company F would have a floating stream, which for it is less risky.

Note, though, that swaps can involve *side payments*. For example, if interest rates had fallen sharply since Company F issued its bonds, then its old payment obligations would be relatively high, and it would have to make a side payment to get S to agree to the swap. Similarly, if the credit risk of one company was higher than that of the other, the stronger company would be concerned about the ability of its weaker “counterparty” to make the required payments. This too would lead to the need for a side payment.

Currency swaps are similar to interest rate swaps. To illustrate, suppose Company A, an American firm, had issued \$100 million of dollar-denominated bonds in the United States to fund an investment in Germany. Meanwhile, Company G, a German firm, had issued \$100 million of euro-denominated bonds in Germany to make an investment in the United States. Company A would earn euros but be required to make payments in dollars, and Company G would be in a reverse situation. Thus, both companies would be exposed to exchange rate risk. However, both companies’ risks would be eliminated if they swapped payment obligations. As with interest rate swaps, differences in interest rates or credit risks would require side payments.

Originally, swaps were arranged between companies by money center banks, which would match up counterparties. Such matching still occurs, but today most swaps are between companies and banks, with the banks then taking steps to ensure that their own risks are hedged. For example, Citibank might arrange a swap with Company A, which would agree to make specified payments in euros to the bank, and the bank would make the dollar payments Company A would otherwise owe. Citibank would charge a fee for setting up the swap, and these charges would reflect the creditworthiness of Company A. To protect itself against exchange rate movements, the bank would hedge its position, either by lining up a German company that needed to make dollar payments or else by using currency futures.

Structured Notes

The term **structured note** often means a debt obligation that is derived from some other debt obligation. For example, in the early 1980s, investment bankers began buying large blocks of 30-year, noncallable Treasury bonds and then *stripping* them to create a series of zero coupon bonds. The zero with the shortest maturity was backed by the first interest payment on the T-bond issue, the second shortest zero was backed by the next interest payment, and so forth, on out to a 30-year zero backed by the last interest payment plus the maturity value of the T-bond. Zeros formed by stripping T-bonds were one of the first types of structured notes.

Another important type of structured note is backed by the interest and principal payments on mortgages. In the 1970s, Wall Street firms began to buy large packages of mortgages backed by federal agencies and then place these packages, or “pools,” with a trustee. Then bonds called *collateralized mortgage obligations (CMOs)*, backed by the mortgage pool held in trust, were sold to pension funds, individuals for their IRA accounts, and other investors who were willing to invest in CMOs but who would not have purchased individual mortgages. This *securitization* of mortgages made billions of dollars of new capital available to home buyers.

CMOs are more difficult to evaluate than straight bonds for several reasons. First, the underlying mortgages can be prepaid at any time, and when this occurs the prepayment proceeds are used to retire part of the CMO debt itself.

Structured Note

A debt obligation derived from another debt obligation.

Therefore, the holder of a CMO is never sure when his or her bond will be called. This situation is further complicated by the fact that when interest rates decline, this causes bond prices to rise. However, declining rates also lead to mortgage prepayments, which cause the CMOs to be called especially rapidly.

It should also be noted that a variety of structured notes can be created, ranging from notes whose cash flows can be predicted with virtual certainty to other notes whose payment streams are highly uncertain. For example, investment bankers can (and do) create notes called *IOs* (for *interest only*), which provide cash flows from the interest component of the mortgage amortization payments, and *POs* (for *principal only*), which are paid from the principal repayment stream. In each case, the value of the note is found as the PV of an expected payment stream, but the length and size of the stream are uncertain. Suppose, for example, that you are offered an IO that you expect to provide payments of \$100 for 10 years (you expect the mortgages to be refinanced after 10 years, at which time your payments will cease). Suppose further that you discount the expected payment stream at a rate of 10 percent and determine that the value is \$614.46. You have \$614.46 to invest, so you buy the IO, expecting to earn 10 percent on your money.

Now suppose interest rates decline. If rates fall, the discount rate would drop, and that would normally imply an increase in the IO's value. However, if rates decline sharply, this would lead to a rash of mortgage refinancings, in which case your payments, which come from interest only, would cease (or be greatly reduced), and the value of your IO would fall sharply. On the other hand, a sharp increase in interest rates would reduce refinancings, lengthen your expected payment stream, and probably increase the value of your IO.

Investment bankers can slice and dice a pool of mortgages into a bewildering array of structured notes, ranging from "plain vanilla" ones with highly predictable cash flows to "exotic" ones (sometimes called "toxic waste") whose risks are almost incalculable but are surely large.

Securitizing mortgages through CMOs serves a useful economic function—it provides an investment outlet for pension funds and others with money to invest, and it makes more money available to homeowners at a reasonable cost. Also, some investors want relatively safe investments, while others are willing to buy more speculative securities for the higher expected returns they provide. Structured notes permit a partitioning of risks to give investors what they want. There are dangers, though. The "toxic waste" is often bought by naive officials managing money for local governments like Orange County, California, when they really ought to be holding only safe securities.

More recently, Wall Street firms have put together a similar set of instruments called *collateralized debt obligations* (*CDOs*). CDOs are similar to CMOs but instead of assembling a portfolio of mortgages, the issuing firm assembles a portfolio of debt instruments. Once again the overall risk is partitioned into several classes. If you are holding the senior class you are first in line to receive cash flows from the portfolio, and as a result, your risk may not be all that great. On the other hand, if you buy one of the riskier classes that have lower priority, you can expect higher returns but a lot more risk.

Inverse Floaters

A floating-rate note has an interest rate that rises and falls with some interest rate index. For example, the interest rate on a \$100,000 note at prime plus 1 percent would be 7.50 percent when the prime rate is 6.50 percent, and the note's rate would move up and down with the prime rate. Because both the cash flows associated with the note and the discount rate used to value it rise and fall together, the market value of the note would be relatively stable.

Credit Instruments Create New Opportunities and Risks

While market participants have traditionally used derivatives to hedge interest rate risk and currency risk, they still often faced credit risk. Perhaps not surprisingly, a new set of derivative instruments has evolved to help market participants manage this credit risk.

One example of a credit derivative is a credit swap (sometimes called a credit default swap). In its simplest form, one party agrees to bear the credit risk of another party in exchange for an ongoing payment. For example, let's say that Company Z agrees to sell a credit swap to Bank A who recently made a loan to Company L. Under the terms of the agreement, Bank A agrees to make regular payments to Company Z. In return, Company Z agrees to compensate Bank A if Company L defaults on the loan. In effect, the seller of the swap is providing a form of insurance to Bank A by agreeing to bear all or part of the loan's credit risk.

Credit derivatives provide value to the extent that they increase market liquidity and help financial institutions manage risk. On the other hand, the value of these positions can change dramatically in a short period of time. Moreover, there are concerns where a sudden loss could create a chain reaction. For example, if a hedge fund loses big money on its credit derivative positions, this could have a negative effect on the banks who have lent money to the hedge fund.

Trying to put this in perspective, a Wall Street veteran quoted in a recent issue of *BusinessWeek* compared credit derivatives to fertilizer: "It can help your garden grow or can be made into bombs."

Source: Mara Der Hovanesian, Chester Dawson, and Kerry Capell, "Taking Risk to Extremes: Will Derivatives Cause a Major Blowup in the World's Credit Markets?" *BusinessWeek*, May 23, 2005, p. 96.

With an **inverse floater**, the rate paid on the note moves counter to market rates. Thus, if interest rates in the economy rose, the interest rate paid on an inverse floater would fall, lowering its cash interest payments. At the same time, the discount rate used to value the inverse floater's cash flows would rise along with other rates. The combined effect of lower cash flows and a higher discount rate would lead to a very large decline in the value of the inverse floater. Thus, inverse floaters are exceptionally vulnerable to increases in interest rates. Of course, if interest rates fall, the value of an inverse floater will soar.

Inverse Floater

A note in which the interest rate paid moves counter to market rates.

We have discussed the most important types of derivative securities, but certainly not all types. This discussion should, though, give you a good idea of how and why derivatives are created, and how they can be used and misused.



Briefly describe the following types of derivative securities:

- (1) Swaps.
- (2) Structured notes.
- (3) Inverse floaters.

18.8 RISK MANAGEMENT

As businesses become increasingly complex, it is becoming more and more difficult for CEOs and directors to know what problems might lie in wait. Therefore, companies need to have someone systematically look for potential

Risk Management

Involves the management of unpredictable events that have adverse consequences for the firm.

problems and design safeguards to minimize potential damage. With this in mind, most larger firms have designated “risk managers” who report to the chief financial officer, while the CFOs of smaller firms personally assume risk management responsibilities. In any event, **risk management** is becoming increasingly important, and it is something finance students should understand. Therefore, in the remainder of this chapter we discuss the basics of risk management, with particular emphasis on how derivatives can be used to hedge financial risks.

It is useful to begin our discussion of risk management by defining some commonly used terms that describe different risks. Some of these risks can be mitigated, or managed, and that is what risk management is all about.

1. *Pure risks* are risks that offer only the prospect of a loss. Examples include the risk that a plant will be destroyed by fire or that a product liability suit will result in a large judgment against the firm.
2. *Speculative risks* are situations that offer the chance of a gain but might result in a loss. Thus, investments in new projects and marketable securities involve speculative risks.
3. *Demand risks* are associated with the demand for a firm’s products or services. Because sales are essential to all businesses, demand risk is one of the most significant risks that firms face.
4. *Input risks* are risks associated with input costs, including both labor and materials. Thus, a company that uses copper as a raw material in its manufacturing process faces the risk that the cost of copper will increase and that it will not be able to pass this increase on to its customers.
5. *Financial risks* are risks that result from financial transactions. As we have seen, if a firm plans to issue new bonds, it faces the risk that interest rates will rise before the bonds can be brought to market. Similarly, if the firm enters into contracts with foreign customers or suppliers, it faces the risk that fluctuations in exchange rates will result in unanticipated losses.
6. *Property risks* are associated with destruction of productive assets. Thus, the threat of fire, floods, and riots imposes property risks on a firm.
7. *Personnel risks* are risks that result from employees’ actions. Examples include the risks associated with employee fraud or embezzlement, or suits based on charges of age or sex discrimination.
8. *Environmental risks* include risks associated with polluting the environment. Public awareness in recent years, coupled with the huge costs of environmental cleanup, has increased the importance of this risk.
9. *Liability risks* are associated with product, service, or employee actions. Examples include the very large judgments assessed against asbestos manufacturers and some health care providers as well as costs incurred as a result of improper actions of employees, such as driving corporate vehicles in a reckless manner.
10. *Insurable risks* are risks that can be covered by insurance. In general, property, personnel, environmental, and liability risks can be transferred to insurance companies. Note, though, that the *ability* to insure a risk does not necessarily mean that the risk *should* be insured. Indeed, a major function of risk management involves evaluating all alternatives for managing a particular risk, including self-insurance, and then choosing the optimal alternative.

Note that the risk classifications we used are somewhat arbitrary, and different classifications are commonly used in different industries. However, the list does give an idea of the wide variety of risks to which a firm can be exposed.

An Approach to Risk Management

Firms often use the following process for managing risks.

1. *Identify the risks faced by the firm.* Here the risk manager identifies the potential risks faced by his or her firm. (See the box entitled “Microsoft’s Goal: Manage Every Risk!”)
2. *Measure the potential effect of each risk.* Some risks are so small as to be immaterial, whereas others have the potential for dooming the company. It is useful to segregate risks by potential effect and then to focus on the most serious threats.
3. *Decide how each relevant risk should be handled.* In most situations, risk exposure can be reduced through one of the following techniques:
 - a. *Transfer the risk to an insurance company.* Often, it is advantageous to insure against, hence transfer, a risk. However, insurability does not necessarily mean that a risk should be covered by insurance. In many instances, it might be better for the company to *self-insure*, which means bearing the risk directly rather than paying another party to bear it.
 - b. *Transfer the function that produces the risk to a third party.* For example, suppose a furniture manufacturer is concerned about potential liabilities arising from its ownership of a fleet of trucks used to transfer products from its manufacturing plant to various points across the country. One way to eliminate this risk would be to contract with a trucking company to do the shipping, thus passing the risks to a third party.
 - c. *Purchase derivative contracts to reduce risk.* As we indicated earlier, firms use derivatives to hedge risks. Commodity derivatives can be used to reduce input risks. For example, a cereal company may use corn or wheat futures to hedge against increases in grain prices. Similarly, financial derivatives can be used to reduce risks that arise from changes in interest rates and exchange rates.
 - d. *Reduce the probability of occurrence of an adverse event.* The expected loss arising from any risk is a function of both the probability of occurrence and the dollar loss if the adverse event occurs. In some instances, it is possible to reduce the probability that an adverse event will occur. For example, the probability that a fire will occur can be reduced by instituting a fire-prevention program, by replacing old electrical wiring, and by using fire-resistant materials in areas with the greatest fire potential.
 - e. *Reduce the magnitude of the loss associated with an adverse event.* Continuing with the fire risk example, the dollar cost associated with a fire can be reduced by such actions as installing sprinkler systems, designing facilities with self-contained fire zones, and locating facilities close to a fire station.
 - f. *Totally avoid the activity that gives rise to the risk.* For example, a company might discontinue a product or service line because the risks outweigh the rewards, as with the decision by Dow-Corning to discontinue its manufacture of silicon breast implants.

Note that risk management decisions, like all corporate decisions, should be based on a cost/benefit analysis for each feasible alternative. For example, suppose it would cost \$50,000 per year to conduct a comprehensive fire safety training program for all personnel in a high-risk plant. Presumably, this program would reduce the expected value of future fire losses. An alternative to the training program would be to place \$50,000 annually in a reserve fund set aside to cover future fire losses. Both alternatives involve expected cash flows, and from an economic standpoint the choice should be made on the basis of the lowest present value of future costs. Thus, the same financial management techniques

Microsoft's Goal: Manage Every Risk!

Twenty years ago, risk management meant buying insurance against fire, theft, and liability losses. Today, though, due to globalization, volatile markets, and a host of lawyers looking for someone to sue, a multitude of risks can adversely affect companies. Microsoft addressed these risks by creating a virtual consulting practice, called Microsoft Risk Co., to help manage the risks faced by its sales, operations, and product groups.

In an article in *CFO*, Scott Lange, who was head of Microsoft Risk at the time the article appeared, identified these 12 major sources of risk:

1. *Business partners* (interdependency, confidentiality, cultural conflict, contractual risks).
2. *Competition* (market share, price wars, industrial espionage, antitrust allegations, etc.).
3. *Customers* (product liability, credit risk, poor market timing, inadequate customer support).
4. *Distribution systems* (transportation, service availability, cost, dependence on distributors).
5. *Financial* (foreign exchange, portfolio, cash, interest rate, stock market).
6. *Operations* (facilities, contractual risks, natural hazards, internal processes and control).
7. *People* (employees, independent contractors, training, staffing inadequacy).
8. *Political* (civil unrest, war, terrorism, enforcement of intellectual property rights, change in leadership, revised economic policies).
9. *Regulatory and legislative* (antitrust, export licensing, jurisdiction, reporting and compliance, environmental).
10. *Reputations* (corporate image, brands, reputations of key employees).
11. *Strategic* (mergers and acquisitions, joint ventures and alliances, resource allocation and planning, organizational agility).
12. *Technological* (complexity, obsolescence, workforce skill-sets).

According to Lange, it is important to resist the idea that risk should be categorized by how the insurance industry views it. Insurance coverage lines are a tiny subset of the risks a modern enterprise faces in the pursuit of its business objectives. He also defined the role of finance in risk management: The role of finance is to put on paper all the risks that can be identified and to try to quantify them. When possible, use a number—one number, perhaps, or a probability distribution. For example, what is the probability of losing \$1 million on a product, or \$10 million? At Microsoft, the finance department works with the product groups to determine the exposure. "We try to use common sense," Lange says.

In many ways risk management mirrors the quality movement of the 1980s and 1990s. The goal of the quality movement was to take the responsibility for quality out of a separate Quality Control Department and to make all managers and employees responsible for quality. Lange had a similar goal for Microsoft—to have risk management permeate the thinking of all Microsoft managers and employees.

Source: Edward Teach, "Microsoft's Universe of Risk," *CFO*, March 1997, pp. 69–72.

applied to other corporate decisions can also be applied to risk management decisions. Note, though, that if a fire occurs and a life is lost, the trade-off between fire prevention and expected losses may not sit well with a jury. The same thing holds true for product liability, as Ford, GM, and others have learned.



Define the following terms:

- (1) Pure risks.
- (2) Speculative risks.
- (3) Demand risks.
- (4) Input risks.
- (5) Financial risks.
- (6) Property risks.

- (7) Personnel risks.
- (8) Environmental risks.
- (9) Liability risks.
- (10) Insurable risks.
- (11) Self-insurance.

Should a firm insure itself against all of the insurable risks it faces? Explain.

18.9 USING DERIVATIVES TO REDUCE RISKS

Firms are subject to numerous risks related to interest rate, stock price, and exchange rate fluctuations in the financial markets. For an investor, one of the most obvious ways to reduce financial risks is to hold a broadly diversified portfolio of stocks and debt securities, including international securities and debt of varying maturities. However, derivatives can also be used to reduce the risks associated with financial and commodity markets.¹³

Security Price Exposure

Firms are obviously exposed to losses due to changes in security prices when securities are held in investment portfolios, and they are also exposed during times when securities are being issued. In addition, firms are exposed to risk if they use floating-rate debt to finance an investment that produces a fixed income stream. Risks such as these can often be mitigated by using derivatives. As we discussed earlier, derivatives are securities whose values stem, or are derived, from the values of other assets. Thus, options and futures contracts are derivatives because their values depend on the prices of some underlying assets. Now we will explore further the use of two types of derivatives, futures and swaps, to help manage certain types of risk.

Futures

Futures are used for both speculation and hedging. **Speculation** involves betting on future price movements, and futures are used because of the leverage inherent in the contract. **Hedging**, on the other hand, is done by a firm or individual to protect against a price change that would otherwise negatively affect profits. For example, rising interest rates and commodity (raw material) prices can hurt profits, as can adverse currency fluctuations. If two parties have mirror-image risks, then they can enter into a transaction that eliminates, as opposed to transfers, risks. This is a “natural hedge.” Of course, one party to a futures contract could be a speculator, the other a hedger. Thus, to the extent that speculators broaden the market and make hedging possible, they help decrease risk to those who seek to avoid it.

There are two basic types of hedges: (1) **long hedges**, in which futures contracts are *bought* in anticipation of (or to guard against) price increases, and (2) **short hedges**, where a firm or individual *sells* futures contracts to guard against price declines. Recall that rising interest rates lower bond prices and thus

Speculation

With futures, it involves betting on future price movements.

Hedging

Using transactions to lower risk.

Long Hedges

Futures contracts are bought in anticipation of (or to guard against) price increases.

Short Hedges

Futures contracts are sold to guard against price declines.

¹³ In Chapter 19, we discuss both the risks involved with holding foreign currencies and procedures for reducing such risks.

decrease the value of bond futures contracts. Therefore, if a firm or individual needs to guard against an *increase* in interest rates, a futures contract that makes money if rates rise should be used. That means selling, or going short, on a futures contract. To illustrate, assume that in August Carson Foods is considering a plan to issue \$10,000,000 of 15-year bonds in December to finance a capital expenditure program. The interest rate would be 7 percent if the bonds were issued today, and at that rate the project would have a positive NPV. However, interest rates may rise over the next four months, and when the issue is actually sold, the interest rate might be substantially above 7 percent, which would make the project a bad investment. Carson can protect itself against a rise in rates by hedging in the futures market.

In this situation, Carson would be hurt by an increase in interest rates, so it would use a short hedge. It would choose a futures contract on that security most similar to the one it plans to issue, long-term bonds. In this case, Carson would probably hedge with Treasury bond futures. Since it plans to issue \$10,000,000 of bonds, it would sell $\$10,000,000/\$100,000 = 100$ Treasury bond contracts for delivery in December. Carson would have to put up $100(\$1,553) = \$155,300$ in margin money and also pay brokerage commissions. For illustrative purposes we use the numbers in Table 18-3. We can see from Table 18-3 that each December contract has a value of 116 plus $\frac{5}{32}$ percent, so the total value of the 100 contracts is $1.1615625(\$100,000)(100) = \$11,615,625$. Now suppose renewed fears of inflation push the interest rate on Carson's debt up by 100 basis points, to 8 percent, over the next four months. If Carson issued 7 percent coupon bonds, they would bring only \$913.54 per bond, because investors now require an 8 percent return. Thus, Carson would lose \$86.46 per bond times 10,000 bonds, or \$864,602, as a result of delaying the financing. However, the increase in interest rates would also bring about a change in the value of Carson's short position in the futures market. Interest rates have increased, so the value of the futures contract would fall, and if the interest rate on the futures contract also increased by the same full percentage point, from 4.5 to 5.5 percent, the contract value would fall to \$10,506,233. Carson would then close its position in the futures market by repurchasing for \$10,506,233 the contracts which it earlier sold short for \$11,615,625, giving it a profit of \$1,109,392, less commissions.

Thus, Carson would, if we ignore commissions and the opportunity cost of the margin money, offset the loss on the bond issue. In fact, in our example Carson more than offsets the loss, pocketing an additional \$244,790. Of course, if interest rates had fallen, Carson would have lost on its futures position, but this loss would have been offset by the fact that Carson could now sell its bonds with a lower coupon.

If futures contracts existed on Carson's own debt, and interest rates moved identically in the spot and futures markets, then the firm could construct a **perfect hedge**, in which gains on the futures contract would exactly offset losses on the bonds. In reality, it is virtually impossible to construct perfect hedges, because in most cases the underlying asset is not identical to the futures asset, and even when they are, prices (and interest rates) may not move exactly together in the spot and futures markets.

Note too that if Carson had been planning an equity offering, and if its stock tended to move fairly closely with one of the stock indexes, the company could have hedged against falling stock prices by selling short the index future. Even better, if options on Carson's stock were traded in the option market, then it could use options rather than futures to hedge against falling stock prices.

The futures and options markets permit flexibility in the timing of financial transactions, because the firm can be protected, at least partially, against changes that occur between the time a decision is reached and the time when

Perfect Hedge

Occurs when the gain or loss on the hedged transaction exactly offsets the loss or gain on the unhedged position.

the transaction will be completed. However, this protection has a cost—the firm must pay commissions. Whether or not the protection is worth the cost is a matter of judgment. The decision to hedge also depends on management's risk aversion as well as the company's strength and ability to assume the risk in question. In theory, the reduction in risk resulting from a hedge transaction should have a value exactly equal to the cost of the hedge. Thus, a firm should be indifferent to hedging. However, many firms believe that hedging is worthwhile. Trammell Crow, a large Texas real estate developer, has used T-bill futures to lock in interest costs on floating-rate construction loans, while Dart & Kraft has used eurodollar futures to protect its marketable securities portfolio. Merrill Lynch, Salomon Smith Barney, and the other investment banking houses hedge in the futures and options markets to protect themselves when they are engaged in major underwritings.

Swaps

A *swap* is another method for reducing financial risks. As we noted earlier, a swap is an exchange.¹⁴ In finance, it is an exchange of cash payment obligations, in which each party to the swap prefers the payment type or pattern of the other party. In other words, swaps occur because the counterparties prefer the terms of the other's debt contract, and the swap enables each party to obtain a preferred payment obligation. Generally, one party has a fixed-rate obligation and the other a floating-rate obligation, or one has an obligation denominated in one currency and the other in another currency.

Major changes have occurred over time in the swaps market. First, standardized contracts have been developed for the most common types of swaps, and this has had two effects: (1) Standardized contracts lower the time and effort involved in arranging swaps, and thus lower transactions costs. (2) The development of standardized contracts has led to a secondary market for swaps, which has increased the liquidity and efficiency of the swaps market. A number of international banks now make markets in swaps and offer quotes on several standard types. Also, as noted above, the banks now take counterparty positions in swaps, so it is not necessary to find another firm with mirror-image needs before a swap transaction can be completed. The bank would generally find a final counterparty for the swap at a later date, so its positioning helps make the swap market more operationally efficient.

To further illustrate a swap transaction, consider the following situation. An electric utility currently has outstanding a five-year floating-rate note tied to the prime rate. The prime rate could rise significantly over the period, so the note carries a high degree of interest rate risk. The utility could, however, enter into a swap with a counterparty, say, Citibank, wherein the utility would pay Citibank a fixed series of interest payments over the five-year period and Citibank would make the company's required floating-rate payments. As a result, the utility would have converted a floating-rate loan to a fixed-rate loan, and the risk of rising interest rates would have been passed from the utility to Citibank. Such a transaction can lower both parties' risks—because banks' revenues rise as interest rates rise, Citibank's risk would actually be lower if it had floating-rate obligations.

Longer-term swaps can also be made. Recently, Citibank entered into a 17-year swap in an electricity cogeneration project financing deal. The project's sponsors were unable to obtain fixed-rate financing on reasonable terms, and

¹⁴ For more information on swaps, see Clifford W. Smith, Jr., Charles W. Smithson, and Lee Macdonald Wakeman, "The Evolving Market for Swaps," *Midland Corporate Finance Journal*, Winter 1986, pp. 20–32; and Mary E. Ruth and Steve R. Vinson, "Managing Interest Rate Uncertainty Amidst Change," *Public Utilities Fortnightly*, December 22, 1988, pp. 28–31.

they were afraid that interest rates would increase and make the project unprofitable. The project's sponsors were, however, able to borrow from local banks on a floating-rate basis and then arrange a simultaneous swap with Citibank for a fixed-rate obligation.

Commodity Price Exposure



An excellent source to find information on physical commodities is from the New York Mercantile Exchange's Web site, <http://www.nymex.com/index.aspx>. NYMEX is the world's largest physical commodity futures exchange.

As we noted earlier, futures markets were established for many commodities long before they began to be used for financial instruments. We can use Porter Electronics, which uses large quantities of copper as well as several precious metals, to illustrate inventory hedging. Suppose that in August 2005, Porter foresaw a need for 100,000 pounds of copper in June 2006 for use in fulfilling a fixed-price contract to supply solar power cells to the U.S. government. Porter's managers are concerned that a strike by Chilean copper miners will occur, which could raise the price of copper in world markets and possibly turn the expected profit on the solar cells into a loss.

Porter could, of course, go ahead and buy the copper that it will need to fulfill the contract, but if it does it will incur substantial carrying costs. As an alternative, the company could hedge against increasing copper prices in the futures market. The New York Commodity Exchange trades standard copper futures contracts of 25,000 pounds each. Thus, Porter could buy four contracts (go long) for delivery in June 2006. Assume that these contracts were trading in August for about \$1.47 per pound, and that the spot price at that date was about \$1.74 per pound. If copper prices continue to rise appreciably over the next 10 months, the value of Porter's long position in copper futures would increase, thus offsetting some of the price increase in the commodity itself. Of course, if copper prices fall, Porter would lose money on its futures contract, but the company would be buying the copper on the spot market at a cheaper price, so it would make a higher-than-anticipated profit on its sale of solar cells. Thus, hedging in the copper futures market locks in the cost of raw materials and removes some risk to which the firm would otherwise be exposed.

Eastman Kodak uses silver futures to hedge against short-term increases in the price of silver, which is the primary ingredient in black-and-white film. Many other manufacturers, such as Alcoa with aluminum and Archer Daniels Midland with grains, routinely use the futures markets to reduce the risks associated with input price volatility.

The Use and Misuse of Derivatives

Most of the news stories about derivatives are related to financial disasters. Much less is heard about the benefits of derivatives. However, because of these benefits, more than 90 percent of large U.S. companies use derivatives on a regular basis. In today's market, sophisticated investors and analysts are demanding that firms use derivatives to hedge certain risks. For example, Compaq Computer was sued by a shareholder group for failing to properly hedge its foreign exchange exposure. The shareholders lost the suit, but Compaq got the message and now uses currency futures to hedge its international operations. In another example, Prudential Securities reduced its earnings estimate for Cone Mills, a North Carolina textile company, because Cone did not sufficiently hedge its exposure to changing cotton prices. These examples lead to one conclusion: If a company can safely and inexpensively hedge its risks, it should do so.

There can, however, be a downside to the use of derivatives. Hedging is invariably cited by authorities as a "good" use of derivatives, whereas speculating with derivatives is often cited as a "bad" use. Some people and organizations can afford to bear the risks involved in speculating with derivatives, but

others are either not sufficiently knowledgeable about the risks they are taking or else should not be taking those risks in the first place. Most would agree that the typical corporation should use derivatives only to hedge risks, not to speculate in an effort to increase profits. Hedging allows managers to concentrate on running their core businesses without having to worry about interest rate, currency, and commodity price variability. However, problems can arise quickly when hedges are improperly constructed or when a corporate treasurer, eager to report relatively high returns, uses derivatives for speculative purposes.



Explain how a company can use the futures market to hedge against rising interest rates.

What is a swap? Describe the mechanics of a fixed-rate to floating-rate swap.

Explain how a company can use the futures market to hedge against rising raw materials prices.

How should derivatives be used in risk management? What problems can occur?

Tying It All Together

Companies face a variety of risks every day, for it is hard to succeed without taking some chances. Back in Chapter 8, we discussed the trade-off between risk and return. If some action can lower risk without lowering returns too much, then the action can enhance value. With this in mind, in this chapter we described the various types of risks that companies face and the basic principles of corporate risk management. One important tool for managing risk is the derivatives market, and this chapter provided an introduction to derivative securities.

SELF-TEST QUESTIONS AND PROBLEMS (Solutions Appear in Appendix A)

ST-1 **Key terms** Define each of the following terms:

- a. Derivative
- b. Option; call option; put option
- c. Exercise value; strike price
- d. Black-Scholes Option Pricing Model; riskless hedge
- e. Risk management
- f. Futures contract; forward contract
- g. Hedging; natural hedge; long hedges; short hedges; perfect hedge
- h. Swap; structured note
- i. Commodity futures; financial futures
- j. Long-term Equity Anticipation Security (LEAPS)
- k. Inverse floater
- l. Speculation

ST-2 Black-Scholes model An analyst is interested in using the Black-Scholes model to value call options on the stock of Ledbetter Inc. The analyst has accumulated the following information:

- The price of the stock is \$33.
- The strike price is \$33.
- The option matures in 6 months ($t = 0.50$).
- The standard deviation of the stock's returns is 0.30 and the variance is 0.09.
- The risk-free rate is 10 percent.

Given this information, the analyst is then able to calculate some other necessary components of the Black-Scholes model:

- $d_1 = 0.34177$.
- $d_2 = 0.12964$.
- $N(d_1) = 0.63369$.
- $N(d_2) = 0.55155$.

$N(d_1)$ and $N(d_2)$ represent areas under a standard normal distribution function. Using the Black-Scholes model, what is the value of the call option?

QUESTIONS

- 18-1** List seven reasons risk management might increase the value of a firm.
- 18-2** Why do options typically sell at prices higher than their exercise values?
- 18-3** Discuss some of the techniques available to reduce risk exposure.
- 18-4** Explain how the futures markets can be used to reduce interest rate and input price risk.
- 18-5** How can swaps be used to reduce the risks associated with debt contracts?
- 18-6** Give two reasons stockholders might be indifferent between owning the stock of a firm with volatile cash flows and that of a firm with stable cash flows.

PROBLEMS

Easy
Problems 1–3

- 18-1 Options** A call option on Bedrock Boulders stock has a market price of \$7. The stock sells for \$30 a share, and the option has an exercise price of \$25 a share.
- What is the exercise value of the call option?
 - What is the premium on the option?
- 18-2 Options** The exercise price on one of Flanagan Company's options is \$15, its exercise value is \$22, and its premium is \$5. What are the option's market value and the price of the stock?
- 18-3 Options** Which of the following events are likely to increase the market value of a call option on a common stock? Explain.
- An increase in the stock's price.
 - An increase in the volatility of the stock price.
 - An increase in the risk-free rate.
 - A decrease in the time until the option expires.

Intermediate
Problems 4–5

- 18-4 Black-Scholes model** Assume you have been given the following information on Purcell Industries:

Current stock price = \$15

Time to maturity of option = 6 months

Variance of stock price = 0.12

$d_2 = 0.08165$

$N(d_2) = 0.53252$

Exercise price of option = \$15

Risk-free rate = 10%

$d_1 = 0.32660$

$N(d_1) = 0.62795$

Using the Black-Scholes Option Pricing Model, what would be the value of the option?

Challenging
Problems 6–7

- 18-5 Futures** What is the implied interest rate on a Treasury bond (\$100,000) futures contract that settled at 100-16? If interest rates increased by 1 percent, what would be the contract's new value?
- 18-6 Hedging** The Zinn Company plans to issue \$20,000,000 of 10-year bonds in December to help finance a new research and development laboratory. It is now August, and the current cost of debt to the high-risk biotech company is 11 percent. However, the firm's financial manager is concerned that interest rates will climb even higher in coming months.
- Use data in Table 18-3 to create a hedge against rising interest rates.
 - Assume that interest rates in general increase by 200 basis points. How well did your hedge perform?
 - What is a perfect hedge? Are most real-world hedges perfect? Explain.
- 18-7 Options** Audrey is considering an investment in Morgan Communications, whose stock currently sells for \$60. A put option on Morgan's stock, with an exercise price of \$55, has a market value of \$3.06. Meanwhile, a call option on the stock with the same exercise price and time to maturity has a market value of \$9.29. The market believes that at the expiration of the options the stock price will be either \$70 or \$50, with equal probability.
- What is the premium associated with the put option? The call option?
 - If Morgan's stock price increases to \$70, what would be the return to an investor who bought a share of the stock? If the investor bought a call option on the stock? If the investor bought a put option on the stock?
 - If Morgan's stock price decreases to \$50, what would be the return to an investor who bought a share of the stock? If the investor bought a call option on the stock? If the investor bought a put option on the stock?
 - If Audrey buys 0.6 share of Morgan Communications and sells one call option on the stock, has she created a riskless hedged investment? What is the total value of her portfolio under each scenario?
 - If Audrey buys 0.75 share of Morgan Communications and sells one call option on the stock, has she created a riskless hedged investment? What is the total value of her portfolio under each scenario?

COMPREHENSIVE/SPREADSHEET PROBLEM

- 18-8 Black-Scholes model** Rework Problem 18-4 using the spreadsheet model. Then work the next two parts of this problem given below.
- Construct data tables for the intrinsic value and Black-Scholes exercise value for this option, and graph this relationship. Include possible stock price values ranging up to \$30.00.
 - Suppose this call option is purchased today. Draw the profit diagram of this option position at expiration.

Integrated Case**Tropical Sweets Inc.**

- 18-9 Derivatives and corporate risk management** Assume that you have just been hired as a financial analyst by Tropical Sweets Inc., a mid-sized California company that specializes in creating exotic candies from tropical fruits such as mangoes, papayas, and dates. The firm's CEO, George Yamaguchi, recently returned from an industry corporate executive conference in San Francisco, and one of the sessions he attended was on the pressing need for smaller companies to institute corporate risk management programs. As no one at Tropical Sweets is familiar with the basics of derivatives and corporate risk management, Yamaguchi has asked you to prepare a brief report that the firm's executives could use to gain at least a cursory understanding of the topics.

To begin, you gathered some outside materials on derivatives and corporate risk management and used these materials to draft a list of pertinent questions that need to be answered. In fact, one possible approach to the paper is to use a question-and-answer format. Now that the questions have been drafted, you have to develop the answers.

- a. Why might stockholders be indifferent to whether or not a firm reduces the volatility of its cash flows?
- b. What are seven reasons risk management might increase the value of a corporation?
- c. What is an option? What is the single most important characteristic of an option?
- d. Options have a unique set of terminology. Define the following terms:
 - (1) Call option.
 - (2) Put option.
 - (3) Exercise price.
 - (4) Striking, or strike, price.
 - (5) Option price.
 - (6) Expiration date.
 - (7) Exercise value.
 - (8) Covered option.
 - (9) Naked option.
 - (10) In-the-money call.
 - (11) Out-of-the-money call.
 - (12) LEAPS.
- e. Consider Tropical Sweets' call option with a \$25 strike price. The following table contains historical values for this option at different stock prices:

Stock Price	Call Option Price
\$25	\$ 3.00
30	7.50
35	12.00
40	16.50
45	21.00
50	25.50

- (1) Create a table that shows (a) stock price, (b) strike price, (c) exercise value, (d) option price, and (e) the premium of option price over exercise value.
 - (2) What happens to the premium of option price over exercise value as the stock price rises? Why?
- f. In 1973, Fischer Black and Myron Scholes developed the Black-Scholes Option Pricing Model (OPM).
 - (1) What assumptions underlie the OPM?
 - (2) Write out the three equations that constitute the model.
 - (3) What is the value of the following call option according to the OPM?

Stock price = \$27.00
 Exercise price = \$25.00
 Time to expiration = 6 months
 Risk-free rate = 6.0%
 Stock return variance = 0.11
 - g. What effect does each of the following call option parameters have on the value of a call option?
 - (1) Current stock price.
 - (2) Exercise price.
 - (3) Option's term to maturity.
 - (4) Risk-free rate.
 - (5) Variability of the stock price.
 - h. What are the differences between forward and futures contracts?
 - i. Explain briefly how swaps work.
 - j. Explain briefly how a firm can use futures and swaps to hedge risk.
 - k. What is corporate risk management? Why is it important to all firms?



Please go to the ThomsonNOW Web site to access the Cyberproblems.