Chapter 27

Risk Management and Financial Engineering

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Southwest Airlines Profits by Hedging Fuel Costs

For the U.S. airline industry as a whole, 2005 was but the latest in a series of financially disastrous years. Significant gains in passenger traffic were more than offset by surging jet fuel prices, which are the second largest operating cost for airlines, after labor. Jet fuel (kerosene) prices hit a record of $2.30 per gallon in September, after Hurricane Katrina shut down over 13 percent of U.S. petroleum refining capacity and crude oil prices rose over $70 per barrel. This was the final straw for Delta Airlines and Northwest Airlines, both of which filed for Chapter 11 bankruptcy protection on the same day, joining United Airlines and US Air.

In contrast to the rest of the industry, however, Southwest Airlines not only survived 2005 but was able to record increased profits. This was largely due to the fact that Southwest had hedged fully 85 percent of its 2005 jet fuel needs, at an average cost of $26 per barrel ($0.61 per gallon). Southwest had been routinely hedging its fuel needs for several years, which reduced its 2004 fuel costs by $455 million. None of the other major U.S. carriers were able to engage in significant hedging programs, largely because their weak financial positions made them risky—thus expensive—counterparties. Since fuel costs account for 22–25 percent of U.S. airline operating costs, Southwest's competitive position was enhanced immensely during 2005.

Unfortunately for its competitors, Southwest's competitive advantage seems certain to grow during the next few years, as the company has already hedged 65 percent of its 2006 jet fuel costs (at $32 per barrel), over 45 percent of its 2007 needs (at $31 per barrel), and over 25 percent of its 2008 and 2009 needs at $33 and $35 per barrel, respectively. Additionally, the company's financial strength allowed it to retrofit its entire fleet of Boeing 737s (the only airplane it operates) with blended winglets by March 2005, which reduce annual fuel costs by 3 percent. Southwest shows just how valuable a well-conceived risk-management program can be.

Sources: Southwest Airlines 2004 Annual Report, plus multiple Financial Times *articles (downloaded from www.ft.com).*

Trading in virtually all types of financial instruments has increased since the mid-1990s, but no markets have experienced growth rates as explosive as those for the financial instruments used for hedging and risk management. Since the collapse of the Bretton Woods fixed exchange rate regime in 1973, corporations have been exposed to extreme fluctuations in interest rates, in exchange rates, and in the prices of virtually all important raw materials.[1] This increased risk has led to a mushrooming demand for financial instruments and strategies that corporations can use to hedge, or offset, their underlying operating and financial exposures.

This chapter discusses *risk management* and *financial engineering* in the modern corporation. Traditionally, **risk management** has meant the process of identifying firm-specific risk exposures and managing those risk exposures using insurance products. In recent years, however, the risk-management function has expanded to include identifying, measuring, and managing all types of risk exposures, including interest rate, commodity, and currency risk exposures. There are three ways to minimize a firm's risk exposures—diversifying, insuring, and hedging; this chapter focuses on hedging. Derivative securities, including currency contracts such as forwards, futures, options, and swaps, are the financial instruments commonly used for hedging and risk management. Figure 27.1 illustrates the growth in the market for these types of products. Currency and interest rate swaps have experienced especially rapid growth.

Though the financial press often portrays derivatives in a negative light, these securities can be an effective means of hedging risk exposures. We will discuss each of these instruments, but we begin with an overview of risk management. Next, we describe each of the major types of derivative securities and discuss how each can be used to manage a firm's risk exposures. Finally, we discuss financial engineering, which is the application of finance principles to the design of securities and strategies that help firms manage their risk exposures.

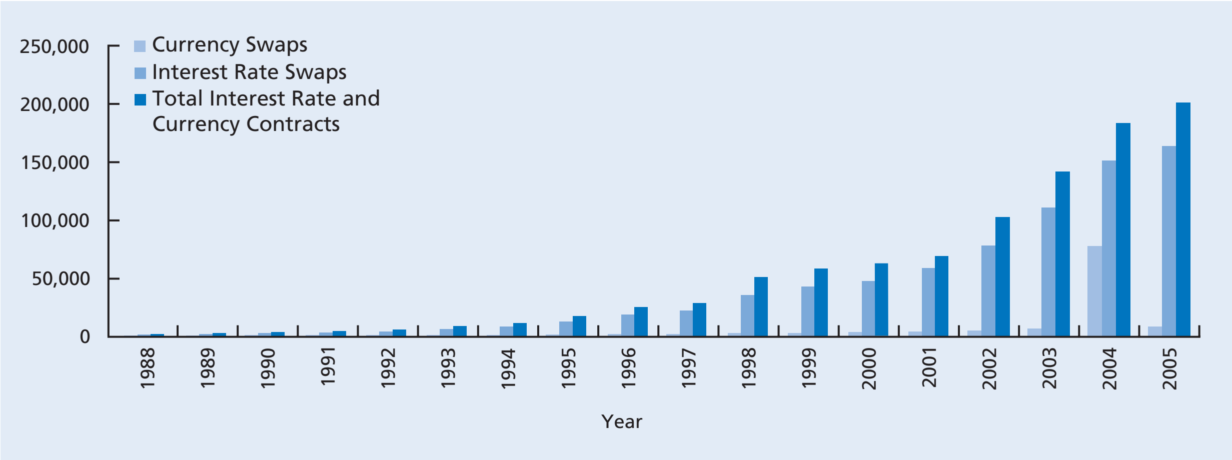


Figure 27.1
Selected Over-the-Counter Derivatives Contracts Outstanding, Year-End Notional Amounts (US$ billions)
Source: International Swaps and Derivatives Association Market Survey and the Bank for International Settlements (www.bis.org).

[1] The dramatic increase in the volatility of financial assets (including currencies) and the development of markets for risk-management instruments is described in detail in Rawls and Smithson (1989), while Muelbroek (2002) describes how practicing managers can use risk-management techniques in the normal course of business.

27.1 OVERVIEW OF RISK MANAGEMENT

As noted, risk management involves identifying potential events that represent a threat to a firm's cash flows and either minimizing the likelihood of those events or minimizing their impact on the firm's cash flows. Although in the past this process has focused on firm-specific events such as workers' compensation claims, product recalls, product liability claims, and loss from fire or flood, in recent years risk management has come to include the process of identifying, measuring, and managing these marketwide sources of exposure. In this section, we provide an overview of this type of risk management.

Risk Factors

If a change in the level of interest rates will adversely affect the cash flows of a company (perhaps by raising its cost of borrowing), that firm is exposed to interest rate risk. This is the single most common concern among managers engaged in risk management. **Interest rate risk** is the risk of suffering losses as a result of unanticipated changes in market rates of interest. The most often-cited example of losses caused by interest rate risk is the experience of the savings and loan (S&L) industry in the early 1980s. S&Ls suffered from a mismatch in terms of the maturity of their assets and liabilities because they funded long-term assets (e.g., 30-year, fixed-rate mortgages) with short-term liabilities (e.g., passbook savings deposits and short-term certificates of deposit). When interest rates spiked in the late 1970s and early 1980s, firms in the industry suffered tremendous losses because they were paying high rates on their short-term deposits while continuing to earn low rates on the long-term mortgages in their portfolio.

As illustrated by the S&L industry, interest rate risk is of particular concern to financial firms. However, more and more nonfinancial firms are recognizing that they also are exposed to this type of risk. For example, a retailing firm that funds its seasonal buildup of inventories with floating-rate debt will face higher interest expenses if market rates of interest increase. This is an example of **transaction exposure,** the risk that a change in prices will negatively affect the value of a specific transaction or series of transactions.

Although most corporations focus on the possibility that changes in market rates of interest will increase interest expenses, changes in interest rates can also affect cash inflows. Some firms have revenue streams that are sensitive to changes in interest rates. For example, a building products manufacturer may experience lower demand when interest rates increase. This is an example of **economic exposure,** the risk that a change in prices will negatively impact the value of all cash flows of a firm. As we will see later in this chapter, there are several ways that corporations can minimize both their transaction and economic exposures to interest rate risk.[2]

At the same time that currency exchange rates were becoming more volatile, world economies were becoming more integrated. In recent years, currency exchange rates have remained volatile, and the pace of global integration has continued to accelerate. This has given rise to ever-increasing exposure to foreign exchange risk, as discussed previously and, in more depth, in Chapter 20.[3] Consider another example

SMART PRACTICES VIDEO

David Childress, Asset Liability Manager, Ford Motor Co.

"Interest rate risk really comes down to how assets and liabilities on the balance sheet reprice."

See the entire interview at SMARTFinance

2. For an intuitive discussion of managing interest rate risk and the building-blocks approach to financial risk management, see Smith, Smithson, and Wilford (1989).

3. For a discussion of foreign exchange risk, see Pringle (1991) and Pringle and Connolly (1993). Allayanis and Weston (2001) document that firms hedging foreign exchange exposures with derivatives are rewarded with a significantly higher market valuation than are similar unhedged firms.

of a transaction exposure. A U.S.-based company with manufacturing operations in Canada denominates the products it sells in international markets in the buyer's home currency. Suppose that it books a sale, denominated in euros, to a buyer in Germany, with delivery and payment to occur in three months. If the euro depreciates in value relative to the Canadian dollar (C$) over the next three months, this company will receive fewer C$ than expected when it converts the euros received in payment into C$ to cover its own production costs.

As another example of economic exposure, if this U.S. manufacturing firm faces stiff competition from a Japanese manufacturer and the value of the yen declines, the Japanese firm may be able to reduce the prices it charges in European markets, thereby hurting demand for the products manufactured by the U.S. firm. Again, most firms concentrate on minimizing transaction exposure, but economic exposures are usually much more important. Unfortunately, these exposures are also much harder to hedge or otherwise manage, because they are systemic.

Although most discussions of risk management focus on interest rate risk and foreign exchange risk, commodity price risk is also very important for many firms. Any firm that uses a commodity as a production input is potentially exposed to losses if the price of the commodity increases. Likewise, the commodity producers are also exposed to the risk that the price of the commodity could decline.[4]

APPLYING THE MODEL 27.1

Hershey Foods Corporation illustrates the importance of a successful risk-management strategy. Cocoa is an important input for Hershey. If the price of cocoa increases, Hershey may be able to pass the increase on to consumers in the form of higher prices for Kisses and other confections. However, an increase in the price of Kisses is bound to hurt the demand for them. Consider the consequences of not hedging this risk exposure, especially if competitors such as Nestle and Mars do hedge their exposure by locking in the price they pay for cocoa. Hershey could be faced with having to increase the price of its products in response to an increase in the price of cocoa while the price of Nestle and Mars products remains the same. Of course, if the price of cocoa declines, Hershey would benefit from the lower price, while Nestle and Mars are committed to paying a higher price.[5]

The Hedging Decision

Although it is clear that the corporate demand for hedging and risk-management products has grown dramatically in recent years, it is less clear why a public company would choose to hedge at all. Risk aversion can explain why individuals and private firms hedge, but this cannot explain why a company that is presumably being run in the interests of a large number of well-diversified shareholders would expend valuable resources to hedge. This section discusses the various potential motivations for hedging and possible hedging strategies.

4. See Haushalter (2000) for an analysis of hedging policies by oil and gas producers.

5. In its 2004 Annual Report, Hershey clearly states (page 24) that "the company utilizes certain derivative instruments, from time to time, including interest rate swaps, foreign currency forward exchange contracts and options, and commodities futures contracts, to manage interest rate, currency exchange rate, and commodity price risk exposures." The report goes on to state that the "company does not hold or issue derivative instruments for trading purposes and is not a party to any instruments with leverage or prepayment features." In other words, Hershey uses derivatives strictly for risk-management purposes, not for speculation.

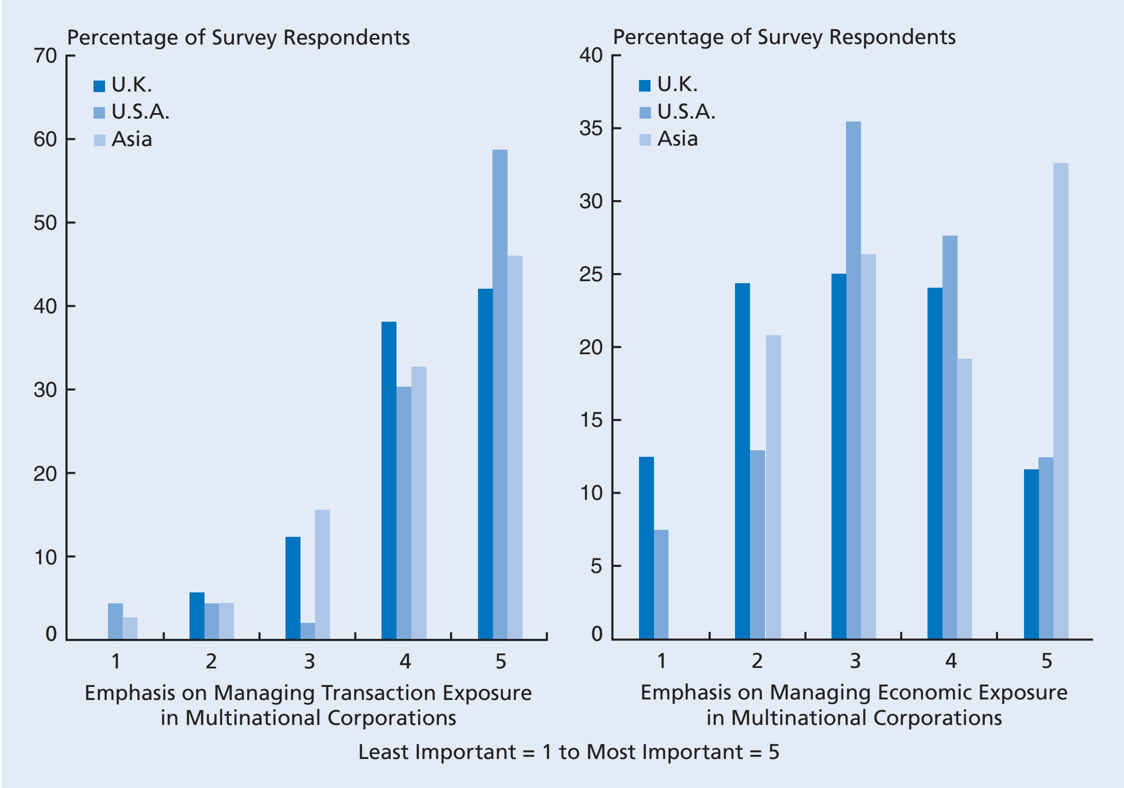
COMPARATIVE CORPORATE FINANCE

International Differences in Foreign Exchange Risk Management Emphasis

The two charts summarize the concerns of managers in multinational corporations in the United Kingdom, the United States, and Asia Pacific countries. Generally, U.S. companies seem to be more concerned with transaction exposures than companies in the U.K. or Asia. Asia Pacific companies, on the other hand, are more concerned about economic exposure than managers in the United States or the U.K.

The differences in emphasis can be attributed, in part, to differences in product markets and the location of production facilities. For example, U.S. multinationals often have product markets that are primarily domestic, while their production facilities are commonly in other countries. Consequently, U.S. multinationals tend to focus more on how changes in exchange rates affect their revenue stream. Asia Pacific multinationals, on the other hand, often have domestic production facilities and foreign product markets. Therefore, they tend to worry less about the impact of exchange rates on their revenue stream.

Source: Andrew P. Marshall, "Foreign Exchange Risk Management in UK, USA, and Asia Pacific Multinational Companies," *Journal of Multinational Financial Management* 10 (2000), pp. 185–211.



Motivations for Hedging. The motivations for buying insurance are similar to those for hedging. However, there are some crucial differences. According to Mayers and Smith (1982), by purchasing insurance, a corporation benefits from the insurance company's expertise in terms of its ability to evaluate and price certain types of risks. Therefore, insurance companies have a comparative advantage in bearing these sources of risk. Similarly, insurance companies have the ability to process claims more efficiently and effectively than other corporations. For example, insurance companies have expertise in negotiating, settling, and providing legal representation in liability suits.

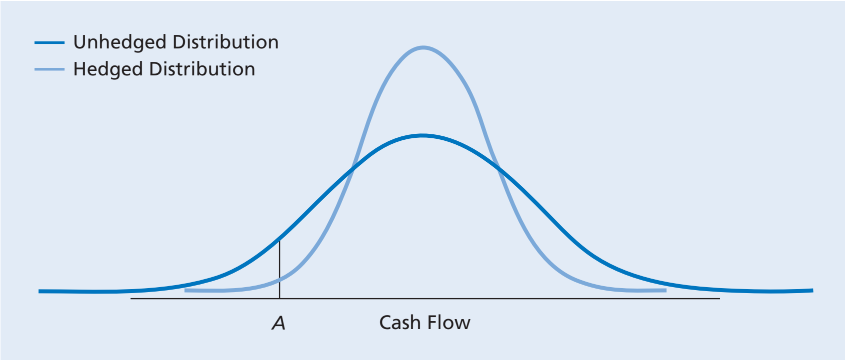
Hedging marketwide sources of risk, on the other hand, does not seem to provide any real service other than reduced volatility. In addition, this risk reduction is costly in terms of the resources required to implement an effective risk-management program. There are direct costs associated with hedging—transactions costs of buying and selling forwards, futures, options, and swaps—and indirect costs in the form of managers' time and expertise.

According to modern hedging theory, value-maximizing firms hedge because hedging can increase firm value in several ways. For most firms, however, the principal reason for hedging is to reduce the likelihood of financial distress. Figure 27.2 illustrates the impact of hedging on the likelihood of financial distress, showing the range of possible cash flows for the firm in a given period and the associated probability distribution. If the firm's cash flows are below point *A* on the *x*-axis, the firm experiences financial distress. By hedging, the firm is able to reduce the probability of the firm's cash flows being below point *A*.

Reducing the likelihood of financial distress benefits the firm by also reducing the likelihood it will experience the costs associated with this distress. Direct costs of distress include out-of-pocket cash expenses that must be paid to third parties (lawyers, auditors, consultants, court personnel, etc.) in the event of bankruptcy or severe financial distress. Many of the indirect costs are contracting costs involving relationships with creditors, suppliers, and employees. For example, a credible promise to hedge can sometimes entice creditors to lend the firm money on more favorable terms than they would be willing to lend to an unhedged borrower. Similarly, suppliers are more likely to extend trade credit when the likelihood of financial distress is low. In addition to potential cost savings, hedging may increase revenue for firms that sell products with warranties or service contracts. Warranties or service contracts are more likely to be honored, and customers will place a higher value on them, if the firm has a lower likelihood of financial distress. Similarly, if the products will require replacement parts or if there is the possibility of future upgrades, minimizing the likelihood of financial distress can promote sales.

Hedging can also reduce a firm's expected tax liability. If a firm's effective marginal tax rate increases as income increases, hedging can reduce the present value of expected tax liabilities. For example, suppose that a firm thinks its taxable earnings over the coming year will be one of three equally likely levels, depending on the ac-

Figure 27.2
Probability Distribution of Possible Cash Flows for a Corporation



tual realized price of a key input: \$0, \$10,000, and \$20,000. The company will pay \$0 taxes if the firm earns \$0 income, \$1,000 in taxes if the firm earns \$10,000, and \$3,000 if the firm earns \$20,000. Because the company assigns equal probability to each of the three possible outcomes, its expected earnings are \$10,000 ($0.333 \times \$0 + 0.333 \times \$10{,}000 + 0.333 \times \$20{,}000$), but the expected tax liability is \$1,333 ($0.333 \times \$0 + 0.333 \times \$1{,}000 + 0.333 \times \$3{,}000$). If the firm hedges by locking in a fixed price for the key input, such that it is assured of \$10,000 in earnings, the tax liability will be \$1,000. By hedging, the firm reduces its expected tax liability by \$333. In addition, hedging can reduce expected tax liabilities by smoothing the profit stream and reducing the likelihood that the firm will pay high taxes in one period while having to forgo (or delay) the benefits of tax shields in another period.[6] Current tax laws limit the extent to which corporations can use losses in one period to offset gains in another period. For this reason, it is in the interest of some corporations to hedge their risk exposures in an effort to avoid losing some of the tax benefits associated with the losses experienced in periods of poor performance.

Closely held firms are more likely to hedge risk exposures because owners of the firm have a greater proportion of their wealth invested in the firm. Because the owners of these firms are less diversified, they generally seek to minimize the risk exposures faced by the firm. Similarly, if the managers of the firm are risk averse, the firm is more likely to pursue strategies that minimize risk exposures. Empirical studies of the relation between ownership structure and hedging activities tend to confirm these expectations. The hedging activities of firms increase as share ownership by managers increases.[7]

Another benefit of hedging is that it makes it easier for the board of directors and outsiders to evaluate the performance of managers. Absent an effective risk-management program, it is difficult to disentangle firm performance due to the manager's performance from firm performance due to external factors. A manager can make his or her performance more observable by minimizing the firm's exposure to external risk factors. For this reason, superior managers may be more inclined to hedge, whereas inferior managers may prefer to disguise their performance behind the firm's unhedged performance.

Finally, even though shareholders can hedge the exposures they face as a result of owning shares in a risky firm, there are some circumstances under which it may be less costly for the firm to minimize risk than for the shareholders to hold a diversified portfolio. For some firms, however, the costs of hedging outweigh the benefits. There are substantial fixed costs associated with hedging, including the costs of acquiring the necessary expertise to implement a successful risk-management program, and small firms are therefore less likely to hedge than large firms.[8]

Hedging Strategies. In some circumstances, a firm may not hedge a risk exposure if it is confident that the risk factor will be changing in a positive direction or that it

6. Various tax credits and tax loss carryforwards are examples of some of the types of tax shields that may be forfeited in the event that a firm suffers losses. For a discussion of how these tax-preference items affect the incentive to hedge, see Nance, Smith, and Smithson (1993).

7. Tufano (1996) finds that hedging activities increase as managerial share ownership increases. However, hedging activities decrease as managers' option holdings increase. Both of these findings are consistent with the argument that managerial incentives affect firms' hedging decisions. In a later article, Tufano (1998) documents that the market values of gold-mining firms are, as expected, highly exposed to gold price changes and that firm exposures are significantly negatively related to the firm's hedging and diversification activities.

8. See Booth, Smith, and Stolz (1984), Dolde (1993), DeMarzo and Duffie (1995), and Nance, Smith, and Smithson (1993). However, improvements in information technology have made it possible for smaller companies to use sophisticated risk-management techniques (see Moore and Culver 2000).

has a comparative advantage in bearing the risk. For example, if a silver mining company is convinced that the price of silver will increase in the coming months, it may choose not to hedge its exposure to changes in the price of silver. When the price of silver increases, the mining company will benefit from the higher price it will receive for silver. In other circumstances, a firm may overhedge if it is certain that a risk factor will be changing in a negative direction. For example, if the mining company is convinced that the price of silver will decrease in the coming months, it may overhedge by taking a position in a derivative security that will more than offset the reduced price it receives for silver, thereby generating a profit on the price decrease. These examples illustrate that derivatives are an effective means for managers to take a position in a risk factor based on their expectations.[9] It is important to note that if a firm chooses *not* to hedge a risk exposure or chooses to overhedge, it is **speculating** on changes in the risk factor.

How a firm chooses to hedge a given risk exposure will depend on the costs of the alternative hedging strategies. The firm needs to consider transactions costs, the effectiveness and accuracy of alternative strategies in offsetting underlying risk exposures, and the liquidity and default risks associated with those strategies. Customized hedging strategies, especially those that are financially engineered, are effective and accurate but suffer from greater transactions costs and low liquidity. Off-the-shelf solutions, such as exchange-traded derivative securities, are attractive because of their low transaction costs, high liquidity, and low default risk but may not effectively and accurately offset the risk exposure.[10]

Derivative Securities

Derivatives are an integral part of a successful risk-management program because they offer an inexpensive means of changing a firm's risk profile. By taking a position in a derivative security that offsets the firm's risk profile, the firm can limit the extent to which firm value is affected by changes in the risk factor. Despite the growth in the markets for derivative securities, it is important to remember that it is not always in the best interests of a firm to hedge its risk exposures. If hedging will not increase firm value, the firm should not hedge.

Concept Review Questions

1. Recently, a U.S. senator described the markets for derivative securities as an electronic pyramid scheme. How do you respond?

2. What does it mean to say that by not hedging, a firm is speculating on changes in the risk factor?

3. Why do you think that derivative securities have acquired a questionable reputation?

4. Based on the discussion in this section, should an investment fund manager hedge? If not, why do you think so many of today's money managers choose to hedge?

[9] For a discussion of the role of selective hedging, see Stulz (1996) and Mello and Parsons (1999). Adam and Fernando (2006) show that gold mining firms often engage in this selective hedging, but that the returns to this strategy are at best modest.

[10] For an analysis of the choice of hedging instruments, see Geczy, Minton, and Schrand (1997).

27.2 FORWARD CONTRACTS

As discussed in Chapter 20, a forward contract involves two parties agreeing today on a price, called the **forward price,** at which the purchaser will buy a specified amount of an asset from the seller at a fixed date sometime in the future. This is in contrast to a cash market transaction, in which the buyer and seller conduct their transaction today at the **spot price.** The buyer of a forward contract has a **long position** and has an obligation to pay the forward price for the asset. The seller of a forward contract has a **short position** and has an obligation to sell the asset to the buyer in exchange for the forward price. The future date on which the buyer pays the seller (and the seller delivers the asset to the buyer) is referred to as the **settlement date.** It is important to note that, unlike options, which were discussed in Chapters 18 and 19, forward contracts are obligations, and failure to make or take delivery of the underlying asset represents default. In addition, no cash changes hands in a forward contract until the contract settlement date. For these two reasons, credit risk is a concern in forward contracts, and market participants enter into such contracts only with parties that they know and trust.

Most forward contracts are individually negotiated between corporations and financial intermediaries, but there are active markets for standard denomination and maturity forward contracts on several currencies and raw materials that institutions (including the bank market-makers themselves) can use to hedge their own exposures.

Forward Prices

The forward price is the price that makes the forward contract have zero net present value. The key to determining the fair forward price for a security is being able to form an alternative to the forward contract that has identical cash flows. For example, consider an asset that pays no income (e.g., a discount bond) and does not cost anything to store (e.g., financial assets). Rather than buy the asset six months forward, we could borrow the current price of the asset and buy it today. Six months from now, we would repay the loan plus interest. Whether we buy the asset six months forward or borrow and buy it today, we end up in the same position—owning the asset in six months. Because both strategies have identical cash flows in all circumstances, we can make the argument that the value of both strategies must be the same. This argument is based on **arbitrage,** which involves generating a riskless profit by simultaneously buying the strategy with the low value and selling the strategy with the high value. In a well-functioning market, these opportunities are quickly eliminated. Therefore, the forward price, F, for an asset that pays no income and does not cost anything to store should be the following:

$$F = S_0(1 + R_f)^n \quad \text{(Eq. 27.1)}$$

where S_0 = spot price of the asset at time 0,

R_f = risk-free rate of interest at time 0,

n = number of years until the settlement date of the contract.

If Equation 27.1 does not hold and F is greater than $S_0(1 - R_f)^n$, we can make a riskless profit by simultaneously borrowing an amount equal to S_0, using the borrowed funds to buy the asset, and selling the asset forward. On the settlement date, assuming we are able to borrow at the risk-free rate, we would sell the asset for F by delivering on the forward contract and pay our debt (including interest) of $S_0(1 + R_f)^n$. This arbitrage strategy would generate $F - S_0(1 + R_f)^n > 0$ in riskless profits on the settlement date without requiring any up-front investment.

Alternatively, if F is less than $S_0(1 + R_f)^n$, we would simultaneously short-sell the asset for S_0, lend the proceeds from the short sale at the risk-free rate, and buy the asset forward. On the settlement date, we would collect $S_0(1 + R_f)^n$ from the loan, pay F for the asset, and close out our short-sale position. This arbitrage strategy would generate $S_0(1 + R_f)^n - F > 0$ in riskless profits on the settlement date without requiring any up-front investment.

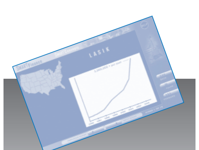
APPLYING THE MODEL 27.2

Helen Clemons is a portfolio manager who plans to buy 1-month Treasury bills in two months with a total face amount of $5 million. The current price for 3-month Treasury bills is $985,149 per $1 million face amount. The current effective annual risk-free rate over the two months is 6.17 percent. The fair forward price is calculated as follows:

$$F = \$985{,}149\ (1 + 0.0617)^{2/12} = \$995{,}029$$

Therefore, the total forward price Helen should pay is $4,975,145 ($995,029 × 5). If this is not the forward rate quoted to her, Helen or another arbitrageur has an opportunity to earn a riskless profit.

A similar approach can be used to determine the forward price for an asset that pays income (e.g., a coupon bond) or is costly to store (e.g., commodities). In this case, we must account for the receipt of income and/or the payment of storage cost before the contract matures. We determine the appropriate forward price for these assets as follows:



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$$F = (S_0 - I + W)(1 + R_f)^n \qquad \textbf{(Eq. 27.2)}$$

where I = present value of income to be paid by the asset during the life of the forward contract,

W = present value of the cost to store the asset for the life of the forward contract.

APPLYING THE MODEL 27.3

Consider a forward contract to purchase a 10-year bond in one year. Currently, an 11-year bond has a coupon rate of 8 percent and a price of $1,100; it will thus make two $40 coupon interest payments over the coming year. The current effective annual risk-free rate of interest over the next year is 5 percent. The fair forward price is calculated as follows:

$$F = \$1{,}074.01$$

Of course, we have made a number of assumptions to arrive at Equations 27.1 and 27.2. First, we have assumed that market participants have the ability to borrow and lend at the risk-free rate, but most individual and institutional investors are not able to do so. However, a sufficiently large number of institutional investors can borrow at or near the risk-free rate, such that Equations 27.1 and 27.2 should hold. Second, we have assumed that there are no transactions costs associated with establishing these positions, which will tend to widen the bounds on futures prices. Third, we have assumed that we can use the proceeds from short-selling and that short-selling does not involve any costs. In reality, only institutional investors can use all the proceeds from short-selling, and there are transactions costs associated with short-selling. These costs can be incorporated into the model by discounting the right-hand side of Equations 27.1 and 27.2.

Currency Forward Contracts[11]

Currency forward contracts, which involve exchanging one currency for another at a fixed date in the future, express the forward price as a **forward rate.** Table 27.1 presents selected exchange rates from the Tuesday, December 20, 2005, *Wall Street Journal* Currency Trading table. The data actually refer to the previous day's trading, Monday, December 19, 2005, as well as the trading day before, Friday, December 16, 2005, though we will use Monday's data throughout this discussion. **Spot rates,** which call for immediate delivery, align with the currency name. For example, the spot rate for British pounds (£) on December 19 is \$1.7626/£. The 1-month forward rate on the British pound is \$1.7622/£.

Figures 27.3 and 27.4 show payoff diagrams for the buyer and seller of a 1-month forward contract on the British pound, where the forward rate, which is agreed on at contract origination, is \$1.7622/£. The x-axis of these diagrams represents possible spot rates for the British pound on the settlement date. In this example, the settlement date is one month after the origination date, on January 19, 2005. The y-axis represents the profit or loss to the parties involved in the transaction. The profit for the buyer is the spot rate for the British pound on the settlement date minus the forward rate. The profit for the seller is the forward rate minus the spot rate on the settlement date. For example, if the spot rate is \$1.8100/£ in one month, the profit for the buyer is \$0.0478/£ (\$1.8100/£ − \$1.7622/£). The seller would have a loss of \$0.0478/£.[12]

Currency Forward Rates. Determining the fair forward rate in a currency contract is slightly more complicated than for a financial asset that pays no income. Unlike the financial asset discussed previously, currencies generate income in the form of interest earned from investing in the currency. However, the principle of how we determine the fair forward price still applies. For example, rather than buy British pounds three months forward, we could borrow $Q_\$$ dollars, convert the dollars to $Q_£$ British pounds at the spot rate, S_0, and lend the pounds. In three months, we would have $Q_£(1 + R_£)$ British pounds. We would owe $Q_\$(1 + R_\$)$ dollars. Therefore,

[11] The theoretical derivation of forward rates is presented in Chapter 20, as are detailed examples of their practical use. We present a much briefer description of their use here as well because forward contracts are such key risk-management tools and because many instructors will choose to cover only one of these two chapters.

[12] To understand why the profit or loss from a forward position depends on the spot rate at the settlement date, consider the following. If we pay \$1.7622/£ on the settlement date and immediately sell the British pounds in the spot market, we will receive \$1.8100/£. The net effect of this transaction is a cash inflow of \$0.04748/£. On the other hand, if we have the short position, we would be selling British pounds for \$0.0478/£ less than they are worth, thus experiencing a loss.

Table 27.1
Exchange Rates versus the U.S. Dollar, December 19, 2005

The foreign exchange mid-range rates below apply to trading among banks in amounts of $1 million and more, as quoted at 4 p.m. Eastern time by Reuters and other sources. Retail transactions provide fewer units of foreign currency per dollar.

	U.S. $ Equivalent		Currency Per U.S. $	
Country	Mon	Fri	Mon	Fri
Argentina (Peso)-y	.3307	.3293	3.0239	3.0367
Australia (Dollar)	.7404	.7442	1.3506	1.3437
Bahrain (Dinar)	2.6530	2.6530	.3769	.3769
Brazil (Real)	.4202	.4279	2.3798	2.3370
Canada (Dollar)	.8552	.8627	1.1693	1.1592
1-month forward	.8560	.8635	1.1682	1.1581
3-months forward	.8574	.8649	1.1663	1.1562
6-months forward	.8593	.8666	1.1637	1.1539
Chile (Peso)	.001931	.001937	517.87	516.26
China (Renminbi)	.1239	.1239	8.0730	8.0736
Colombia (Peso)	.0004370	.0004391	2288.33	2277.39
Czech. Rep. (Koruna)				
Commercial rate	.04147	.04139	24.114	24.160
Denmark (Krone)	.1610	.1612	6.2112	6.2035
Ecuador (US Dollar)	1.0000	1.0000	1.0000	1.0000
Egypt (Pound)-y	.1741	.1741	5.7438	5.7425
Hong Kong (Dollar)	.1290	.1290	7.7520	7.7523
Hungary (Forint)	.004769	.004765	209.69	209.86
India (Rupee)	.02223	.02209	44.984	45.269
Indonesia (Rupiah)	.0001014	.0001012	9862	9881
Israel (Shekel)	.2169	.2183	4.6104	4.5809
Japan (Yen)	.008618	.008642	116.04	115.71
1-month forward	.008652	.008675	115.58	115.27
3-months forward	.008715	.008739	114.74	114.43
6-months forward	.008819	.008843	113.39	113.08
Jordan (Dinar)	1.4094	1.4094	.7095	.7095
Kuwait (Dinar)	3.4271	3.4247	.2918	.2920
Lebanon (Pound)	.0006634	.0006649	1507.39	1503.99
Malaysia (Ringgit)-b	.2646	.2646	3.7793	3.7793
Malta (Lira)	2.7972	2.7912	.3575	.3583
New Zealand (Dollar)	.6891	.6905	1.4512	1.4482
Norway (Krone)	.1500	.1505	6.6667	6.6445
Pakistan (Rupee)	.01669	.01670	59.916	59.880
Peru (new Sol)	.2910	.2908	3.4364	3.4388
Philippines (Peso)	.01879	.01873	53.220	53.390
Poland (Zloty)	.3113	.3099	3.2123	3.2268
Russia (Ruble)-a	.03490	.03492	28.653	28.637
Saudi Arabia (Riyal)	.2666	.2666	3.7509	3.7509
Singapore (Dollar)	.6016	.6004	1.6622	1.6656
Slovak Rep. (Koruna)	.03162	.03161	31.626	31.636
South Africa (Rand)	.1571	.1556	6.3654	6.4267
South Korea (Won)	.0009838	.0009828	1016.47	1017.50
Sweden (Krona)	.1276	.1269	7.8370	7.8802
Switzerland (Franc)	.7739	.7753	1.2922	1.2898
1-month forward	.7764	.7777	1.2880	1.2858
3-months forward	.7807	.7821	1.2809	1.2786
6-months forward	.7876	.7890	1.2697	1.2674
Taiwan (Dollar)	.03013	.03015	33.190	33.168

Country	U.S. $ Equivalent Mon	U.S. $ Equivalent Fri	Currency Per U.S. $ Mon	Currency Per U.S. $ Fri
Thailand (Baht)	.02442	.02443	40.950	40.933
Turkey (New Lira)-d	.7399	.7410	1.3515	1.3495
U.K. (Pound)	1.7626	1.7719	.5673	.5644
1-month forward	1.7622	1.7716	.5675	.5645
3-months forward	1.7623	1.7715	.5674	.5645
6-months forward	1.7639	1.7725	.5669	.5642
United Arab (Dirham)	.2722	.2723	3.6738	3.6724
Uruguay (Peso) Financial	.04290	.04290	23.310	23.310
Venezuela (Bolivar)	.000466	.000466	2145.92	2145.92
SDR	1.4435	1.4424	.6928	.6933
Euro	1.2009	1.2014	.8327	.8324

Source: Wall Street Journal, December 20, 2005, p. C10.
Special Drawing Rights (SDR) are based on exchange rates for the U.S., British, and Japanese currencies. *Source:* International Monetary Fund.
a-Russian Central Bank rate. b-Government rate. d-Rebased as of Jan. 1, 2005. y-Floating rate.

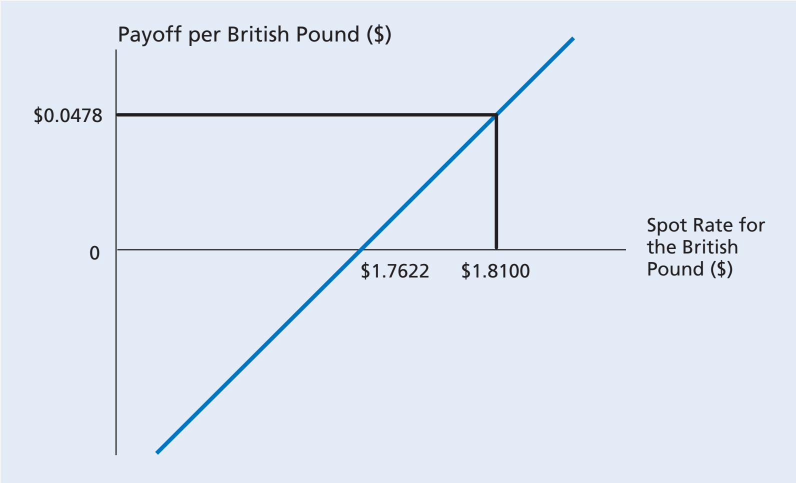


Figure 27.3
Payoff Diagram for the Buyer of a 1-Month Forward Contract on the British Pound

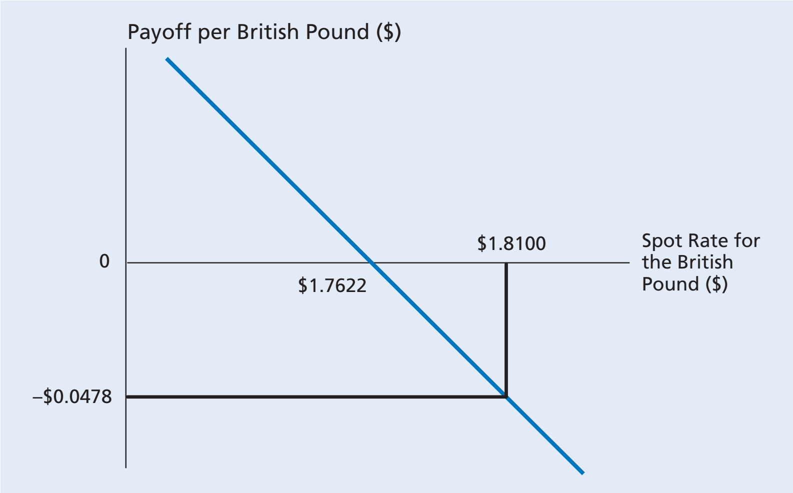


Figure 27.4
Payoff Diagram for the Seller of a 1-Month Forward Contract on the British Pound

since this alternative strategy will arrive at the same position as the forward contract, we can determine the forward price for British pounds:

$$F_£ = \frac{Q_£(1 + R_£)^n}{Q_\$(1 + R_\$)^n} \quad \text{or} \quad F_£ = S_0\frac{(1 + R_£)^n}{(1 + R_\$)^n} \qquad \textbf{(Eq. 27.3)}$$

where $F_£$ = forward price for British pounds, expressed as the number of pounds per dollar, for delivery in n years (where $n = 0.25$ for a 3-month contract and $n = 0.0833$ for a 1-month contract),

S_0 = spot price for British pounds, expressed as the number of pounds per dollar, $\frac{Q_£}{Q_\$}$, at time 0,

$R_\$$ = risk-free rate of interest at time 0 for borrowing/lending U.S. dollars,

$R_£$ = risk-free rate of interest at time 0 for borrowing/lending in British pounds,

n = number of years until the settlement date of the contract.

If the forward price violates Equation 27.3 such that $F_£ \neq S_0[(1 + R_£)^n \div (1 + R_\$)^n]$, we could earn a riskless profit by selling the high-priced position and buying the low-priced position. For example, if $F_£ > S_0[(1 + R_£)^n \div (1 + R_\$)^n]$, we would sell British pounds forward at $F_£$, borrow dollars at the rate of $r_\$$, exchange the dollars for British pounds at the spot rate of S_0, and lend the pounds at the rate of $R_£$. On the settlement date of the forward contract, we would collect $Q_£(1 + R_£)^n$ pounds from repayment of the loan, deliver British pounds at the forward rate in exchange for dollars, and use the dollars to repay our debt. If $F_£ > S_0[(1 + R_£)^n \div (1 + R_\$)^n]$, the dollars we would receive from selling pounds forward would be more than we would need to repay our debt, thereby generating a riskless profit.

APPLYING THE MODEL 27.4

Suppose that the current spot exchange rate on the Swiss franc (SF) is \$0.7739/SF, or SF1.2922/\$. The effective 1-year risk-free rate for borrowing in dollars is 6 percent, and the rate for borrowing in Swiss francs is 5 percent. According to Equation 27.3, the following is the 1-year forward exchange rate on the Swiss franc:

$$F_{SF} = SF1.2922\frac{(1 + 0.05)}{(1 + 0.06)} = SF1.2800$$

Hedging with Currency Forward Contracts. To see how forward contracts can be used to hedge foreign exchange risk, consider a multinational company's treasurer who expects to receive a 10 million Swiss franc (SF) payment in 90 days. Using the information in Table 27.1, the spot rate is \$0.7739/SF on Monday, December 19, 2005. In 90 days, however, the spot rate may be lower. For example, if the spot rate declines to \$0.7500/SF, then the SF10 million payment will be worth only \$7,500,000 (\$0.7500/SF × SF10,000,000) rather than the \$7,739,000 (\$0.7739/SF × SF10,000,000) it would be worth today.

This type of foreign exchange risk can be hedged by selling the payment forward. The 3-month forward rate for exchanging Swiss francs into dollars is $0.7807/SF on Monday, December 19, 2005. In three months, after receiving the SF10 million payment, the company will deliver SF10 million to the counterparty in the forward contract and receive in exchange $7,807,000 ($0.7807/SF × SF10,000,000), regardless of what the spot rate happens to be at that time. By doing this, the treasurer has hedged the company's foreign exchange risk associated with this payment by locking in the dollar price the company will receive for its foreign currency cash flow.

Interest Rate Forward Contracts

The underlying asset in an interest rate forward contract is either an interest rate or a debt security. Contracts involving an interest rate as the underlying security are cash settled, which simply means that the underlying security is not transferred from the seller to the buyer. Instead, the buyer and seller exchange the cash value of the contract. Either way, interest rate forward contracts are used to hedge an interest rate risk exposure in much the same way that currency forward contracts are used to hedge a currency risk exposure.

Forward Rate Agreements. A **forward rate agreement (FRA)** is an example of a forward contract where the underlying asset is not an asset at all but an interest rate. An FRA is an agreement between two parties to exchange cash flows based on a reference interest rate and principal amount at a single point in time in the future. In an FRA, the first party will pay the second party if the market rate of interest at a specified future time is greater than the forward rate specified in the contract. If, however, the market rate of interest is less than the forward rate, the second party will pay the first party. The size of the payment will depend on the hypothetical principal amount, called the **notional principal,** and the difference between the market rate of interest and the forward rate. Equation 27.4 shows how to determine the cash flow in an FRA (CF_{FRA}). Note that, by convention, this computation uses a 360-day year.

$$CF_{\text{FRA}} = \frac{\text{notional principal} \times (r_S - r_F) \times \left(\dfrac{D}{360}\right)}{1 + \left[r_S \times \left(\dfrac{D}{360}\right)\right]} \qquad \text{(Eq. 27.4)}$$

where r_S = reference rate on the contract settlement date (e.g., the 3-month treasury bill rate),

r_F = forward rate established at contract origination,

D = number of days in the contract period.

Hedging with Interest Rate Forward Contracts. To see how FRAs can be used to hedge interest rate risk, consider CFE Manufacturing (CFE). The company is planning to borrow $10 million in six months at LIBOR plus 100 basis points and is concerned that LIBOR will increase before the company borrows.[13] To hedge this exposure, CFE and BankAmerica enter into a 6-month *FRA* with a notional principal

[13] LIBOR, the London interbank offered rate, is the rate of interest charged for Eurodollar borrowing between banks. Virtually all large bank loans are priced versus LIBOR.

of \$10 million. The terms of the contract are such that CFE will pay BankAmerica if the 3-month LIBOR six months from now is less than the forward rate of 6 percent. If the 3-month LIBOR exceeds 6 percent, BankAmerica must pay CFE. The size of the cash flow is determined by Equation 27.4. For example, if the 3-month LIBOR six months from now is 7 percent, BankAmerica must pay CFE the following:

$$\frac{\$10{,}000{,}000 \times (0.07 - 0.06) \times \left(\frac{92}{360}\right)}{1 + \left[0.07 \times \left(\frac{93}{360}\right)\right]} = \$25{,}106.43$$

However, if the 3-month LIBOR six months from now is 5 percent rather than 7 percent, CFE must pay BankAmerica \$25,233.14.

Concept Review Questions

5. If Equation 27.2 does not hold, how might an arbitrageur earn a riskless profit?

6. What is the difference in the timing of cash flows in a forward contract and a spot market transaction?

27.3 FUTURES CONTRACTS

Like a forward contract, a **futures contract** involves two parties agreeing today on a price at which the purchaser will buy a given amount of a commodity or financial instrument from the seller at a fixed date sometime in the future. In fact, the contracts are so similar that, for most purposes, we can use the same pricing formulas to price futures contracts that we used for forward contracts.[14] Similarly, we can use the same payoff diagram for futures that we used for forwards.

Although futures and forwards serve the same economic function, there are differences in the characteristics of the two contracts. In contrast to a forward contract, a futures contract is an exchange-traded contract that promises the delivery of a specified volume of a commodity or financial instrument on a standardized date of the month in which the contract expires.[15] For example, gold futures contracts are traded on the New York Mercantile Exchange. The gold futures contract calls for the delivery of 100 troy ounces. Contracts are available for delivery in the current month; the next two months; any February, April, August, and October falling within the next two years; and any June and December falling within the next five years.

Table 27.2 provides data on the prices of gold futures contracts on Monday, December 19, 2005. The first trade of the day for the February 2006 contract, called the **opening futures price,** was \$505.70 per troy ounce. The highest price for the day was \$512.10/oz. The low for the day was \$503.60/oz. The last February 2006 futures price for the day was \$506.10/oz. This **closing futures price** is the result of a \$0.20/oz increase in the settle price from the previous day, as indicated by the change column. The closing price, also known as the **settlement price,** is used to settle all contracts at

[14] An intuitive discussion of the pricing of financial futures is provided in French (1989). There are small differences in the pricing of forward and futures contracts. For some purposes these differences may be important, but for most purposes the differences are insignificant. For a discussion of these differences, see Cox, Ingersoll, and Ross (1981).

[15] In practice, delivery can take place on any day during the delivery month for most futures contracts. When a seller decides to deliver, he will notify his broker of his intent to deliver. Two days later, the seller will deliver on the contract.

Table 27.2
Gold Futures Prices, Monday, December 19, 2005

	Open	High	Low	Settle	Change	Lifetime High	Lifetime Low	Open Interest
GOLD (Cmx.Div.NYM)—100 troy oz.; $ per troy oz.								
Dec 2005	509.50	509.50	504.50	503.60	+0.20	538.50	298.40	702
Feb 2006	505.70	512.10	503.60	506.10	+0.20	544.50	415.00	255,302
Apr	509.70	516.60	509.30	510.30	+0.20	548.40	418.00	12,187
Jun	515.00	521.00	514.30	514.50	+0.20	551.80	312.00	20,804
Dec	526.00	533.50	526.00	527.40	+0.20	565.60	338.00	11,918
Dec 2007	556.00	556.00	554.70	552.90	+0.20	592.50	368.00	7,350

Source: Wall Street Journal Futures Prices, December 20, 2005, p. C10.

the end of each day's trading, in a process called *marking-to-market* (described later). Also shown are the **lifetime high price** and the **lifetime low price** for this contract, which are the highest and lowest settlement prices recorded for this contract since its inception—perhaps several months (or even a year or more) before. The **open interest** represents the number of contracts that are currently outstanding. This number changes every day as contracts are bought and sold. If a trader were to take a long position in gold futures contracts at the settle price of $506.10/oz, the total futures price of one contract would be $50,610 ($506.10/oz × 100 troy ounces).

Table 27.3 provides a few examples of the types of available futures contracts and the exchanges on which they are traded. All the contracts traded on these exchanges are standardized with respect to size and delivery date. The economic rationale for designing futures contracts in this way is that it provides a standardized, high-trading-volume (hence low-transactions-cost) financial instrument that can be used by both individuals and businesses to hedge underlying commercial risks as well as by speculators wishing to place a highly leveraged bet on the direction of commodity prices. Contract sizes are small enough for individuals to be able to participate in futures markets, and the volume is high enough for businesses to take significant positions by buying or selling multiple contracts.

SMART PRACTICES VIDEO

Keith Woodward, Vice President of Finance, General Mills

"For General Mills, hedging commodities is core to our business."

See the entire interview at SMARTFinance

Although both futures and forwards impose obligations on their holders, the default risk of a futures contract is much lower, for two reasons. First, every major futures exchange operates a clearinghouse that acts as the counterparty to all buyers and sellers. This means that traders need worry not about the creditworthiness of the party they trade with (as forward market traders must), but only about the creditworthiness of the exchange itself. Second, futures contracts feature daily cash settlement of all contracts, called **marking-to-market.** By its very nature, a futures contract is a zero-sum game because whenever the market price of a commodity changes, the underlying value of a long (purchase) or short (sale) position also changes—and one party's gain is the other party's loss. By requiring each contract's loser to pay the winner the net amount of this change each day, futures exchanges eliminate the possibility that large, unrealized losses will build up over time. In a forward contract, on the other hand, there are no cash flows between origination and termination of the contract.

APPLYING THE MODEL 27.5

As an example of marking-to-market, consider the gold futures discussed previously. Recall that the settle price for the February 2006 contract was $506.10 per

Table 27.3 Examples of Exchange-Traded Futures Contracts

Contract	Exchange	Face Amount
Grains and oilseeds		
Corn	Chicago Board of Trade	5,000 bushels
Oats	Chicago Board of Trade	5,000 bushels
Wheat	Chicago Board of Trade	5,000 bushels
Livestock and meat		
Cattle—feeder	Chicago Mercantile Exchange	50,000 lbs.
Cattle—live	Chicago Mercantile Exchange	40,000 lbs.
Pork bellies	Chicago Mercantile Exchange	40,000 lbs.
Food and fiber		
Cocoa	New York Board of Trade	10 metric tons
Coffee	New York Board of Trade	37,500 lb
Sugar—world	New York Board of Trade	112,000 lb
Sugar—domestic	New York Board of Trade	112,000 lb
Cotton	New York Board of Trade	50,000 lb
Orange juice	New York Board of Trade	15,000 lb
Metals and petroleum		
Copper	Comex, New York Mercantile Exchange	25,000 lb
Gold	Comex, New York Mercantile Exchange	100 troy oz
Platinum	New York Mercantile Exchange	50 troy oz
Silver	Comex, New York Mercantile Exchange	5,000 troy oz
Crude oil	New York Mercantile Exchange	1,000 bbl
Natural gas	New York Mercantile Exchange	10,000MM Btu
Interest rate		
Treasury bonds	Chicago Board of Trade	$100,000
5-year Treasury notes	Chicago Board of Trade	$100,000
30-day federal funds	Chicago Board of Trade	$5 million
LIBOR	Chicago Mercantile Exchange	$3 million
Eurodollars	Chicago Mercantile Exchange	$1 million
Index		
Dow Jones Industrial Average	Chicago Board of Trade	$10 × average
S&P 500	Chicago Mercantile Exchange	$250 × average
Nasdaq 100	Chicago Mercantile Exchange	$100 × average
Currency		
Japanese yen (Y)	Chicago Mercantile Exchange	Y12.5 million
Deutschemark (DM)	Chicago Mercantile Exchange	DM125,000
British pound (BP)	Chicago Mercantile Exchange	BP62,500
Swiss franc (SF)	Chicago Mercantile Exchange	SF125,000

Source: Wall Street Journal Futures Prices, December 20, 2005, p. C10.

troy ounce. If the settle price on the next business day is $506.70/oz, the person with the long position will receive $0.60/oz (the new futures price minus the original futures price), or a total of $60.00 per contract ($0.60/oz × 100 troy ounces). The person with the short position must pay $0.60/oz. In effect, the new contract with a futures price of $506.70/oz replaces the original contract. The party with the long position is compensated (and the person with the short position must pay) for the increase in the futures price. This type of daily settlement takes place on every trading day until delivery takes place. It is important to note that the party with the long position ultimately ends up paying a total of $506.10/oz, and the party with the short position receives a total of $506.10/oz upon delivery.

When taking a position in a futures contract, the investor must deposit a minimum dollar amount called the **initial margin,** which varies by contract, in a **margin account.** The investor deposits gains in or withdraws losses from this account. Each exchange has margin requirements, and brokerage firms may require additional margin above the minimum specified. If losses deplete the margin below the level needed to maintain an open position, the **maintenance margin,** the investor must deposit additional funds in the account to bring the account back to the initial margin. Failure to deposit additional funds before the next day's trading results in the position's being closed out by the exchange.

In addition to these distinctions, futures differ from forward contracts in two other important respects. First, futures contracts are designed to have a value (usually around $100,000) that will appeal to a "retail" market of individuals and smaller companies, whereas most actively traded forward contracts have minimum denominations of $1 million or more. This small contract size is rarely a problem for futures traders, however, for those wishing to hedge large exposures can simply purchase multiple contracts. Second, most forward contracts are settled by actual delivery, but this rarely occurs with futures contracts. Instead, futures market hedgers will execute an offsetting trade to close out their position in the futures market whenever they have closed out their underlying commercial risk through delivery in the normal course of business.

The ability to close out a position by taking an offsetting position is referred to as **fungibility.** Fungibility is made possible because the counterparty in a futures contract is the clearinghouse and because futures contracts are settled daily. If an investor were to take a long position in a futures contract and subsequently take a short position in the same contract, the contracts would cancel each other out for two reasons: (1) After marking-to-market, the futures prices of the two contracts would be the same, and (2) the clearinghouse is the counterparty to both contracts. It is important to note that unless buyers or sellers close out their positions, they are required to make or take delivery of the underlying asset.

Hedging with Futures Contracts

Futures contracts are a very effective mechanism for hedging. In addition to futures markets for metals, there are futures markets for foreign currencies, interest rates, stock indexes, and commodities. *Long hedges* involve buying a futures contract to offset an underlying short (sold) position. *Short hedges* involve selling a futures contract to offset an underlying long (purchased) position.

Hedging with Foreign Currency Futures. The multinational company with the SF10 million exposure discussed earlier could have chosen to hedge that exposure in the futures market rather than with a forward contract by selling 80 Swiss franc futures contracts (each mandating delivery of SF125,000). Recall that the multinational company will be receiving a payment of 10 million Swiss francs in 90 days. By selling 80 SF futures contracts that expire after the date on which it will receive the SF payments (because futures contracts have fixed delivery periods, they will only rarely exactly match a trader's desired payment date), the company can hedge this exposure using futures rather than forwards. On December 19, 2005, the settle price for March

2006 Swiss franc futures is \$0.7820/SF. When the SF payment is received, the company will exchange it for dollars at whatever the spot \$/SF exchange rate happens to be at the time and will simultaneously buy 80 SF futures contracts with the same delivery date as the contracts purchased earlier—thereby offsetting or closing out its futures position. If the dollar value of the Swiss franc declines from \$0.7739/SF to, say, \$0.6689/SF during the 90 days in question, then the company will lose \$0.1050/SF, or a total of \$1,050,000, on its spot market sale of the SF payment. But this loss will be offset by the profit the company will achieve on its futures position. If the futures price declines from \$0.7820/SF to \$0.6770/SF, the profit in the futures position will be \$0.1050/SF, or a total of \$1,050,000, exactly offsetting the loss in the cash market position. If the Swiss franc appreciates rather than depreciates against the dollar, then the company will gain on its cash market transaction and lose on its futures contracts. Either way, hedgers can use a futures contract to hedge an underlying commercial risk without actually having to take physical delivery on the futures contract.

Hedging with Interest Rate Futures. We can use futures contracts to hedge interest rate risk in much the same way that we hedged foreign exchange risk. Consider a corporate treasurer who anticipates borrowing \$1 million in five months. The loan will be at 100 basis points over the 3-month LIBOR at the time of borrowing. LIBOR is currently at 5 percent. Eurodollar futures contracts for delivery in six months are trading at a yield of 5.2 percent.[16] By selling one Eurodollar futures contract, the treasurer can effectively lock in a borrowing rate of 6.2 percent (5.2 percent plus 100 basis points) for the three months beginning in six months. As in the currency contract, the treasurer would close out the position in Eurodollar futures and borrow at the same time.

Concerns When Using Futures Contracts

In the previous examples, we ignored several potential problems associated with using futures markets to hedge. We discuss some of these problems in the following sections.

Basis Risk. The basis in a futures contract is the difference between the futures price and the spot price. **Basis risk** arises from the possibility of unanticipated changes in the basis. As the maturity date approaches, the basis goes to zero. However, if a contract is closed out prior to maturity, as in the previous examples, basis risk can cause gains (losses) in the underlying risky position to differ from the offsetting losses (gains) in the futures position. For example, if the futures price in the example of currency hedging had not changed by exactly the same amount as the spot price, the loss in the cash position would have differed from the gain in the futures position.

Cross-Hedging. The underlying securities in the futures contracts were identical to the assets being hedged in the two previous examples. However, the underlying securities in the futures contract and the assets being hedged often have different characteristics, which is called **cross-hedging.** For example, a farmer who uses orange juice futures to hedge his crop of grapefruits is cross-hedging. To minimize basis risk in a cross-hedge, we need to determine the relation between changes in the value of the asset being hedged and changes in the value of the asset in the futures contract. It is possible to estimate this relation using historical data. Once we measure the sensitiv-

[16] Eurodollar futures contracts are available in the current month, the next month, and every March, June, September, and December in the next 10 years. The Eurodollar futures contracts are based on the 3-month LIBOR.

ity of the asset being hedged to changes in the price of the underlying asset in the futures contract, we can use that information to adjust the number of futures contracts to buy or sell in order to achieve an effective hedge.

Tailing the Hedge. Because of the marking-to-market feature of futures contracts, interest is earned on gains to the futures position as they are paid in, and interest is lost on losses as they are paid out. This causes gains on a long position in futures to be slightly greater than the losses on a short position in the underlying asset because of the interest earned on the gains. To avoid overhedging, we would want to purchase enough futures contracts to hedge the risk exposure, but not so many that we overhedge. To achieve a perfect hedge in the example of currency hedging, we would need to sell slightly fewer than 80 Swiss franc futures contracts. This is called **tailing the hedge.**

Delivery Options. The deliverable instrument in some futures contracts can take a variety of forms. For example, the underlying security in a Treasury bond futures contract is a 20-year Treasury bond. However, the contract allows for the delivery of any Treasury bond that has a maturity date of at least 15 years from the first day of the delivery month. If the bond is callable, it must not be callable for at least 15 years from the first day of the delivery month. When delivery occurs, a conversion factor is used to account for differences in the characteristics of the deliverable instruments. See the Chicago Board of Trade's website (http://www.cbot.com) for information on current conversion factors.

Another delivery option is the timing option. Many futures contracts allow delivery to take place at any time during the delivery month. In fact, several futures contracts allow for delivery to take place several days after the last trading day for a contract. For example, the delivery process for Treasury bond futures contracts is as follows: (1) Sometime during the delivery month, the seller notifies the clearinghouse of the intent to deliver on the futures contract; (2) the clearinghouse notifies the party with the oldest long position that delivery will take place in two days; (3) delivery takes place, with the seller delivering Treasury bonds to the individual with the long position; and (4) the seller receives the futures price (adjusted by the conversion factors associated with the bonds).

Because delivery rarely takes place in a futures contract, delivery options are not generally a major concern for the manager who is using futures to hedge risk. However, these delivery options do affect futures prices and are important for those market participants who are planning to make or take delivery of the underlying asset in the futures market.

Concept Review Questions

7. What is the difference in the cash flows for a forward contract and a futures contract?

8. What features of a futures contract tend to reduce default risk?

9. Describe how tailing a hedge keeps a firm from overhedging.

27.4 OPTIONS AND SWAPS

Options and swaps can also be used to hedge risk exposures. This section discusses both these instruments and describes how they can be used to hedge risk exposures.

Options

As discussed in Chapters 18 and 19, options contracts are pervasive in modern financial systems. There are exchange-traded options contracts on individual common stocks, on stock indexes, on numerous currencies and interest rates, on a bewildering number of industrial and agricultural commodities, and even on futures contracts. Financial institutions custom-design even more options to meet the needs of their customers (these are often called *over-the-counter,* or *OTC,* options). A call option gives its holder the right to buy a fixed amount of a commodity at a fixed price, on (with a European option) or by (with an American option) a fixed date in the future, whereas a put option entails a similar right to sell that commodity. The valuation of, and payoff patterns for, options are discussed in depth in Chapters 18 and 19.

For our purposes, the key feature of an option as a hedging tool is that it provides protection against adverse price risk (an investor has the right to exercise the option if price changes make it optimal to do so) without having to forfeit the right to profit if the price on the underlying commodity moves in the investor's favor (in which case, the investor allows the option to expire unexercised).

Hedging with Currency Options. Recall the multinational corporation that is expecting to receive a payment of SF10 million. Earlier, we demonstrated how this foreign exchange risk could be hedged using forwards or futures. We can also hedge this risk using options. For example, the multinational company could have purchased 160 Swiss franc put options (each granting the right to deliver SF62,500) that expire after the date on which it will receive the SF payments (like futures contracts, exchange-traded options have fixed expiration dates and will only rarely exactly match a trader's desired payment date). When the SF payment is received, the company will exchange it for dollars at whatever the spot $/SF exchange rate happens to be at the time and will simultaneously sell 160 SF put options with the same delivery date as the contracts purchased earlier—thereby offsetting or canceling out its options position. If the dollar value of the Swiss franc has declined from $0.7739/SF to, say, $0.6700/SF during the 90 days in question, then the company will lose on its cash market transaction and gain on its options contract. If the Swiss franc appreciates against the dollar, the company will gain on its cash market transaction, and its losses on the options contract will be limited to the premium paid for the option. By using an option to hedge this foreign exchange risk, the multinational corporation minimizes its downside risk without giving up its upside potential. The cost of this hedge is the premium paid for the option.

Hedging with Interest Rate Options. In addition to hedging foreign exchange risk, options are commonly used to hedge interest rate risk. For example, a retailer that has borrowed using a variable-rate loan is probably concerned about rising interest rates. If the loan rate is tied to Treasury bill rates, the firm could hedge this interest rate risk by purchasing a call option on the 13-week T-bill yield. Call options on interest rates are called **interest rate caps.**

The Chicago Board Options Exchange (CBOE) offers options on the 13-week T-bill rate and other, longer-term Treasury rates. See the CBOE website (http://www.cboe.com) for more information on interest rate options traded on that exchange. The underlying instruments in CBOE interest rate options are yields rather than prices, as in stock options. The underlying values for these options are 10 times the underlying Treasury yields, and the contracts are cash settled at $100 times the difference between the underlying value at option expiration and the strike price. For the retailer, the underlying value would be 10 times the yield to maturity (*YTM*) on 13-week T-bills. If the retailer paid 1.00 for a July 55 call, the total price of one contract is \$100 (1.00 × \$100). If the *YTM* on 13-week T-bills is 6 percent on the option expiration date, the cash settlement will be \$500 [(60 − 55) × \$100]. The net profit for the hedge will be \$400 (\$500 settlement − \$100 premium). This profit will offset the higher interest costs of the variable-rate loan. If the *YTM* on 13-week T-bills declines to 5 percent, however, the option will expire worthless, and the retailer will have lost only the \$100 premium paid for the option. The advantage of using options to hedge the retailer's interest rate risk is that the retailer retains the potential for lower interest costs if interest rates decline but is able to offset the potential for higher interest costs if interest rates increase.

Just as an interest rate cap is a call option on interest rates, an **interest rate floor** is a put option on interest rates. Recall from Chapter 18 that a put option represents the right to sell an asset for a specified price within a specified period of time. In the case of interest rate options, which involve cash settlement, a put option will generate a positive payoff for the buyer when the underlying value (\$100 times the *YTM*) declines below the strike price.

One common strategy, called an **interest rate collar,** is to buy an interest rate cap and simultaneously sell an interest rate floor. The purpose of this strategy is to use the proceeds from selling the floor to purchase the cap. Of course, by selling the floor, an investor forgoes some upside potential. If our intrepid retailer sold a July 50 put for 0.75 and bought the July 55 call at the same time, the retailer would receive \$75 (0.75 × \$100) for the put. This would offset all but \$25 of the premium paid for the call. The result of this strategy would be the same as just purchasing the cap for all yields above 5.0 percent. Below 5.0 percent, however, gains from the lower interest costs will be offset by losses from selling the put.

Swaps

In a **swap contract,** two parties agree to exchange payment obligations on two underlying financial liabilities that are equal in principal amount but differ in payment patterns. Investors use swaps to change the characteristics of cash flows, most often to change the characteristics of cash outflows. We will concentrate on the most common types, *interest rate swaps* and *currency swaps.* According to a survey by the International Swaps and Derivatives Association (http://www.isda.org), the total notional volume of over-the-counter derivative contracts outstanding totaled more than \$200 trillion at the end of June 2005, with interest rate swaps accounting for more than 80 percent (\$163.7 trillion) of this total. It is important to note that, like forward contracts, swap contracts are over-the-counter instruments and subject to default risk. For this reason, swap market participants enter into contracts only with parties that they know and trust.

Interest Rate Swaps. An **interest rate swap** is the most common type of swap transaction. In a typical interest rate swap, one party will make fixed-rate payments to another party in exchange for floating-rate payments. This is often called a **fixed-for-floating interest rate swap.** As in the FRAs discussed earlier, the interest payments on a fixed-for-floating swap will be based on a hypothetical principal amount called the *notional principal.*[17]

[17] A discussion of swap default risk can be found in Sorenson and Bollier (1994). For an intuitive discussion of interest rate swaps, see Bicksler and Chen (1986).

Figure 27.5
Typical Structure of a Fixed-for-Floating Swap

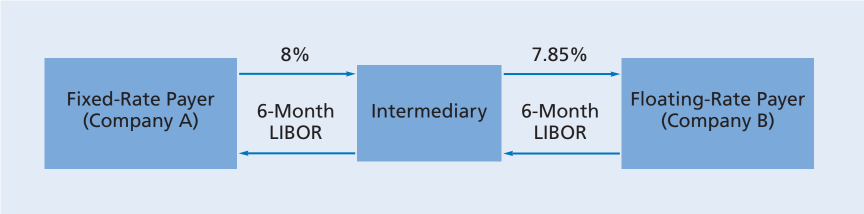
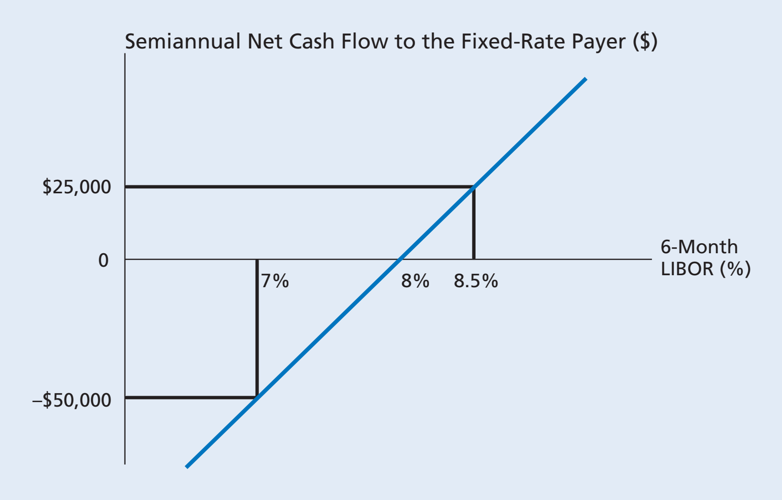


Figure 27.5 illustrates the structure of a fixed-for-floating swap. The party making fixed-rate payments, Company A, promises to make fixed-rate payments based on some notional principal amount to a financial intermediary in exchange for floating-rate payments.[18] In this example, as in many swap transactions, an intermediary has arranged the swap and is acting as the counterparty to both contracts. The contract calls for Company A to pay the intermediary 8 percent per year based on a notional principal of $10 million. In return, the intermediary will pay Company A the 6-month LIBOR applied to the same $10 million notional principal amount. In practice, only the **interest differential** is exchanged between the intermediary and Company A.

At the same time that the intermediary and the company agree to swap interest payments, the intermediary enters into an agreement to pay a fixed rate of interest to the floating-rate payer, Company B, in exchange for a floating rate. In this example, the intermediary agrees to pay Company B 7.85 percent in exchange for the 6-month LIBOR. The intermediary's compensation is the spread between the fixed rate received from Company A and the fixed rate paid to Company B.

Figures 27.6 and 27.7 show payoff diagrams for Company A and Company B in the interest rate swap. The *x*-axis of these diagrams represents possible spot rates for the 6-month LIBOR at the end of each 6-month period. The *y*-axis represents the cash flow to the parties involved in the transaction. If the contract calls for semiannual payments, the cash flow for Company A is [$\$10{,}000{,}000 \times (\text{LIBOR} - 8\%) \div 2$].

Figure 27.6
Semiannual Net Cash Flow for the Fixed-Rate Payer in a Fixed-for-Floating Swap with a Notional Principal of $10 Million



[18] Empirical evidence, as in Samant (1996), on the use of swaps by nonfinancial firms suggests that fixed-rate payers tend to have greater leverage and more volatile earnings than floating-rate payers. Titman (1992) suggests that when a firm expects its credit quality to improve, it will borrow short-term and use a fixed-for-floating swap to hedge interest rate risk.

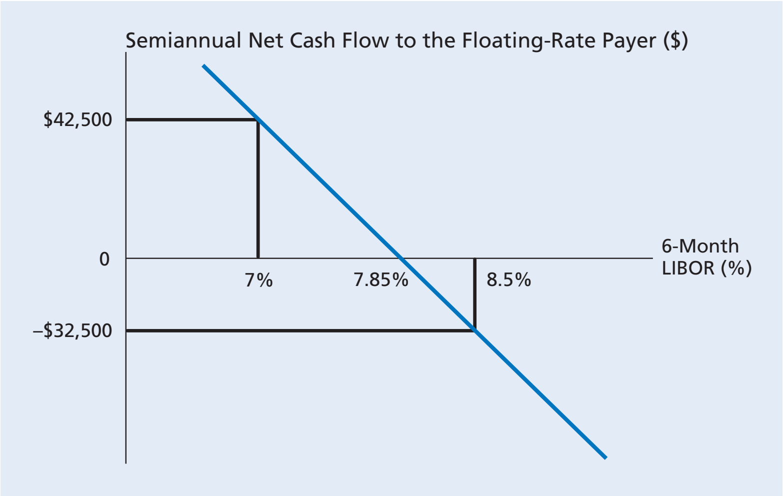


Figure 27.7
Semiannual Net Cash Flow for the Floating-Rate Payer in a Fixed-for-Floating Swap with a Notional Principal of $10 Million

The cash flow for Company B is [$10,000,000 × (7.85% − LIBOR) ÷ 2]. If the 6-month LIBOR is 7 percent at the end of the first 6-month period, Company A will pay the intermediary $50,000 [$10,000,000 × (0.07 − 0.08) ÷ 2]. The intermediary will pay Company B $42,500 [$10,000,000 × (0.0785 − 0.07) ÷ 2]. Six months later, if the 6-month LIBOR is 8.5 percent, the intermediary will pay Company A $25,000 [$10,000,000 × (0.085 − 0.08) ÷ 2]. Company B will pay the intermediary $32,500 [$10,000,000 × (0.0785 − 0.085) ÷ 2]. These exchanges will take place every six months until the termination date.

Typically, these interest rate swaps arise because one party wanted to issue fixed-rate debt but chose instead to issue floating-rate debt, because the fixed-rate market either was closed to this issuer or was more costly. By entering a swap agreement, the floating-rate issuer can effectively obtain a fixed-rate payment obligation. By paying a fixed rate and receiving a floating rate, this firm can use the cash inflows in the form of floating-rate payments to make the floating-rate payments on the debt that is outstanding. The net effect of the swap agreement is to offset the floating-rate payments being paid on the floating-rate debt with the floating-rate payments received on the swap. The fixed-rate payments being made on the swap are all that remain.

The counterparty in the swap contract (who has better access to fixed-rate debt markets) achieves a preferred floating-rate pattern of payments. As mentioned previously, rather than exchange gross amounts, the two parties will exchange only the net difference between the two payment obligations, the interest differential; therefore, the party that has swapped a fixed-rate payment obligation for one with a floating rate will lose (have to increase payment amounts) if market rates rise and will benefit if market rates fall.

Currency Swaps. The second most common type of swap contract is the **currency swap,** in which two parties exchange payment obligations denominated in different currencies. For example, a U.S. company wishing to invest in Switzerland would prefer to borrow in Swiss francs rather than in dollars. If, however, the company could borrow on more attractive terms in dollars (as is often the case) than in francs, a logical strategy would be to borrow the money needed for investment in dollars, say, by issuing bonds and then to swap payment obligations with a Swiss company seeking dollars for investment in the United States. The Swiss company would issue bonds that are denominated in Swiss francs.

The U.S. company would make periodic Swiss franc payments to the Swiss company. The Swiss company would make periodic dollar payments to the U.S. company. The dollar payments made by the Swiss company would cover the interest and principal payments on the dollar borrowing by the U.S. company, and the Swiss franc payments made by the U.S. company would cover the interest and principal payments on the Swiss franc borrowing by the Swiss company. By engaging in the swap, the U.S. company has transformed its dollar liabilities into Swiss franc liabilities, and the Swiss company has transformed its Swiss franc liabilities into dollar liabilities.

Suppose that the U.S. company issues \$7 million in 10-year bonds that have a coupon rate of 8 percent. The Swiss company issues SF10 million in 10-year bonds that also have a coupon rate of 8 percent. In this example, we will assume that the companies have agreed on a fixed exchange rate in the swap contract of \$0.70/SF. The two parties will exchange the principal amounts at contract origination. At the end of the first 6-month period, the U.S. company will pay SF400,000 (SF10,000,000 $\times$ 0.08 $\div$ 2) to the Swiss company in exchange for \$280,000 (\$7,000,000 $\times$ 0.08 $\div$ 2). These payments will occur every six months until the termination date. On the termination date, the two parties will exchange principal amounts again to terminate the contract. The principal amounts will then be used to retire the bonds each company originally issued.

Note that unlike interest rate swaps, the notional principal in a currency swap is often exchanged at the origination and termination dates of the contract. If the notional principal were not exchanged at the termination date, the U.S. company would still be faced with a dollar liability when the dollar-denominated bonds mature, and the Swiss company would be faced with a Swiss franc liability.

Another variant of the currency swap is the **fixed-for-floating currency swap.** This is simply a combination of a currency swap and an interest rate swap. In this transaction, the first party pays a fixed rate of interest denominated in one currency to the second party in exchange for a floating rate of interest denominated in another currency. For example, if the U.S. company in the previous example preferred to borrow in Swiss francs at a floating rate of interest and the Swiss company preferred to borrow in dollars at a fixed rate of interest, the two firms could engage in a fixed-for-floating currency swap.

Suppose that the U.S. company was able to borrow \$7 million in 10-year bonds with a coupon rate of 8 percent. The Swiss company borrows SF10 million in 10-year bonds with a coupon rate of LIBOR + 100 basis points. As in the currency swap, the two parties will exchange the principal amounts at contract origination. At the end of the first 6-month period, if LIBOR is 6.5 percent, the cost of the loan will be 7.5 percent (0.065 + 0.01). The U.S. company will pay SF375,000 [SF10,000,000 $\times$ (0.065 $-$ 0.01) $\div$ 2] to the Swiss company in exchange for \$280,000 (\$7,000,000 $\times$ 0.08 $\div$ 2). For both parties, the semiannual cash inflows from the swap contract are used to make the interest payments on the bonds that were issued in the cash market. Upon termination of the swap contract, the principal amounts are exchanged again and the bonds are retired.

Concept Review Questions

10. Describe how an interest rate swap is just a portfolio of FRAs.

11. Why would any corporation hedge with forwards, futures, or swaps if it can keep its upside potential by hedging with options?

27.5 FINANCIAL ENGINEERING

The key to a successful hedging strategy is the ability to offset the underlying risk exposure. For many firms, however, the underlying risk exposure is unique because the risk exposure is based on an asset whose value is not easily hedged. **Financial engineering,** at least for our purposes here, can be defined as the process of using the principles of financial economics to design and price financial instruments. In particular, financial engineering has meant combining the risk-management building blocks—forwards, futures, options, and swaps—in complex patterns in order to achieve specific risk profiles that benefit corporate issuers or to offer investors unique payoff structures that help complete the capital markets, or both. For example, some firms are not able to use off-the-shelf hedging instruments because those instruments do not have payoff structures that will offset the firm's underlying risk exposures. Similarly, an institutional investor may desire an investment security that has specific payoff structures when no such security is currently available.

By combining elements of forwards, futures, options, and swaps, however, it is often possible to create a financial instrument that meets the needs of the corporation trying to hedge its risk exposure or that offers the institutional investor an investment opportunity with a unique payoff structure. Modern corporations, and the financial institutions that cater to them, have become extremely adept at this process. For example, Chidambaran, Fernando, and Spindt (2001) describe how Freeport-McMoRan used financial engineering to finance an expansion of its mining facilities in Indonesia. Rather than issue fixed-rate bonds, Freeport-McMoRan issued depository shares that act like bonds, with principal and interest payments that are directly tied to the price of gold. This built-in hedge actually enhanced the credit quality of Freeport-McMoRan because of the reduced risk of default.

SMART IDEAS VIDEO

Mitchell Petersen, Northwestern University

"Derivative markets have given investors, as well as managers, a lot more choices."

See the entire interview at SMARTFinance

Given that the returns to successful financial innovation can be very high, a great many new financial products are developed every year. Enough of these products succeed that we can identify certain trends that are likely to continue for the foreseeable future. First, longer-maturity risk-management products will continue to be developed. Standard futures, forwards, and options are all short-term contracts, but recent years have seen the introduction of contracts with much longer dates as well as the development of intermediate- and long-term securities that effectively perform hedging roles. Second, even more complex securities will be developed to hedge multiple interest rate, currency, and input/output pricing risks, particularly in the international arena. Third, new techniques for hedging pricing and underwriting risks in the issuance of new securities will continue to arise as the securitization trend accelerates around the world. Finally, it seems inevitable that new methods of hedging the strategic and currency risks of investing in small, politically unstable or financially underdeveloped countries will emerge in the coming decade as Western capital is committed to the transformation of the formerly socialist or mixed economies of China, India, Russia, and Eastern Europe.

The practice of risk management and financial engineering is evolving, and we have only touched on the basic strategies here. As the markets for derivative securities grow and the practice of risk management develops, it is likely that we will see increasingly complex financially engineered instruments. However, it is important to remember that even the most complex instrument includes elements of the securities we described here.

Concept Review Question

12. Under what circumstances might a corporation prefer a financially engineered solution for a risk-management problem to an off-the-shelf solution?

27.6 SUMMARY

- Increased volatility in interest rates, currency exchange rates, and commodity prices has led to mushrooming demand for financial instruments that corporations can use to hedge their exposure to these risk factors.
- It is not always in the corporation's best interest to hedge. However, hedging can reduce the likelihood of financial distress, thereby reducing the expected costs of financial distress.
- A forward contract is an over-the-counter instrument that involves two parties agreeing on a price at which the purchaser will buy a specified amount of an asset from the seller at a fixed date sometime in the future. A futures contract is similar to a forward contract but is traded on an organized exchange.
- The fair forward price (or rate) in a forward contract is the price that eliminates the possibility of an arbitrageur's generating riskless profits by trading in the forward contract.
- Unlike forward contracts, which are customized instruments, futures are standardized. Several issues to consider when using futures to hedge include basis risk, cross-hedging, tailing the hedge, and delivery options.
- Options offer a corporation the opportunity to hedge its downside risk without giving up its upside potential. However, this comes at a cost in the form of the premium paid for the option. Swap contracts are longer-term hedging instruments that allow corporations to change the characteristics of their periodic cash flows.
- In some cases, a corporation may not be able to hedge its risk exposure using off-the-shelf forwards, futures, options, or swaps. In these cases, the corporation may turn to financial engineering in an effort to create a specialized financial instrument that will hedge the exposure.

INTERNET RESOURCES

Note: *For updates to links, please go to the book's website at http://smart.swcollege.com.*

http://www.cbot.com—Website of Chicago Board of Trade (CBOT), the oldest major futures exchange, which lists futures contracts for both commodities (corn, wheat, soybeans, gold) and financial instruments (2-, 5-, 10-, and 30-year Treasury bonds, Eurodollars); the CBOT and its Chicago rival, the Chicago Mercantile Exchange (http://www.cme.com), have retained face-to-face, open-outcry trading in futures "pits," whereas most international futures exchanges are purely electronic markets.

http://www.liffe.com—Website of the London International Financial Futures and Options Exchange (LIFFE), until recently the leading international futures market; remains an important market for trading global interest rate, equity, swap, and commodity contracts; acquired by Euronext during 2002 and now officially called Euronext-LIFFE.

http://www.eurexchange.com—Website of the Eurex futures exchange, which began in December 1996 as a joint venture between the Swiss Exchange and the Deutsche

Börse and within an amazingly short period of time emerged as the leading international futures market; among its more successful products are the German government Bund contract and options on several European stock indexes; Eurex has established a reputation as the world's most technologically advanced futures market.

KEY TERMS

arbitrage
basis risk
closing futures price
cross-hedging
currency forward contracts
currency swap
economic exposure
financial engineering
fixed-for-floating currency swap
fixed-for-floating interest rate swap
forward price
forward rate
forward rate agreement (FRA)
fungibility
futures contract
initial margin
interest differential
interest rate caps
interest rate collar
interest rate floor
interest rate risk
interest rate swap
lifetime high price
lifetime low price
long position
maintenance margin
margin account
marking-to-market
notional principal
open interest
opening futures price
risk management
settlement date
settlement price
short position
speculating
spot price
spot rates
swap contract
ailing the hedge
transaction exposure

QUESTIONS

27-1. Historically, what types of risk were the focus of most firms' risk-management practices?

27-2. Distinguish between the motivations for purchasing insurance and the motivations for hedging marketwide sources of risk.

27-3. Distinguish between transaction exposure and economic exposure.

27-4. In what way can hedging reduce the risk of financial distress? How might reducing the risk of financial distress increase firm value?

27-5. Explain how hedging can reduce a firm's tax liability.

27-6. Why do closely held firms tend to hedge more than firms with diffuse ownership?

27-7. How can hedging make it easier to evaluate a manager's performance?

27-8. What are the advantages of using exchange-traded derivatives to hedge a risk exposure? What are the advantages of over-the-counter derivatives?

27-9. Conceptually, how do we determine the fair forward price for an asset? What are the necessary assumptions to arrive at a fair forward price?

27-10. Conceptually, what are the differences between Equations 27.1, 27.2, and 27.3? Which equation would you use to determine the fair forward price for an asset that does not earn any income but is costly to store, such as gold or silver? How would you modify the equation?

27-11. Describe the features of a futures contract that make it more liquid than a forward contract.

27-12. Explain the features of a futures contract that make it have less credit risk than a forward contract.

27-13. Why is fungibility an important feature of futures contracts?

27-14. Describe the delivery process for futures contracts. Why does delivery rarely take place in futures contracts?

27-15. Why is a call option on an interest rate called an interest rate cap and a put option called an interest rate floor?

27-16. Explain how a fixed-for-floating swap can be considered a portfolio of forward contracts on 6-month discount bonds.

27-17. Go to the CBOT website (http://www.cbot.com), and determine the contract specifications for soybean meal futures and 10-year U.S. Treasury note futures. Apart from the difference in the type of asset, what is the difference between the two contracts in terms of what qualifies as deliverable grades?

27-18. Go to the CBOT website (http://www.cbot.com), and determine the minimum initial margin requirements for speculators in the contracts traded on that exchange. Which contracts have the smallest margin requirements? Which contracts have the largest requirements? Why do you suppose these contracts have such different margin requirements?

PROBLEMS

Forward Contracts

27-1. Suppose that an investor has agreed to pay $94,339.62 for a 1-year discount bond in one year. Two years from now, the investor will receive the bond's face value of $100,000. The current effective annual risk-free rate of interest is 5.8 percent, and the current spot price for a 2-year discount bond is $88,999.64. Has the investor agreed to pay too much or too little? How might an arbitrageur capitalize on this opportunity?

SMART SOLUTIONS
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SMARTFinance

27-2. Company A's stock will pay a dividend of $5 in three months and $6 in six months. The current stock price is $200, and the risk-free rate of interest is 7 percent per year with monthly compounding for all maturities. What is the fair forward price for a 7-month forward contract?

27-3. The current price of gold is $500 per troy ounce. The cost of storing gold is $0.03/oz per month. Assuming an annual risk-free rate of interest of 6 percent compounded monthly, what is the approximate futures price of gold for delivery in four months?

27-4. A certain commodity sells for $150 today. The present value of the cost of storing this commodity for one year is $10. The risk-free rate is 4 percent. What is a fair price for a one-year forward contract on this asset?

27-5. Following is the current yield to maturity on Treasury bills of various maturities:

Time to Maturity (months)	Yield (%)
1	5.0
3	5.2
6	5.4
9	5.8

Assuming monthly compounding, what should the forward interest rate of a 3-month T-bill be if it is to be delivered at the end of three months? What if it is to be delivered at the end of six months?

27-6. Using the information in Table 27.1, determine whether the 3-month forward rate on Swiss francs is fair if the annualized yield for risk-free borrowing over the next three months is 8 percent in Switzerland and 5 percent in the United States. If the price is not fair, how could you capitalize on the arbitrage opportunity? What is the potential profit? Assume monthly compounding for borrowing and lending.

27-7. The spot exchange rate is \$1.6666/£. The risk-free rate is 4 percent in the United States and 6 percent in the U.K. What is the forward exchange rate (assume a 1-year contract)?

27-8. A U.S. automobile importer is expecting a shipment of custom-made cars from Britain in six months. Upon delivery, the importer will pay for the cars in pounds. Using the information in Table 27.1, suggest a hedging strategy for the importer. Explain the consequences for the spot market transaction and the forward market transaction if the \$/£ spot exchange rate increases by 10 percent over the next six months.

27-9. Suppose that KF Exports enters into an FRA with Interfirst Bank with a notional principal of \$50 million and the following terms: In six months, if LIBOR is above 6 percent, KF will pay Interfirst according to the standard FRA formula. On the other hand, if LIBOR is less than 6 percent, Interfirst will pay KF. If LIBOR is 5.5 percent in six months, who pays and how much will the company pay? What if LIBOR is 6.5 percent?

Futures Contracts

27-10. An investor purchases one gold futures contract for delivery in June 2006. Using the information in Table 27.2, determine the settle price for the contract on Monday, December 19, 2005, according to the Tuesday, December 20, 2005, *Wall Street Journal*.

What is the total futures price for the contract? If the settle price on the next trading day is \$516.50/oz, will the investor have money deposited into his margin account or withdrawn? How much? Suppose that the investor eventually closes out the position by selling at a price of \$518.30/oz. How much is his profit or loss?

27-11. Consider the following scenarios, determine how to hedge each scenario using bond futures, and comment on whether it would be appropriate to hedge the exposure.

a. A bond portfolio manager will be paid a large bonus if her \$10 million portfolio earns 6 percent in the current fiscal year. She has done very well through the first nine months. However, she is concerned that interest rates might increase over the next few months.

b. The manager of a company is selling one of its warehouses. The deal will close in two months. The manager plans to buy 6-month Treasury bills when the company receives payment for the warehouse space, but the manager is worried that interest rates might decline in the next two months.

c. Sam Blackwell plans to retire in a year. Upon retirement, he will be paid a lump sum based on the value of the securities in his defined-contribution retirement plan. Sam's portfolio consists largely of Treasury bonds, and he is worried that interest rates will be increasing in the coming year.

Options and Swaps

27-12. Chipman Products Company will suffer an increase in borrowing costs if the 13-week Treasury bill rate increases in the next six months. Chipman Products is willing to accept the risk of small changes in the 13-week T-bill rate but wishes to avoid the potential losses associated with large changes. The company plans to hedge its risk exposure using an interest rate collar. If the company buys a call option on the 13-week T-bill rate with a strike price of 60 and sells a put option with a strike price of 50, describe how this strategy will limit the company's exposure to changes in the T-bill rate. The premium on the call is 0.75, and the premium on the put is 0.85. What is the company's profit (or loss) in the option market if the T-bill rate is 4.5 percent in five months? If the T-bill rate is 5.5 percent? If the T-bill rate is 6.5 percent?

27-13. Go to the CBOT website (http://www.cbot.com), and determine the contract specifications for Dow Jones Industrial Average futures. Determine the current futures price for the next available contract month. What would your profit or loss be if you bought one contract today and the Dow Jones Industrial Average increased by 100 points before the last settlement date?

27-14. Company A is based in Switzerland and would like to borrow \$10 million at a fixed rate of interest. Because the company is not well known, however, it has not been able to find a willing U.S. lender. However, the company can borrow SF17,825,000 at 11 percent per year for five years. Company B is based in the United States and would like to borrow SF17,825,000 for five years at a fixed rate of interest. It has not been able to find a Swiss lender. However, it has been offered a loan of \$10 million at 9 percent per year. Five-year government bonds are yielding 9.5 percent and 8.5 percent in Switzerland and the United States, respectively. Suggest a currency swap that would net the financial intermediary 0.5 percent per year. Be sure to consider default risk in your analysis.

27-15. Citibank and ABM Company enter into a 5-year interest rate swap with a notional principal of \$100 million and the following terms: Every year for the next five years, ABM agrees to pay Citibank 6 percent and receive from Citibank LIBOR. Using the following information about LIBOR at the end of each of the next five years, determine the cash flows in the swap.

Year	LIBOR (%)
1	5.0
2	5.5
3	6.2
4	6.0
5	6.4

27-16. Based on the type of swap ABM entered into in the previous problem, what type of liabilities do you think ABM has? Long-term or short-term?