WEB CHAPTER

4 Financial Derivatives

Learning Objectives

- Define a hedge, a long position, and a short position.
- Define a forward contract, and summarize its advantages and disadvantages.
- Summarize the differences between a forward contract and a financial futures contract.
- Identify the different types of options contracts, and summarize the three conclusions regarding call and put options.
- Define a swap, and summarize the advantages and disadvantages of interest-rate swaps.
- Summarize the three types of credit derivatives.

Preview

Starting in the 1970s, and increasingly in the 1980s and 1990s, the world became a riskier place for the financial institutions described in this part of the book. Swings in interest rates widened, and the bond and stock markets went through some episodes of increased volatility. As a result of these developments, managers of financial institutions became more concerned with reducing the risk their institutions faced. Given the greater demand for risk reduction, the process of financial innovation described in Chapter 11 came to the rescue by producing new financial instruments to help financial institution managers better manage risk. These instruments, called **financial derivatives**, have payoffs that are linked to previously issued securities and are extremely useful risk reduction tools.

In this chapter, we look at the most important financial derivatives that managers of financial institutions use to reduce risk: forward contracts, financial futures, options, and swaps. We examine not only how the markets for each of these financial derivatives work but also how they can be used by financial institutions to manage risk. We also study financial derivatives because they have become an important source of profits for financial institutions, particularly larger banks, which, as we saw in Chapter 11, have found their traditional business declining.

HEDGING

Financial derivatives are so effective at reducing risk because they enable financial institutions to **hedge**—that is, to engage in a financial transaction that reduces or eliminates risk. When a financial institution has bought an asset, it is said to have taken a **long position**, and this exposes the institution to risk if the returns on the asset are uncertain. Conversely, if it has sold an asset that it has agreed to deliver to another party at a future date, it is said to have taken a **short position**, and this can also expose the institution to risk. Financial derivatives can be used to reduce risk by invoking the following basic principle of hedging: ***Hedging risk involves engaging in a financial transaction that offsets a long position by taking an additional short position, or offsets a short position by taking an additional long position.*** In other words, if a financial institution has *bought* a security and has therefore taken a long position, it conducts a hedge by contracting to *sell* that security (take a short position) at some future date. Alternatively, if it has taken a short position by *selling* a security that it needs to deliver at a future date, then it conducts a hedge by contracting to *buy* that security (take a long position) at a future date. We look at how this principle can be applied using forward and futures contracts.

INTEREST-RATE FORWARD CONTRACTS

A **forward contract** is an agreement between two parties to engage in a financial transaction at a future (forward) point in time. Here we focus on forward contracts that are linked to debt instruments, called **interest-rate forward contracts**; later in the chapter, we discuss forward contracts for foreign currencies.

Interest-rate forward contracts involve the future sale (or purchase) of a debt instrument and have several dimensions: (1) specification of the actual debt instrument that will be delivered at a future date, (2) the amount of the debt instrument to be delivered, (3) the price (or interest rate) to be paid on the debt instrument when it is delivered, and (4) the date on which delivery will take place. An example of an interest-rate forward contract might be an agreement that the First National Bank will sell to the Rock Solid Insurance Company, one year from today, $5 million face value of the 6s of 2035 Treasury bonds (that is, coupon bonds with a 6% coupon rate that mature in 2035) at a price that yields the same interest rate on these bonds as today's rate—say, 6%. Because Rock Solid will buy the securities at a future date, it is said to have taken a long position, whereas the First National Bank, which will sell the securities on that date, has taken a short position.

APPLICATION Hedging with Interest-Rate Forward Contracts

Why would the First National Bank want to enter into this forward contract with Rock Solid Insurance Company in the first place?

To understand, suppose that you are the manager of the First National Bank and that you have bought $5 million of the 6s of 2035 Treasury bonds. The bonds are currently selling at par value, so their yield to maturity is 6%. Because these are long-term bonds, you recognize that you are exposed to substantial interest-rate risk: If interest rates rise in the future, the price of these bonds will fall, resulting in a substantial capital loss that may cost you your job. How do you hedge this risk?

Knowing the basic principle of hedging, you see that your long position in these bonds can be offset by an equal short position for the same bonds with a forward contract. That is, you need to contract to sell these bonds at a future date at the current par value price. To ensure that this happens, you form an agreement with another party—in this case, Rock Solid Insurance Company—in which you promise to sell to Rock Solid the $5 million of the 6s of 2035 Treasury bonds at par one year from today. By entering into this forward contract, you have successfully hedged against interest-rate risk. By locking in the future price of the bonds, you have eliminated the price risk that you face from uncertain interest-rate changes.

Why would Rock Solid Insurance Company want to enter into the forward contract with the First National Bank? Rock Solid expects to receive premiums of $5 million in one year's time that it will want to invest in the 6s of 2035, but worries that interest rates on these bonds will decline between now and next year. By using the forward contract, it is able to lock in the 6% interest rate on the Treasury bonds that it will buy from the First National Bank.

Pros and Cons of Forward Contracts

The advantage of forward contracts is that they can be as flexible as the parties involved want them to be. This means that an institution like the First National Bank may be able to hedge completely the interest-rate risk on the exact security it is holding in its portfolio, just as it did in our example.

However, forward contracts suffer from two problems that severely limit their usefulness. The first is that it may be very hard for an institution like the First National Bank to find another party (called a *counterparty*) to make the contract with. There are brokers to facilitate the matching up of parties like the First National Bank and the Rock Solid Insurance Company, but few institutions may want to engage in a forward contract specifically for the 6s of 2035. This means that it may prove impossible to find a counterparty when a financial institution (like the First National Bank) wants to make a specific type of forward contract. Furthermore, even if the First National Bank finds a counterparty, it may not get the price it was hoping for because, if the counterparty is not willing to pay the asking price, there may not be anyone else available to make the deal with. A serious problem for the market in interest-rate forward contracts, then, is that it can be difficult for one party to find another party with which to make a particular financial agreement; even if a willing party is found, the transaction may have to be made at a disadvantageous price. In the parlance of financial economists, this market suffers from a *lack of liquidity*. (Note that this use of the term *liquidity,* in which it is applied to a market, is somewhat broader than its use when it is applied to an asset. For an asset, liquidity refers to the ease with which the asset can be turned into cash; for a market, liquidity refers to the ease of carrying out financial transactions.)

The second problem with forward contracts is that they are subject to default risk. Suppose that in one year's time, interest rates rise, and so the price of the 6s of 2035 falls. The Rock Solid Insurance Company might then decide that it would like to default on the forward contract with the First National Bank, because it can now buy the bonds at the lower price. Or perhaps Rock Solid may not have been rock solid after all, and may have gone bust during the year, and therefore is no longer available to complete the terms of the forward contract. Because no outside organization is guaranteeing the contract, the only recourse is for the First National Bank to go to the courts to sue Rock Solid, but this process will be costly. Furthermore, if Rock Solid is already bankrupt, the First National Bank will suffer a loss; the bank can no longer sell the 6s of 2035 at the price it had agreed on with Rock Solid, but instead will have to sell at a price well below that, because the price of these bonds has fallen.

The presence of default risk in forward contracts means that parties to these contracts must check that the counterparty is both financially sound and likely to live up to its contractual obligations. Because this type of investigation is costly, and because all the adverse selection and moral hazard problems discussed in earlier chapters apply, default risk is a major barrier to the use of interest-rate forward contracts. If we consider the dual problems of default risk and lack of liquidity, we see that forward contracts may be of limited usefulness to financial institutions. Although a market does exist for interest-rate forward contracts, particularly in Treasury and mortgage-backed securities, it is not nearly as large as the financial futures market, to which we turn next. ◆

FINANCIAL FUTURES CONTRACTS AND MARKETS

Given the default risk and liquidity problems inherent in the interest-rate forward market, another solution to hedging interest-rate risk was needed. The solution was provided by the Chicago Board of Trade when it began developing financial futures contracts in 1975.

A **financial futures contract** is similar to an interest-rate forward contract in that it specifies that a financial instrument must be delivered by one party to another on a stated future date. However, it differs from an interest-rate forward contract in several ways, and these differences help overcome some of the liquidity and default problems of forward markets.

To understand what financial futures contracts are all about, let's look at one of the most widely traded futures contracts—that for Treasury bonds, which are traded on the Chicago Board of Trade. The contract value is for $100,000 face value of bonds. Prices are quoted in points, with each point equal to $1,000, and the smallest change in price is 1/32 of a point ($31.25). This contract specifies that the bonds to be delivered must have at least fifteen years to maturity at the delivery date (and also must not be *callable*—that is, redeemable by the Treasury at its option—in less than fifteen years). If the Treasury bonds delivered to settle the futures contract have a coupon rate different from the (for example) 6% specified in the futures contract, the amount of bonds to be delivered is adjusted to reflect the difference in value between the delivered bonds and the 6% coupon bond. In line with the terminology used for forward contracts, parties who have bought a futures contract and thereby have agreed to buy (take delivery of) the bonds are said to have taken a *long position*, and parties who have sold a futures contract and thereby have agreed to sell (deliver) the bonds have taken a *short position*.

To make our understanding of this type of contract more concrete, let's consider what happens when you buy or sell a Treasury bond futures contract. Let's say that on February 1, you sell one $100,000 June contract at a price of 115 (that is, $115,000). By selling this contract, you agree to deliver $100,000 face value of the long-term Treasury bonds to the contract's counterparty at the end of June for $115,000. By buying the contract at a price of 115, the buyer has agreed to pay $115,000 for the $100,000 face value of bonds when you deliver them at the end of June. If interest rates on long-term bonds rise, so that when the contract matures at the end of June, the price of these bonds has fallen to 110 ($110,000 per $100,000 of face value), the buyer of the contract will have lost $5,000, because he or she paid $115,000 for the bonds but can sell them only for the market price of $110,000. But you, the seller of the contract, will have gained $5,000, because you can now sell the bonds to the buyer for $115,000 even though you have to pay only $110,000 for them in the market.

It is even easier to describe what happens to the parties who have purchased futures contracts and those who have sold futures contracts if we recognize the following fact: ***At the expiration date of a futures contract, the price of the contract converges to the price of the underlying asset to be delivered.*** To see why this is the case, consider what happens on the expiration date of the contract at the end of June when the price of the underlying $100,000 face value Treasury bond is 110 ($110,000). If the futures contract is selling below 110—say, at 109—a trader can buy the contract for $109,000, take delivery of the bond, and immediately sell it for $110,000, thereby earning a quick profit of $1,000. Because earning this profit involves no risk, it is a great deal that everyone would like to get in on. That means that everyone will try to buy the contract, and as a result, its price will rise. Only when the price rises to 110 will the profit opportunity cease to exist and the buying pressure disappear. Conversely, if the price of the futures contract is above 110—say, at 111—everyone will want to sell the contract. Now the sellers get $111,000 from selling the futures contract but have to pay only $110,000 for the Treasury bonds that they must deliver to the buyer of the contract, and the $1,000 difference is their profit. Because this profit involves no risk, traders will continue to sell the futures contract until its price falls back down to 110, at which price there are no longer any profits to be made. The elimination of riskless profit opportunities in the futures market is referred to as **arbitrage**, and it guarantees that the price of a futures contract at expiration equals the price of the underlying asset to be delivered.[1]

Armed with our knowledge that a futures contract at expiration equals the price of the underlying asset, we can see even more easily who profits and who loses from such a contract when interest rates change. If interest rates have risen, so that the price of the Treasury bond is 110 on the expiration day at the end of June, the June Treasury bond futures contract will also have a price of 110. Thus, if you bought the contract for 115 in February, you have suffered a loss of 5 points, or $5,000 (5% of $100,000). But if you sold the futures contract at 115 in February, the decline in price to 110 means that you have gained a profit of 5 points, or $5,000.

APPLICATION Hedging with Financial Futures

The First National Bank can also use financial futures contracts to hedge the interest-rate risk on its holdings of $5 million of the 6s of 2035. To see how, suppose that in March 2016, the 6s of 2035 are the long-term bonds that will be delivered in the Chicago Board of Trade's T-bond futures contract expiring one year in the future, in March 2017. Also suppose that the interest rate on these bonds is expected to remain at 6% over the next year, so that both the 6s of 2035 and the futures contract are selling at par (i.e., the $5 million of bonds is selling for $5 million and the $100,000 futures contract is selling for $100,000). The basic principle of hedging indicates that you, as the manager of the First National Bank, need to offset the long position in these bonds with a short position, so you have to sell the futures contract. But how many contracts should you sell? The number of contracts required to hedge the interest-rate risk is found by dividing the amount of the asset to be hedged by the dollar value of each contract, as shown in Equation 1:

$$NC = VA/VC \tag{1}$$

where NC = number of contracts for the hedge
VA = value of the asset
VC = value of each contract

Given that the 6s of 2035 are the long-term bonds that will be delivered in the CBT T-bond futures contract expiring one year in the future and that the interest rate on these bonds is expected to remain at 6% over the next year, so that both the 6s of 2035 and the futures contract are selling at par, how many contracts must First National sell

[1]In actuality, futures contracts sometimes set conditions for the timing and delivery of the underlying assets that cause the price of the contract at expiration to differ slightly from the price of the underlying assets. Because the difference in price is extremely small, we ignore it in this chapter.

to remove its interest-rate risk exposure from its $5 million holdings of the 6s of 2035?[2] Since $VA = \$5$ million and $VC = \$100{,}000$,

$$NC = \$5 \text{ million}/\$100{,}000 = 50$$

You therefore hedge the interest-rate risk by selling 50 of the Treasury Bond futures contracts.

Now suppose that over the next year, an increased threat of inflation causes interest rates to increase to 8%. The value of the 6s of 2035 that the First National Bank is holding will then fall to $4,039,640 in March 2017.[3] Thus the loss from the long position in these bonds is $960,360:

Value on March 2017 @ 8% interest rate	$4,039,640
Value on March 2016 @ 6% interest rate	−$5,000,000
Loss	−$960,360

However, the short position in the 50 futures contracts that obligate you to deliver $5 million of the 6s of 2035 on March 2017 has a value equal to $4,039,640, the value of the $5 million of bonds after the interest rate has risen to 8%, as we saw before. Yet when you sold the futures contract, the buyer was obligated to pay you $5 million on the maturity date. Thus the gain from the short position on these contracts is also $960,360:

Amount paid to you on March 2017, agreed upon in March 2016	$5,000,000
Value of bonds delivered on March 2017 @ 8% interest rate	−$4,039,640
Gain	$960,360

Therefore, the net gain for the First National Bank is zero, indicating that the hedge has been conducted successfully.

The hedge just described is called a **micro hedge** because the financial institution is hedging the interest-rate risk for a specific asset it is holding. A second type of hedge that financial institutions engage in is called a **macro hedge**, in which the hedge is for the institution's entire portfolio. For example, if a bank has more rate-sensitive liabilities than assets, we learned in Chapter 9 that a rise in interest rates will cause the value of the bank's net worth to decline. By selling interest-rate futures contracts that will yield a profit when interest rates rise, the bank can offset the losses on its overall portfolio from an interest-rate rise and thereby hedge its interest-rate risk.

[2]In the real world, designing a hedge is somewhat more complicated than indicated by the example here, because the bond that is most likely to be delivered might not be a 6s of 2035.

[3]The value of the bonds can be calculated using a financial calculator as follows: $FV = \$5{,}000{,}000$, $PMT = \$300{,}000$, $I = 8\%$, $N = 19$, $PV = \$4{,}039{,}640$.

TABLE 1 Widely Traded Financial Futures Contracts in the United States

Type of Contract	Contract Size	Open Interest, August 2014
Interest-Rate Contracts		
Treasury bonds	$100,000	984,935
Treasury notes	$100,000	2,753,371
Five-year Treasury notes	$100,000	2,192,905
Two-year Treasury notes	$200,000	1,377,298
Thirty-day Fed funds rate	$5 million	544,115
Eurodollar	$4 million	12,988,737
Stock Index Contracts		
Standard & Poor's 500 Index	$250 × index	164,586
Standard & Poor's MIDCAP 400	$500 × index	835
NASDAQ 100	$100 × index	7,001
Nikkei 225 Stock Average	$5 × index	62,676
Currency Contracts		
Yen	12,500,000 yen	226,449
Euro	125,000 euros	413,159
Canadian dollar	100,000 Canadian $	110,965
British pound	100,000 pounds	234,219
Swiss franc	125,000 francs	57,511
Mexican peso	500,000 new pesos	147,059

Source: *CME Group:* http://www.cmegroup.com/market-data/volume-open-interest; click on CME Group Open Interest Report.

Organization of Trading in Financial Futures Markets

Financial futures contracts are traded in the United States on organized exchanges such as the Chicago Board of Trade and the Chicago Mercantile Exchange. The futures exchanges and all trades in financial futures in the United States are regulated by the Commodity Futures Trading Commission (CFTC), which was created in 1974 to take over the regulatory responsibilities for futures markets from the Department of Agriculture. The CFTC oversees futures trading and the futures exchanges to ensure that prices in the market are not being manipulated, and it also registers and audits the brokers, traders, and exchanges to prevent fraud and to ensure the financial soundness of the exchanges. In addition, the CFTC approves proposed futures contracts to make sure that they serve the public interest. Table 1 lists the most widely traded financial futures contracts in the United States, along with their contract size and the number of contracts outstanding, called **open interest**, for August 2014.

Given the globalization of other financial markets in recent years, it is not surprising that increased competition from abroad has been occurring in financial futures markets as well.

The Globalization of Financial Futures Markets

Because the United States was the first country to develop financial futures, American futures exchanges dominated the trading of financial futures in the early 1980s. For example, in 1985, all of the top ten futures contracts were traded on exchanges in the United States. With the rapid growth of financial futures markets and the high profits made by the American futures exchanges, foreign exchanges saw a profit opportunity and began to enter this business. By the 1990s, Eurodollar contracts traded on the London International Financial Futures Exchange, Japanese government bond contracts and Euroyen contracts traded on the Tokyo Stock Exchange, French government bond contracts traded on the Marché à Terme International de France (now Euronext), and Nikkei 225 contracts traded on the Osaka Securities Exchange all were among the most widely traded futures contracts in the world.

Foreign competition has spurred knockoffs of the most popular financial futures contracts initially developed in the United States. These contracts, which are traded on foreign exchanges, are virtually identical to those traded in the United States and have the advantage that they can be traded when the American exchanges are closed. The movement to 24-hour-a-day trading in financial futures has been further stimulated by the development of the Globex electronic trading platform, which allows traders throughout the world to trade futures even when the exchanges are not officially open. Financial futures trading thus has become completely internationalized, and competition between U.S. and foreign exchanges is now intense.

Explaining the Success of Futures Markets

The tremendous success of the financial futures market in Treasury bonds alone is evident from the fact that the total open interest of Treasury bond contracts was 984,935 in August 2014, for a total value of $98 billion (984,935 × $100,000). There are several differences between financial futures contracts and forward contracts, and between the organizations of their markets, that help explain why financial futures markets such as those for Treasury bonds have been so successful.

Futures contracts were designed to overcome the liquidity problem inherent in forward contracts. They do this in several ways. First, in contrast to forward contracts, the quantities delivered and the delivery dates of futures contracts are standardized, making it more likely that different parties can be matched in the futures market, thereby increasing the liquidity of the market. In the case of the Treasury bond contract, the quantity delivered is $100,000 face value of bonds, and the delivery dates are set to be the last business days of March, June, September, and December. Second, after the futures contract has been bought or sold, it can be traded (bought or sold) again at any time up until the delivery date. In contrast, once a forward contract is agreed on, it typically cannot be traded. Third, in a futures contract, not just one specific type of Treasury bond is deliverable on the delivery date, as is the case in a forward contract. Instead, any Treasury bond that matures in more than fifteen years and is not callable for fifteen years is eligible for delivery. Allowances for continual trading increase the liquidity of the futures market, as does the option to deliver a range of Treasury bonds rather than one specific type of bond.

Another reason why futures contracts specify that more than one bond is eligible for delivery is to limit the possibility that someone might corner the market and "squeeze" traders who have sold contracts. To corner the market, someone buys up all the deliverable securities so that investors with a short position cannot obtain from anyone else the securities that they contractually must deliver on the delivery date. As a result, the person who has cornered the market can set exorbitant prices for the securities that investors with a short position must buy to fulfill their obligations under the futures contract. The person who has cornered the market makes a fortune, but investors with a short position take a terrific loss. Clearly, the possibility that corners might occur in the market will discourage people from taking a short position and might therefore decrease the size of the market. By allowing for the delivery of many different securities, the futures contract makes it harder for any one party to corner the market, because a much larger amount of securities would have to be purchased to establish the corner. Corners are of concern to both regulators and the organized exchanges that design futures contracts.

Trading in the futures market has been organized differently from trading in forward markets to overcome the default risk problems inherent in forward contracts. In both types of markets, for every contract, there must be a buyer who is taking a long position and a seller who is taking a short position. However, the buyer and seller of a futures contract make their contract not with each other but with the clearinghouse associated with the futures exchange. This setup means that, in contrast to the forward market, the buyer of the futures contract does not need to worry about the financial health or trustworthiness of the seller, and vice versa. As long as the clearinghouse is financially solid, buyers and sellers of futures contracts do not have to worry about default risk.

To make sure that the clearinghouse is financially sound and does not run into financial difficulties that might jeopardize its contracts, buyers or sellers of futures contracts must put an initial deposit, called a **margin requirement**, of perhaps \$2,000 per Treasury bond contract into a margin account kept at their brokerage firm. Futures contracts are then **marked to market** every day: At the end of every trading day, the change in the value of the futures contract is added to or subtracted from the margin account. Suppose that after you buy a Treasury bond contract at a price of 115 on Wednesday morning, its closing price at the end of the day, the *settlement price*, falls to 114. You now have a loss of 1 point, or \$1,000, on the contract, and the seller who sold you the contract has a gain of 1 point, or \$1,000. The \$1,000 gain is added to the seller's margin account, making a total of \$3,000 in that account, and the \$1,000 loss is subtracted from your account, so that you now have only \$1,000 in your account. If the amount in this margin account falls below the maintenance margin requirement (which can be the same as the initial requirement, but is usually a little less), the trader is required to add money to the account. For example, if the maintenance margin requirement is also \$2,000, you will have to add \$1,000 to your account to bring it up to \$2,000. Margin requirements and marking to market make it far less likely that a trader will default on a contract, thus protecting the futures exchange from losses.

A final advantage that futures markets have over forward markets is that most futures contracts do not end in delivery of the underlying asset on the expiration date, whereas forward contracts do. A trader who sold a futures contract is allowed to avoid delivery on the expiration date by making an offsetting purchase of a futures contract. Because the simultaneous holding of the long and short positions means that the trader would in effect be delivering the bonds to itself, under the exchange rules the trader is allowed to cancel both contracts. Allowing traders to cancel their contracts in this way lowers the cost of conducting trades in the futures market relative to the forward market: a futures trader can avoid the costs of physical delivery, something that is not so easy to do with forward contracts.

APPLICATION Hedging Foreign Exchange Risk

As we discussed in Chapter 1, foreign exchange rates have been highly volatile in recent years. The large fluctuations in exchange rates subject financial institutions and other businesses to significant foreign exchange risk because such fluctuations generate substantial gains and losses. Luckily for financial institution managers, the financial derivatives discussed in this chapter—forward and financial futures contracts—can be used to hedge foreign exchange risk.

To understand how financial institution managers manage foreign exchange risk, let's suppose that in January, the First National Bank's customer Frivolous Luxuries, Inc., is due a payment of 10 million euros in two months for $10 million worth of goods it has just sold in Germany. Frivolous Luxuries is concerned that if the value of the euro falls substantially from its current value of $1, the company might suffer a large loss because the 10 million euro payment will no longer be worth $10 million. So Sam, the CEO of Frivolous Luxuries, calls his friend Mona, the manager of the First National Bank, and asks her to hedge this foreign exchange risk for his company. Let's see how the bank manager could do this by using either forward or financial futures contracts.

Hedging Foreign Exchange Risk with Forward Contracts

Forward markets in foreign exchange have been highly developed by commercial banks and investment banking operations that engage in extensive foreign exchange trading and are widely used to hedge foreign exchange risk. Mona knows that she can use this market to hedge the foreign exchange risk for Frivolous Luxuries. Such a hedge is quite straightforward for her to execute. Because the payment of euros in two months means that Sam will hold a long position in euros at that time, Mona knows that the basic principle of hedging indicates that she should offset this long position by a short position. Thus she simply enters a forward contract that obligates her to sell 10 million euros two months from now in exchange for dollars at the current forward rate of $1 per euro.[4]

In two months, when her customer receives the 10 million euros, the forward contract ensures that they will be exchanged for dollars at an exchange rate of $1 per euro, thus yielding $10 million. No matter what happens to future exchange rates, Frivolous Luxuries will be guaranteed $10 million for the goods it sold in Germany. Mona calls her friend Sam to let him know that his company is now protected from any foreign exchange movements, and he thanks her for her help.

Hedging Foreign Exchange Risk with Futures Contracts

As an alternative, Mona can use the currency futures market to hedge the foreign exchange risk. In this case, she will do some research and find that the Chicago Mercantile Exchange has a euro contract with a contract amount of 125,000 euros and a price of $1 per euro. To conduct the hedge, Mona must sell euros as with the forward

[4]The forward exchange rate will probably differ slightly from the current spot rate of $1 per euro because the interest rates in Germany and the United States probably will not be equal. In that case, as we will see from the interest parity condition in the Chapter 17 Appendix, the future expected exchange rate will not equal the current spot rate, and neither will the forward rate. However, since interest differentials have typically been less than 6% at an annual rate (1% bimonthly), the expected appreciation or depreciation of the euro over a two-month period has always been less than 1%. Thus the forward rate is always close to the current spot rate, and our assumption in the example that the forward rate and the spot rate are the same is a reasonable one.

contract, to the tune of 10 million euros of the March futures. How many of the Chicago Mercantile Exchange March euro contracts must Mona sell to hedge the 10 million euro payment due in March?

Using Equation 1 with $VA = 10$ million euros and $VC = 125{,}000$ euros, we get:

$$NC = 10 \text{ million}/125{,}000 = 80$$

Thus Mona conducts the hedge by selling 80 of the CME euro contracts. Given the \$1-per-euro price, the sale of the contract yields $80 \times 125{,}000$ euros = \$10 million. This futures hedge enables her to lock in the exchange rate for Frivolous Luxuries so that it gets its payment of \$10 million.

One advantage of using the futures market is that the contract size of 125,000 euros, worth \$125,000, is quite a bit smaller than the minimum size of a forward contract, which is usually \$1 million or more. However, in this case, the bank manager is making a large enough transaction that she can use either the forward or the futures market. Her choice depends on whether the transaction costs are lower in one market than in the other. If the First National Bank is active in the forward market, that market would probably have the lower transaction costs. If First National rarely deals in foreign exchange forward contracts, Mona might do better by sticking with the futures market. ◆

OPTIONS

Another vehicle for hedging interest-rate and stock market risk involves the use of *options* on financial instruments. **Options** are contracts that give the purchaser the option, or *right*, to buy or sell the underlying financial instrument at a specified price, called the **exercise price** or **strike price**, within a specific period of time (the *term to expiration*). The seller (sometimes called the *writer*) of the option is *obligated* to buy or sell the financial instrument from or to the purchaser if the owner of the option exercises the right to sell or buy. These option contract features are important enough to be emphasized: The *owner* or buyer of an option does not *have* to exercise the option; he or she can let the option expire without using it. Hence the owner of an option is not obligated to take any action, but rather has the *right* to exercise the contract if he or she so chooses. The seller of an option, by contrast, has no choice in the matter; he or she *must* buy or sell the financial instrument if the owner exercises the option.

Because the right to buy or sell a financial instrument at a specified price has value, the owner of an option is willing to pay an amount, called a **premium**, for this right. Option contracts are of two types: **American options** can be exercised *at any time up to* the expiration date of the contract, and **European options** can be exercised only *on* the expiration date.

Option contracts are written on a number of financial instruments. Options on individual stocks are called **stock options**, and such options have existed for a long time. Option contracts on financial futures, called **financial futures options** or, more commonly, **futures options**, were developed in 1982 and have become the most widely traded option contracts.

You might wonder why option contracts are more likely to be written on financial futures than on underlying debt instruments such as bonds or certificates of deposit. As we saw earlier in the chapter, on the expiration date, the price of the futures contract and that of the deliverable debt instrument will be the same because of arbitrage. So it would seem that investors should be indifferent about having the option written on the debt instrument or on the futures contract. However, financial futures contracts have been so well designed that their markets are often more liquid than the markets in the underlying debt instruments. So investors would rather have the option contract written on the more liquid instrument—in this case, the futures contract. This explains why the most popular futures options are written on many of the same futures contracts listed in Table 1.

The regulation of options markets is split between the Securities and Exchange Commission (SEC), which regulates stock options, and the Commodity Futures Trading Commission (CFTC), which regulates futures options. Regulation focuses on ensuring that writers of options have enough capital to make good on their contractual obligations and on overseeing traders and exchanges to prevent fraud and to ensure that the market is not being manipulated.

Option Contracts

A **call option** is a contract that gives the owner the right to buy a financial instrument at the exercise price within a specific period of time. A **put option** is a contract that gives the owner the right to sell a financial instrument at the exercise price within a specific period of time.

Remembering which option is a call option and which is a put option is not always easy. To keep them straight, just remember that having a *call* option to buy a financial instrument is the same as having the option to *call* in the instrument for delivery at a specified price. Having a *put* option to sell a financial instrument is the same as having the option to *put* up an instrument for the other party to buy at a specified price.

Profits and Losses on Option and Futures Contracts

To understand option contracts more fully, let's first examine the option on the same June Treasury bond futures contract that we looked at earlier in the chapter. Recall that if you bought this futures contract at a price of 115 (that is, $115,000), you agreed to pay $115,000 for $100,000 face value of long-term Treasury bonds when they are delivered to you at the end of June. If you sold this futures contract at a price of 115, you agreed, in exchange for $115,000, to deliver $100,000 face value of the long-term Treasury bonds at the end of June. An option contract on the Treasury bond futures contract has several key features: (1) It has the same expiration date as the underlying futures contract; (2) it is an American option and so can be exercised at any time before the expiration date; and (3) the premium (price) of the option is quoted in points that mimic the futures contract, so each point corresponds to $1,000. If, for a premium of $2,000, you buy one call option contract on the June Treasury bond contract with an exercise price of 115, you have purchased the right to buy (call in) the June Treasury bond futures contract for a price of 115 ($115,000 per contract) at any time until the expiration date of this contract at the end of June. Similarly, if you buy for $2,000 a put option on the June Treasury bond contract with an exercise price of 115, you have the right to sell (put up) the June Treasury bond futures contract for a price of 115 ($115,000 per contract) at any time until the end of June.

Futures option contracts are somewhat complicated, so to explore how they work and how they can be used to hedge risk, let's first examine how profits and losses occur on the call option on the June Treasury bond futures contract. In February, our old friend Irving the Investor buys, for a $2,000 premium, a call option on the $100,000 June Treasury bond futures contract with a strike price of 115. (We will assume that if

Irving exercises the option, he does so on the expiration date at the end of June and not before.) Suppose that the underlying Treasury bond for the futures contract has a price of 110 on the expiration date at the end of June. Recall that on the expiration date, arbitrage forces the price of the futures contract to be the same as the price of the underlying bond, so the contract also has a price of 110 on the expiration date at the end of June. If Irving exercises the call option and buys the futures contract at an exercise price of 115, he will lose money by buying at 115 and selling at the lower market price of 110. Because Irving is smart, he will not exercise the option, but he will be out the $2,000 premium he paid. In such a situation, in which the price of the underlying financial instrument is below the exercise price, a call option is said to be "out of the money." At the price of 110 (less than the exercise price), Irving thus suffers a loss on the option contract of the $2,000 premium he paid. This loss is plotted as point A in panel (a) of Figure 1.

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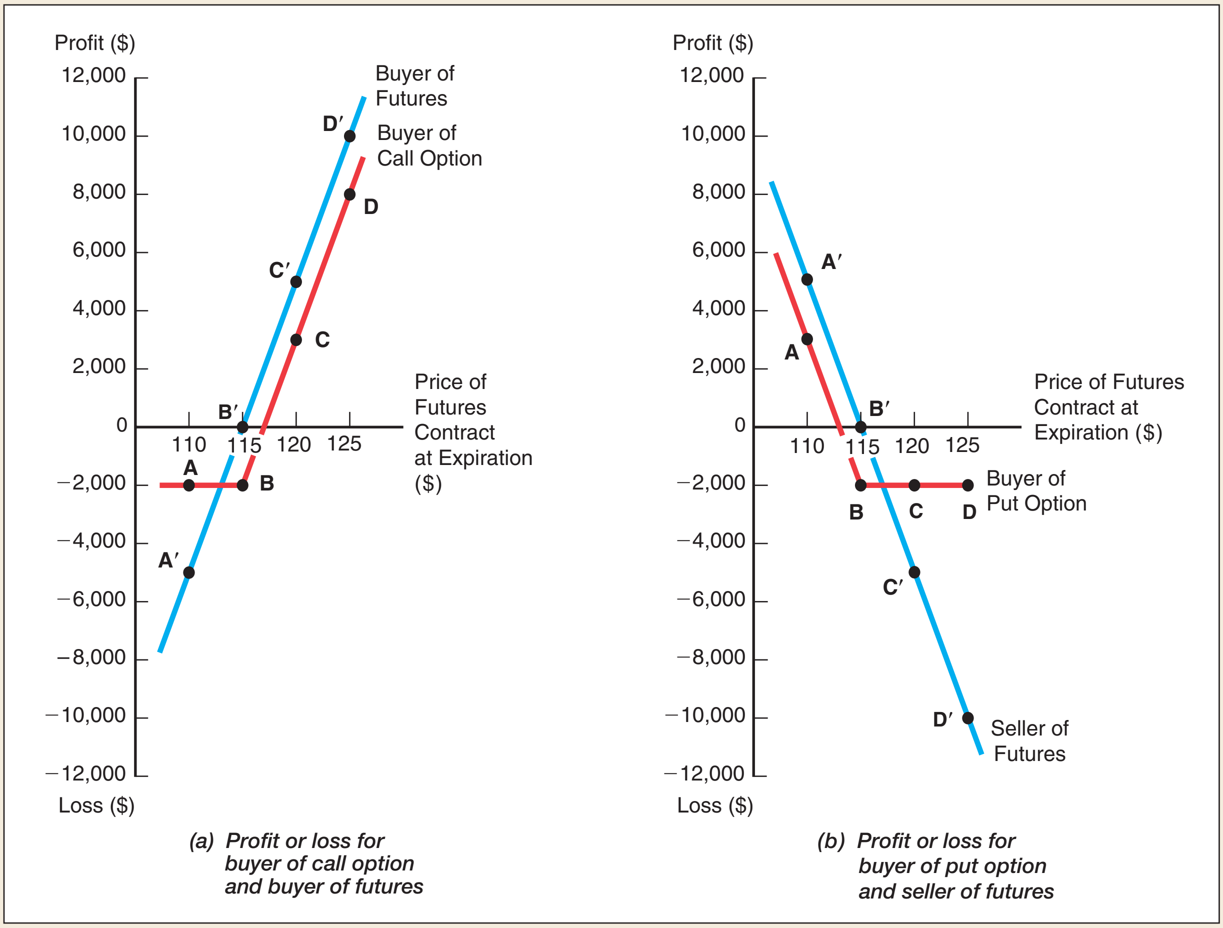

FIGURE 1 Profits and Losses on Options Versus Futures Contracts

The futures contract is the $100,000 June Treasury bond contract, and the option contracts are written on this futures contract with an exercise price of 115. Panel (a) shows the profits and losses for the buyer of the call option and the buyer of the futures contract, and panel (b) shows the profits and losses for the buyer of the put option and the seller of the futures contract.

On the expiration date, if the price of the futures contract is 115, the call option is "at the money," and Irving is indifferent regarding his option to buy the futures contract, because exercising the option at 115 when the market price is also at 115 produces no gain or loss. Because he has paid the $2,000 premium, at the price of 115 his contract again has a net loss of $2,000, plotted as point B. If the futures contract instead has a price of 120 on the expiration day, the option is "in the money," and Irving benefits from exercising the option: He will buy the futures contract at the exercise price of 115 and then sell it for 120, thereby earning a 5-point gain ($5,000 profit) on the $100,000 Treasury bond contract. Because Irving paid a $2,000 premium for the option contract, however, his net profit is $3,000 ($5,000 − $2,000). The $3,000 profit at a price of 120 is plotted as point C. Similarly, if the price of the futures contract rises to 125, the option contract will yield a net profit of $8,000 ($10,000 from exercising the option minus the $2,000 premium), plotted as point D. Connecting these points, we get the kinked profit curve for the call option that we see in panel (a).

Suppose that instead of purchasing the futures *option* contract in February, Irving decides instead to buy the $100,000 June Treasury bond *futures* contract at the price of 115. If the price of the bond on the expiration day at the end of June declines to 110, meaning that the price of the futures contract also falls to 110, Irving suffers a loss of 5 points, or $5,000. The loss of $5,000 on the futures contract at a price of 110 is plotted as point A′ in panel (a). At a price of 115 on the expiration date, Irving will have a zero profit on the futures contract, plotted as point B′. At a price of 120, Irving will have a profit of 5 points on the contract, or $5,000 (point C′), and at a price of 125, the profit will be 10 percentage points, or $10,000 (point D′). Connecting these points, we get the linear (straight-line) profit curve for the futures contract, graphed in panel (a).

Now we can see the major difference between a futures contract and an option contract. As indicated by the profit curve for the futures contract in panel (a), the futures contract has a linear profit function: Profits grow by an equal dollar amount for every point increase in the price of the underlying financial instrument. By contrast, the kinked profit curve for the option contract is nonlinear, meaning that profits do not always grow by an equal dollar amount with a given change in the price of the underlying financial instrument. This nonlinearity indicates that the call option protects Irving from suffering losses that are greater than the amount of the $2,000 premium. In contrast, Irving's loss on the futures contract is $5,000 if the price on the expiration day falls to 110, and if the price falls even further, Irving's loss will be even greater. This insurance-like feature of option contracts explains why their purchase price is referred to as a premium. Once the underlying financial instrument's price rises above the exercise price, however, Irving's profits will grow linearly. Irving has given up something by buying an option rather than a futures contract. As we see in panel (a), when the price of the underlying financial instrument rises above the exercise price, Irving's profits are always less than the profits he would have made on the futures contract—by exactly the $2,000 premium he paid.

Panel (b) plots the results of the same profit calculations if Irving buys not a call option but a put option (an option to sell) with an exercise price of 115 for a premium of $2,000, and if he sells the futures contract rather than buying it. In this case, if on the expiration date the Treasury bond futures have a price above the 115 exercise price, the put option is "out of the money." Irving will not want to exercise the put option because by doing so he would have to sell the futures contract he owns at a price below the market price, and he would lose money. He therefore will not exercise his option, and he will be out only the $2,000 premium he paid. Once the price of the futures contract falls below the 115 exercise price, Irving benefits from exercising the put option because he can sell the futures contract at a price of 115 but can buy it at a price less than 115. In such a situation, in which the price of the underlying instrument is below the exercise price, the put option is "in the money," and profits rise linearly as the price of the futures contract falls. The profit function for the put option illustrated in panel (b) of Figure 1 is kinked, indicating that Irving is protected from losses greater than the amount of the premium he paid. The profit curve for the sale of the futures contract is just the negative of the profit curve for the futures contract in panel (a), and is therefore linear.

Panel (b) of Figure 1 confirms the conclusion from panel (a) that profits on option contracts are nonlinear, but profits on futures contracts are linear.

Two additional differences between futures and option contracts must be mentioned. The first is that the initial investment on the two types of contracts differs. As we saw earlier in the chapter, when a futures contract is purchased, the investor must put a fixed amount, called the margin requirement, into a margin account. But when an option contract is purchased, the initial investment is the premium that is paid for the contract. The second important difference between the contracts is that with a futures contract, money changes hands daily when the contract is marked to market, whereas with an option contract, money changes hands only when the option is exercised.

APPLICATION Hedging with Futures Options

Earlier in the chapter, we saw how the First National Bank could hedge the interest-rate risk on its $5 million holdings of 6s of 2035 by selling $5 million of T-bond futures. A rise in interest rates and the resulting fall in bond prices and bond futures contracts would lead to profits on the bank's sale of the futures contracts that would exactly offset the losses on the 6s of 2035 that the bank is holding.

As suggested in panel (b) of Figure 1, an alternative way for the manager to protect against a rise in interest rates and hence a decline in bond prices is to buy $5 million of put options written on the same Treasury bond futures. As long as the exercise price is not too far from the current price, as in panel (b), the rise in interest rates and decline in bond prices will lead to profits on the futures and the futures put options, profits that will offset any losses on the $5 million of Treasury bonds.

The one problem with using options rather than futures is that the First National Bank will have to pay premiums on the options contracts, thereby lowering the bank's profits in an effort to hedge the interest-rate risk. Why might the bank manager be willing to use options rather than futures to conduct the hedge? The answer is that the option contract, unlike the futures contract, allows the First National Bank to gain if interest rates decline and bond prices rise. With the hedge using futures contracts, the First National Bank does not gain from increases in bond prices because the profits on the bonds it is holding are offset by the losses from the futures contracts it has sold. However, as indicated in panel (b) of Figure 1, the situation when the hedge is conducted with put options is quite different: Once bond prices rise above the exercise price, the bank does not suffer additional losses on the option contracts. At the same time, the value of the Treasury bonds the bank is holding will increase, thereby leading to a profit for the bank. Thus by using options rather than futures to conduct the micro hedge, the bank can protect itself from rises in interest rates but will still benefit from interest-rate declines (although the bank's profit will be reduced by the amount of the premium).

Similar reasoning indicates that the bank manager might prefer to use options to conduct the macro hedge to immunize the entire bank portfolio from interest-rate risk. Again, by using options rather than futures, the First National Bank will have to pay the premiums on these contracts up front. By contrast, the use of options allows the bank to keep the gains from a decline in interest rates (which will raise the value of the bank's assets relative to its liabilities), because these gains will not be offset by large losses on the option contracts.

In the case of a macro hedge, there is another reason why the bank might prefer option contracts to futures contracts. Profits and losses on futures contracts can cause accounting problems for banks because such profits and losses are not allowed to be offset by changes in the value of the rest of the bank's portfolio that are not yet realized by the actual sale of the assets. Consider what happens if interest rates fall. If First National sells futures contracts to conduct the macro hedge, then if interest rates fall and the prices of the Treasury bond futures contracts rise, the bank will suffer large losses on these contracts. Of course, these losses will be offset by profits in the rest of the bank's portfolio that are not yet realized by actual sale of the assets, but the bank is not allowed to offset these losses in its accounting statements. So even though the macro hedge is serving its intended purpose of immunizing the bank's portfolio from interest-rate risk, the bank will experience large accounting losses if interest rates fall. Indeed, bank managers have lost their jobs when perfectly sound hedges with interest-rate futures generated large accounting losses. Not surprisingly, for this reason bank managers might shrink from using financial futures to conduct macro hedges.

Futures options, however, can come to the rescue of the managers of banks and other financial institutions. Suppose that First National conducts the macro hedge by buying put options rather than selling Treasury bond futures. Now, if interest rates fall and bond prices rise well above the exercise price, the bank will not suffer large losses on the option contracts because it will just decide not to exercise its options. The bank will not suffer the accounting problems that it would have suffered if it had hedged with financial futures. Because of the accounting advantages of using futures options to conduct macro hedges, option contracts have become important tools for financial institution managers who are looking to hedge interest-rate risk.

Factors Affecting Option Premiums

Several interesting facts can be noted about how the premiums on option contracts are priced. First, when the strike (exercise) price for a contract is set at a higher level, the premium for the call option is lower and the premium for the put option is higher. For example, in going from a contract with a strike price of 112 to one with a strike price of 115, the premium for a call option for the month of March might fall from $1\frac{45}{64}$ to $\frac{16}{64}$, and the premium for the March put option might rise from $\frac{19}{64}$ to $1\frac{54}{64}$.

Our understanding of the profit function for option contracts, illustrated in Figure 1, helps explain this fact. As we saw in panel (a), a lower price for the underlying financial instrument (in this case, a Treasury bond futures contract) relative to the option's exercise price results in lower profits on the call (buy) option. Thus, the higher the strike price, the lower the profits on the call option contract and the lower the premium that investors like Irving will be willing to pay. Similarly, we saw in panel (b) that a lower price for the underlying financial instrument relative to the exercise price increases profits on the put (sell) option, so that a higher strike price increases profits and thus causes the premium to increase.

Second, as the period of time over which the option can be exercised (the term to expiration) increases, the premiums for both call and put options rise. For example, at a strike price of 112, the premium on a call option might increase from $1\frac{45}{64}$ in March to $1\frac{50}{64}$ in April to $2\frac{28}{64}$ in May. Similarly, the premium on a put option might increase from $\frac{19}{64}$ in March to $1\frac{43}{64}$ in April to $2\frac{22}{64}$ in May. The fact that the premium increases with increases in the term to expiration is also explained by the nonlinear profit function for option contracts. As the term to expiration lengthens, there is a greater chance that the price of the underlying financial instrument will be very high or very low on the expiration date. If the price becomes very high and goes well above the exercise price, the call (buy) option will yield a high profit; if the price becomes very low and goes well below the exercise price, the losses will be small because the owner of the call option will simply decide not to exercise the option. The possibility of greater variability of the price of the underlying financial instrument as the term to expiration lengthens raises profits, on average, for the call option.

Similar reasoning tells us that the put (sell) option also becomes more valuable as the term to expiration increases, because the possibility of greater price variability of the underlying financial instrument increases as the term to expiration increases. The greater chance of a low price increases the chance that profits on the put option will be very high. But the greater chance of a high price does not increase the chance of substantial losses on the put option, because the owner again will just decide not to exercise the option.

We can think about this feature of option contracts in another way: Option contracts have an element of "heads, I win; tails, I don't lose too badly." The greater variability of the final price on the expiration date increases the value of both kinds of options. Because a longer term to the expiration date leads to greater variability in the final price on the expiration date, a longer term to expiration raises the value of an option contract.

The reasoning we just developed explains another important fact about option premiums. When the volatility of the price of the underlying instrument is great, the premiums on both call and put options are higher. Higher volatility of price means that, for a given expiration date, there will again be greater variability in the final price on the expiration date. The "heads, I win; tails, I don't lose too badly" property of options implies that the greater variability of possible prices on the expiration date increases average profits for the option and thus increases the premium that investors are willing to pay.

Summary

Our analysis in this application leads us to the following conclusions about the factors that determine the premium on an option contract:

1. The higher the strike price, everything else being equal, the lower the premium on call (buy) options and the higher the premium on put (sell) options.
2. The greater the term to expiration, everything else being equal, the higher the premiums on both call and put options.
3. The greater the volatility of prices of the underlying financial instrument, everything else being equal, the higher the premiums on both call and put options.

The results we have derived here appear in more formal models, such as the Black-Scholes model, that analyze how the premiums on options are priced. You might study such models in finance courses. ◆

SWAPS

In addition to forwards, futures, and options, financial institutions use one other important financial derivative to manage risk. **Swaps** are financial contracts that obligate each party to the contract to exchange (swap) a set of payments (not assets) that it owns for another set of payments that are owned by another party. Swaps are of two basic kinds. **Currency swaps** involve the exchange of a set of payments in one currency for a set of payments in another currency. **Interest-rate swaps** involve the exchange of one set of interest payments for another set of interest payments, all denominated in the same currency.

Interest-Rate Swap Contracts

Interest-rate swaps are an important tool for managing interest-rate risk. They first appeared in the United States in 1982, when, as we have seen, demand increased for financial instruments that could be used to reduce interest-rate risk. The most common type of interest-rate swap (called the *plain vanilla swap*) specifies (1) the interest rate on the payments that are being exchanged; (2) the type of interest payments (variable or fixed-rate); (3) the amount of **notional principal**, which is the amount on which the interest is being paid; and (4) the time period over which the exchanges will continue to be made. There are many other, more complicated versions of swaps, including forward swaps and swap options (called *swaptions*), but here we will look only at the plain vanilla swap. Figure 2 illustrates an interest-rate swap between the Midwest Savings Bank and the Friendly Finance Company. Midwest Savings agrees to pay Friendly Finance a fixed rate of 5% on $1 million of notional principal for the next ten years, and Friendly Finance agrees to pay Midwest Savings the one-year Treasury bill rate plus 1% on $1 million of notional principal for the same period. Thus, as shown in Figure 2, every year the Midwest Savings Bank will pay the Friendly Finance Company 5% on $1 million, while Friendly Finance will pay Midwest Savings the one-year T-bill rate plus 1% on $1 million.

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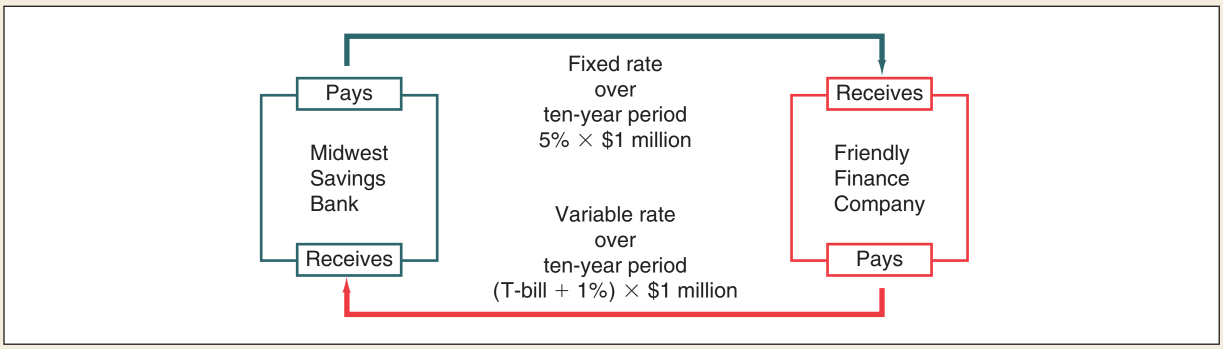

FIGURE 2 Interest-Rate Swap Payments
In this swap arrangement, with a notional principal of $1 million and a term of ten years, the Midwest Savings Bank agrees to pay a fixed rate of 5% × $1 million to the Friendly Finance Company, which in turn agrees to pay the one-year Treasury bill rate plus 1% × $1 million to the Midwest Savings Bank.

APPLICATION Hedging with Interest-Rate Swaps

You might wonder why these two parties would find it advantageous to enter into this swap agreement. The answer is that it may help both of them hedge interest-rate risk.

Suppose that Midwest Savings Bank, which tends to borrow short-term and then lend long-term in the mortgage market, has $1 million less of rate-sensitive assets than it has of rate-sensitive liabilities. As we learned in Chapter 9, this situation means that as interest rates rise, the increase in the cost of funds (liabilities) will be greater than the increase in interest payments the bank receives on its assets, many of which are fixed-rate. Rising interest rates thus will lead to a shrinking of Midwest Savings' net interest margin and a decline in its profitability. As we saw in Chapter 9, to avoid this interest-rate risk, Midwest Savings would like to convert $1 million of its fixed-rate assets into $1 million of rate-sensitive assets, in effect making rate-sensitive assets equal to rate-sensitive liabilities, thereby eliminating the gap. This is exactly what happens when Midwest Savings engages in the interest-rate swap. By taking $1 million of its fixed-rate income and exchanging it for $1 million of rate-sensitive Treasury bill income, it has converted income on $1 million of fixed-rate assets into income on $1 million of rate-sensitive assets. Now, when interest rates rise, the increase in rate-sensitive income on the bank's assets will exactly match the increase in the rate-sensitive cost of funds on its liabilities, leaving the net interest margin and bank profitability unchanged.

The Friendly Finance Company, which issues long-term bonds to raise funds and uses them to make short-term loans, finds itself in exactly the opposite situation of Midwest Savings: It has $1 million more of rate-sensitive assets than of rate-sensitive liabilities. It is therefore concerned that a fall in interest rates, which will result in a larger drop in income from its assets than the decline in the cost of funds on its liabilities, will cause a decline in profits. By conducting the interest-rate swap, Friendly Finance eliminates this interest-rate risk because it has converted $1 million of rate-sensitive income into $1 million of fixed-rate income. Now the Friendly Finance Company finds that when interest rates fall, the decline in rate-sensitive income is smaller and so is matched by the decline in the rate-sensitive cost of funds on its liabilities, leaving its profitability unchanged.

Advantages of Interest-Rate Swaps

To eliminate interest-rate risk, both the Midwest Savings Bank and the Friendly Finance Company could have rearranged their balance sheets by converting fixed-rate assets into rate-sensitive assets, and vice versa, instead of engaging in an interest-rate swap. However, this strategy would have been costly for both financial institutions for several reasons. First, financial institutions incur substantial transaction costs when they rearrange their balance sheets. Second, different financial institutions have different informational advantages and often make loans to select customers who prefer certain maturities. Thus, by adjusting the balance sheet to eliminate interest-rate risk, the institution might lose these informational advantages, which most financial institutions are unwilling to give up. Interest-rate swaps solve these problems for financial institutions because, in effect, they allow the institutions to convert fixed-rate assets into rate-sensitive assets without affecting the balance sheet. Large transaction costs are avoided, and the financial institutions can continue to use their informational advantage to make loans to preferred customers.

We have learned that financial institutions can also hedge interest-rate risk with other financial derivatives, such as futures contracts and futures options. Interest-rate swaps have one big advantage over these other derivatives: They can be written for very long horizons, sometimes as long as twenty years, whereas financial futures and futures options typically have much shorter horizons, usually not much more than a year. If a financial institution needs to hedge interest-rate risk for a long horizon, financial futures and option markets may not do it much good. Instead, it can turn to the swap market.

Disadvantages of Interest-Rate Swaps

Although interest-rate swaps have important advantages that make them very popular with financial institutions, they also have weaknesses that limit their usefulness. Swap markets, like forward markets, can suffer from a lack of liquidity. Let's return to the swap between the Midwest Savings Bank and the Friendly Finance Company. As is sometimes the case with a forward contract, it might be difficult for the Midwest Savings Bank to link up with the Friendly Finance Company to arrange the swap. In addition, even if the Midwest Savings Bank is able to find a willing counterparty like the Friendly Finance Company, it might not be able to negotiate a good deal because it has no other institution with which to negotiate.

Swap contracts also are subject to the same default risk as forward contracts. If interest rates rise, the Friendly Finance Company would love to get out of the swap contract, because the fixed-rate interest payments it receives are less than the rates it could get in the open market. It might then default on the contract, exposing Midwest Savings to a loss. Alternatively, the Friendly Finance Company could go bust, meaning that the terms of the swap contract would not be fulfilled.

Financial Intermediaries in Interest-Rate Swaps

As we have just seen, financial institutions do have to be aware of the possibility of losses from a default on swaps. As with a forward contract, each party to a swap must have a lot of information about the other party to make sure that the contract is likely to be fulfilled. The need for information about counterparties and the liquidity problems in swap markets can limit the usefulness of these markets. However, as we saw in Chapter 8, when informational and liquidity problems crop up in a market, financial intermediaries come to the rescue. That is exactly what happens in swap markets. Intermediaries such as investment banks and especially large commercial banks are able to acquire information cheaply about the creditworthiness and reliability of parties to swap contracts, and are also able to match parties to a swap. Hence large commercial banks and investment banks have set up swap markets in which they act as intermediaries. ◆

CREDIT DERIVATIVES

In recent years, a new type of derivative to hedge credit risk has arrived on the scene. Like other derivatives, **credit derivatives** offer payoffs on previously issued securities, but only on securities that bear credit risk. In the past ten years, the markets in credit derivatives have grown at an astounding pace, and the notional amounts of these derivatives now number in the trillions of dollars. These credit derivatives take several forms.

Credit Options

Credit options work just like the options discussed earlier in the chapter: For a fee, the purchaser gains the right to receive profits that are tied either to the price of an underlying security or to an interest rate. Suppose you buy $1 million of General Motors bonds but worry that a potential slowdown in the sale of SUVs might lead a credit-rating agency to *downgrade* (lower the credit rating on) GM bonds. As we saw in Chapter 6, such a downgrade would cause the price of GM bonds to fall. To protect yourself, you could buy an option—for, say, $15,000—to sell the $1 million of bonds at a strike price that is the same as the current price. With this strategy, you would not suffer any losses if the value of the GM bonds declined because you could exercise the option and sell them at the price you paid for them. In addition, you would be able to reap any gains if GM bonds rose in value.

The second type of credit option ties profits to changes in an interest rate, such as a credit spread (the interest rate on the average bond with a particular credit rating minus the interest rate on default-free bonds, such as those issued by the U.S. Treasury). Suppose that your company, which has a Baa credit rating, plans to issue $10 million of one-year bonds in three months and expects to have a credit spread of 1 percentage point (i.e., it will pay an interest rate that is 1 percentage point higher than the one-year Treasury rate). You are concerned that the market might start to think that Baa companies in general will become riskier in the coming months. If this were to happen by the time you are ready to issue your bonds in three months, you would have to pay a higher interest rate than the 1 percentage point in excess of the Treasury rate, and your cost of issuing the bonds would increase. To protect yourself against these higher costs, you could buy—for, say, $20,000—a credit option on $10 million of Baa bonds that would pay you the difference between the average Baa credit spread in the market and the 1 percentage point credit spread on $10 million. If the credit spread jumps to 2 percentage points, you would receive $100,000 from the option ($= [2\% - 1\%] \times \$10$ million), which would exactly offset the $100,000 higher interest costs from the 1 percentage point higher interest rate you would have to pay on your $10 million of bonds.

Credit Swaps

Suppose you manage a bank in Houston called Oil Drillers' Bank (ODB), which specializes in lending to a particular industry in your local area, oil drilling companies. Another bank, Potato Farmers Bank (PFB), specializes in lending to potato farmers in Idaho. Both ODB and PFB have a problem because their loan portfolios are not sufficiently diversified. To protect ODB against a collapse in the oil market, which would result in defaults on most of its loans made to oil drillers, you could reach an agreement to have the loan payments on, say, $100 million worth of your loans to oil drillers paid to the PFB in exchange for PFB paying you the loan payments on $100 million of its loans to potato farmers. Such a transaction, in which risky payments on loans are swapped for each other, is called a **credit swap**. As a result of this swap, ODB and PFB have increased their diversification and lowered the overall risk of their loan portfolios because some of the loan payments to each bank are now coming from a different type of loan.

Another form of credit swap is, for arcane reasons, called a **credit default swap**, although it functions more like insurance. With a credit default swap, one party that wants to hedge credit risk pays a fixed payment on a regular basis in return for a contingent payment that is triggered by a *credit event,* such as the bankruptcy of a particular firm or the downgrading of the firm's credit rating by a credit-rating agency. For example, you could use a credit default swap to hedge the $1 million of General Motors bonds that you are holding by arranging to pay an annual fee of $1,000 in exchange for a payment of $10,000 if the GM bonds' credit rating is lowered. If a credit event happens and GM's bonds are downgraded so that their price falls, you will receive a payment that will offset some of the loss you will suffer if you sell the bonds at this lower price.

Credit-Linked Notes

Another type of credit derivative, the **credit-linked note**, is a combination of a bond and a credit option. Just like any corporate bond, the credit-linked note makes periodic coupon (interest) payments and a final payment of the face value of the bond at maturity. If a key financial variable specified in the note changes, however, the issuer of the note has the right (option) to lower the payments on the note. For example, General Motors could issue a credit-linked note that pays a 5% coupon rate with the specification that if a national index of SUV sales falls by 10%, then GM has the right to lower the coupon rate by 2 percentage points, to 3%. In this way, GM can lower its risk because when it is losing money as SUV sales fall, it can offset some of these losses by making smaller payments on its credit-linked notes.

APPLICATION Lessons from the Global Financial Crisis: When Are Financial Derivatives Likely to Be a Worldwide Ticking Time Bomb?

Although financial derivatives can be useful in hedging risk, the AIG blowup discussed in the previous chapter illustrates that they can pose a real danger to the financial system. Indeed, Warren Buffet warned about the dangers of financial derivatives by characterizing them as "financial weapons of mass destruction." Particularly scary are the notional amounts of derivatives contracts—more than $700 trillion worldwide. How can we tell when financial derivatives are likely to be a ticking time bomb that might explode at any minute, bringing down the world financial system? We can find some answers by studying the recent global financial crisis.

Two major concerns surround financial derivatives. The first is that financial derivatives allow financial institutions to increase their leverage; that is, these institutions can, in effect, hold an amount of the underlying asset that is many times greater than the amount of money they had to put up. Increasing their leverage enables them to take huge bets, which, if the bets turn sour, can bring down the institution. This is exactly what AIG did, to its great regret, when it plunged into the credit default swap market. Even more of a problem was the fact that AIG's speculation in the credit default swap (CDS) market had the potential to bring down the whole global financial system. An important lesson from the global financial crisis is that allowing one player to take huge positions in a derivatives market is a highly dangerous move.

A second concern is that banks often hold huge notional amounts of financial derivatives—in particular, interest-rate and currency swaps—that greatly exceed the amount of bank capital, and so these derivatives might expose the banks to serious risk of failure. Banks are indeed major players in the financial derivatives markets, particularly in the interest-rate and currency swaps markets. Our earlier analysis showed that banks are the natural market makers because they can act as intermediaries between two counterparties that would not necessarily be able to make a swap without the bank's involvement. However, looking at the notional amount of interest-rate and currency swaps at banks gives us a very misleading picture of the banks' risk exposure. Because banks act as intermediaries in the swap markets, they typically are exposed only to credit risk—the risk of default by one of their counterparties. Furthermore, these swaps, unlike loans, do not involve payments of the notional amount, but rather much smaller payments that are *based on* the notional amount. For example, in the case of a 7% interest rate, the payment is only $70,000 for a $1 million swap. Estimates of the credit risk exposure from swap contracts indicate that they are on the order of only 1% of the notional value of the contracts and that credit risk exposure at banks from derivatives is generally less than a quarter of their total credit risk exposure from loans. Banks' credit risk exposures from their derivative positions are thus not out of line with other credit risk exposures they face. Furthermore, an analysis by the GAO (Government Accountability Office) indicated that actual credit losses incurred by banks from their derivatives contracts have been very small, on the order of 0.2% of their gross credit exposure. Indeed, during the recent global financial crisis, in which the entire financial system was put under great stress, derivatives exposure at banks was not a serious problem.

In conclusion, recent events indicate that financial derivatives pose serious dangers to the financial system, but some of these dangers have been overplayed. The biggest danger lies in the trading activities of financial institutions, particularly their trading in credit derivatives, as was illustrated by AIG's activities in the CDS market. As discussed in Chapter 10, regulators have been paying increased attention to this danger and are continuing to develop new disclosure requirements and regulatory guidelines that outline rules for derivatives trading. Financial institutions need to disclose their risk exposure in derivatives contracts so that regulators can make sure that a large institution is not playing too big a role in the derivatives market and does not carry too large an exposure to derivatives relative to its capital, as was the case with AIG. Another concern is that derivatives, particularly credit derivatives, must have better clearing mechanisms, that is, the methods of settling contracts, so that the failure of one institution does not bring down many other institutions whose net derivatives positions are small even though they have many offsetting positions. Better clearing could be achieved either by trading these derivatives in an organized exchange, like a futures market, or by having one clearing organization net out trades. Regulators such as the Federal Reserve Bank of New York have been active in making proposals along these lines.

The credit risk exposure posed by interest-rate derivatives, in contrast, seems to be manageable using the standard methods of dealing with credit risk. New regulations for derivatives markets are sure to come in the wake of the global financial crisis. The industry has been given a wake-up call regarding the potential dangers of derivatives products. Now the hope is that any time bomb arising from derivatives can be defused with appropriate efforts on the parts of markets and regulators. ◆

SUMMARY

1. Interest-rate forward contracts, which are agreements to sell a debt instrument at a future (forward) point in time, can be used to hedge (protect against) interest-rate risk. The advantage of forward contracts is that they are flexible; the disadvantages are that they are subject to default risk and their market is illiquid.
2. A financial futures contract is similar to an interest-rate forward contract in that it specifies that a debt instrument must be delivered by one party to another on a stated future date. However, it has advantages over a forward contract in that it is not subject to default risk and is more liquid. Forward and futures contracts can be used by financial institutions to hedge interest-rate risk.
3. An option contract gives the purchaser the right to buy (call option) or sell (put option) a security at the exercise (strike) price within a specific period of time. The profit function for options is nonlinear—profits do not always grow by an equal dollar amount with a given change in the price of the underlying financial instrument. The nonlinear profit function for options explains why their value (as reflected by the premium paid for them) is negatively related to the exercise price for call options, positively correlated to the exercise price for put options, positively related to the term to expiration for both call and put options, and positively related to the volatility of the price of the underlying financial instrument for both call and put options. Financial institutions use futures options to hedge interest-rate risk in a similar fashion to the way they use financial futures and forward contracts. Futures options may be preferred over futures contracts when conducting macro hedges because futures options lead to fewer accounting problems.
4. Interest-rate swaps involve the exchange of one set of interest payments for another set of interest payments. They have default risk and liquidity problems similar to those of forward contracts. As a result, interest-rate swaps often involve intermediaries such as large commercial banks and investment banks that make a market in swaps. Financial institutions find that interest-rate swaps are useful ways to hedge interest-rate risk. Interest-rate swaps have one big advantage over financial futures and options: They can be written for very long horizons.
5. Credit derivatives are a new type of derivative that offers payoffs on previously issued securities that have credit risk. These derivatives—credit options, credit swaps, and credit-linked notes—can be used to hedge credit risk.
6. There are two major concerns about derivatives: They allow financial institutions to more easily increase their leverage and take big bets (by effectively enabling them to hold a larger amount of the underlying assets than the amount of money put down), and they expose financial institutions to large credit risks because the huge notional amounts of derivative contracts greatly exceed the capital of these institutions. The second danger seems to have been overplayed, but the danger from increased leverage using derivatives is very real, as was revealed during the global financial crisis.

KEY TERMS

American option, p. W-11
arbitrage, p. W-5
call option, p. W-12
credit default swap, p. W-21
credit derivatives, p. W-20
credit-linked note, p. W-22
credit options, p. W-21
credit swap, p. W-21
currency swaps, p. W-18
European option, p. W-11
exercise price (strike price), p. W-11
financial derivatives, p. W-1
financial futures contract, p. W-4
financial futures option (futures option), p. W-11
forward contracts, p. W-2
hedge, p. W-1
interest-rate forward contracts, p. W-2
interest-rate swaps, p. W-18
long position, p. W-1
macro hedge, p. W-6
margin requirement, p. W-9
marked to market, p. W-9
micro hedge, p. W-6
notional principal, p. W-18
open interest, p. W-7
option, p. W-11
premium, p. W-11
put option, p. W-12
short position, p. W-1
stock option, p. W-11
swaps, p. W-18

QUESTIONS

All questions are available in MyEconLab *at* http://www.myeconlab.com.

1. What are the advantages and disadvantages of using forward contracts to hedge?

2. What advantages do futures contracts have over forward contracts?

3. What is the difference between a micro hedge and a macro hedge?

4. What are the advantages and disadvantages of using an options contract rather than a futures contract?

5. Explain why greater volatility or a longer term to maturity leads to a higher premium on both call and put options.

6. Why does a lower strike price imply that a call option will have a higher premium and a put option a lower premium?

7. What are the advantages and disadvantages of using interest-rate swaps?

8. If the finance company you manage has a gap of +$5 million (rate-sensitive assets greater than rate-sensitive liabilities by $5 million), describe an interest-rate swap that would eliminate the company's income gap.

9. If the savings and loan you manage has a gap of −$42 million, describe an interest-rate swap that would eliminate the S&L's income risk from changes in interest rates.

10. How can financial derivatives create excessive risk in the financial system?

APPLIED PROBLEMS

All applied problems are available in MyEconLab at http://www.myeconlab.com.

11. If the pension fund you manage expects to have an inflow of $120 million six months from now, what forward contract would you seek to enter into to lock in current interest rates?

12. If the portfolio you manage is holding $25 million of 6s of 2035 Treasury bonds with a price of 110, what forward contract would you enter into to hedge the interest-rate risk on these bonds over the coming year?

13. If you buy a $100,000 June Treasury bond contract for 108 and the price of the deliverable Treasury bond on the expiration date is 102, what is your profit or loss on the contract?

14. If, on the expiration date, the deliverable Treasury bond is selling for 101 but the Treasury bond futures contract is selling for 102, what will happen to the futures price? Explain your answer.

15. If your company has a payment of 200 million euros due one year from now, how would you hedge the foreign exchange risk in this payment with 125,000-euro futures contracts?

16. If your company has to make a 10 million euro payment to a German company three months from now, how would you hedge the foreign exchange risk in this payment with a 125,000-euro futures contract?

17. Suppose your company will be receiving 30 million euros six months from now, and the euro is currently selling for 1 euro per dollar. If you want to hedge the foreign exchange risk in this payment, what kind of forward contract should you enter into?

18. Suppose the pension fund you are managing is expecting an inflow of funds of $100 million next year, and you want to make sure that you will earn the current interest rate of 8% when you invest the incoming funds in long-term bonds. How would you use the futures market to do this?

19. If you buy a put option on a $100,000 Treasury bond futures contract with an exercise price of 95 and the price of the Treasury bond is 120 at expiration, is the contract in the money, out of the money, or at the money? What is your profit or loss on the contract if the premium was $4,000?

20. Suppose that you buy a call option on a $100,000 Treasury bond futures contract with an exercise price of 110 for a premium of $1,500. If, upon expiration, the futures contract has a price of 111, what is your profit or loss on the contract?

21. A hedger takes a short position in five T-bill futures contracts at the price of $98\frac{5}{32}$. Each contract is for $100,000 principal. When the position is closed, the price is $95\frac{12}{32}$. What is the gain or loss on this transaction?

22. Futures are available on three-month T-bills with a contract size of $1 million. If you take a long position at 96.22 and later sell the contracts at 96.87, what is the total net gain or loss on this transaction?

23. A bank customer will be going to London in June to purchase £100,000 in new inventory. The current spot and futures exchange rates are as follows:

Exchange Rates (dollars/pound)

Period	Rate
Spot	1.5342
March	1.6212
June	1.6901
September	1.7549
December	1.8416

The customer enters into a position in June futures to fully hedge her position. When June arrives, the actual exchange rate is $1.725 per pound. How much did she save?

24. Consider a put contract on a T-bond with an exercise price of $101\frac{12}{32}$. The contract represents $100,000 of bond principal and has a premium of $750. The actual T-bond price falls to $98\frac{16}{32}$ at the expiration. What is the gain or loss on the position?

25. A swap agreement calls for Durbin Industries to pay interest annually, based on a rate of 1.5% above the one-year T-bill rate, currently 6%. In return, Durbin receives interest at a rate of 6% on a fixed-rate basis. The notional principal for the swap is $50,000. What is Durbin's net interest for the year after entering into the agreement?

DATA ANALYSIS PROBLEMS

The Problems update with real-time data in MyEconLab *and are available for practice or instructor assignment.*

1. Go to the St. Louis Federal Reserve FRED database, and find data on the dollar/euro exchange rate (DEXUSEU). Suppose that one month ago you entered into a forward contract to sell 10 million euros at the forward rate equivalent to the spot rate one month ago. What exchange rate was specified on the forward contract? (Find the most recent data available, and then use the data from one month prior.) What will be the payment in dollars when the contract is executed? In hindsight, would you have been better off or worse off by not entering into the forward contract?

2. Go to the St. Louis Federal Reserve FRED database, and find data on the ten-year swap rate (DSWP10) and the three-month LIBOR rate (USD3MTD156N). The ten-year swap rate is the fixed rate reported on a ten-year interest-rate swap contract in return for interest payments based on the three-month LIBOR rate. Suppose that one year ago you entered into a swap contract. (For both data series, find the most recent data available, and then use the data from one year prior.) If you entered into a $10,000,000 notional principal ten-year interest-rate swap with the fixed payment at the ten-year swap rate and the variable payment at the LIBOR rate + 2%, what is the fixed payment? What was the variable payment one year ago, and what is the current variable payment?

WEB EXERCISES

1. The following website can be used to demonstrate how the features of an option affect the option's prices. Go to http://www.option-price.com/index.php. What happens to the price of an option under each of the following situations?

a. The strike price increases.

b. Interest rates increase.

c. Volatility increases.

d. The time until the option matures increases.

WEB REFERENCES

http://www.cmegroup.com

The website of the CME Group reports information on all the contracts traded on its exchanges.

http://www.rmahq.org

The website of the Risk Management Association reports useful information such as annual statement studies, online publications, and so on.