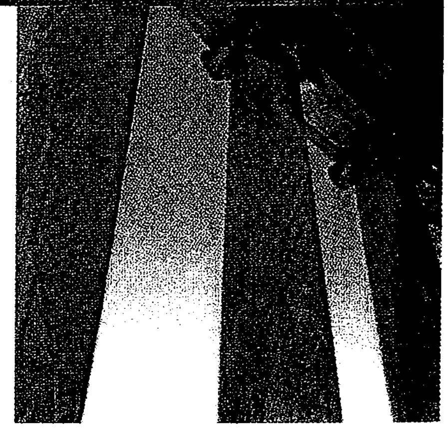
CHAPTER

13 Financial 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 10 came to the rescue by producing new financial instruments that help financial institution managers manage risk better. 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 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 10, have found their traditional business declining.

HEDGING

Financial derivatives are so effective in reducing risk because they enable financial institutions to **hedge**—that is, 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

Forward contracts are agreements by 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) amount of the debt instrument to be delivered, (3) price (interest rate) on the debt instrument when it is delivered, and (4) date on which delivery will take place. An example of an interest-rate forward contract might be an agreement for the First National Bank to sell to the Rock Solid Insurance Company, one year from today, $5 million face value of the 6s of 2023 Treasury bonds (that is, coupon bonds with a 6% coupon rate that mature in 2023) at a price that yields the same interest rate on these bonds as today's, say 6%. Because Rock Solid will buy the securities at a future date, it is said to have taken a long position, while the First National Bank, which will sell the securities, 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 have bought $5 million of the 6s of 2023 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 and result 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. As a result, you agree with another party—in this case, Rock Solid Insurance Company—to sell it the $5 million of the 6s of 2023 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 you face from interest-rate changes.

Why would Rock Solid Insurance Company want to enter into the futures 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 2023, 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 will be sold to it by 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 for the exact security it is holding in its portfolio, just as it has 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 with the Rock Solid Insurance Company, but there may be few institutions that want to engage in a forward contract specifically for the 6s of 2023. 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 as high a price as it wants because there may not be anyone else to make the deal with. A serious problem for the market in interest-rate forward contracts, then, is that it may be difficult to make the financial transaction or that it will 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* when 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 so that the price of the 6s of 2023 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 a price lower than the agreed price in the forward contract. Or perhaps Rock Solid may not have been rock solid after all, and may have gone bust during the year, and no longer be available to complete the terms of the forward contract. Because there is no outside organization 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 2023 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 each other out to be sure that the counterparty is both financially sound and likely to be honest and 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. When the default risk problem is combined with a lack of liquidity, we see that these contracts may be of limited usefulness to financial institutions. Although there is a market 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 in the interest-rate forward market, another solution to hedging interest-rate risk was needed. This solution was provided by the development of financial futures contracts by the Chicago Board of Trade starting in 1975.

Following the Financial News Financial Futures

The prices for financial futures contracts for debt instruments are published daily. In the *Wall Street Journal*, these prices are found in the "Commodities" section under the "Interest Rate" heading of the "Future Prices" columns. An excerpt is reproduced here.

	OPEN	HIGH	LOW	SETTLE	CHG	LIFETIME HIGH	LIFETIME LOW	OPEN INT
Interest Rate Futures								
Treasury Bonds ((BT)-$100,000; pts 32nds of 100%								
Mar	111-04	111-19	111-04	111-12	7	118-19	110-01	20,263
June	111-01	111-17	110-30	111-09	7	117-24	109-31	570,075

Information for each contract is presented in columns, as follows. (The Chicago Board of Trade's contract for delivery of long-term Treasury bonds in March 2006 is used as an example.)

Open: Opening price; each point corresponds to $1,000 of face value—111 4/32 is $111,125 for the March contract

High: Highest traded price that day—111 19/32 is $111,594 for the March contract

Low: Lowest traded price that day—111 4/32 is $111,125 for the March contract

Settle: Settlement price, the closing price that day—111 12/32 is $111,375 for the March contract

Chg: Change in the settlement price from the previous trading day—7/32 is $218.75 for the March contract

Lifetime High: Highest price ever—118 19/32 is $118,594 for the March contract

Lifetime Low: Lowest price ever—110 1/32 is $110,031 for the March contract

Open Interest: Number of contracts outstanding—20,263 for the March contract, with a face value of $2 billion (20,263 × $100,000)

Source: Wall Street Journal, March 21, 2006, p. C11.

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 that 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. (An illustration of how prices on these contracts are quoted can be found in the Following the Financial News box, "Financial Futures".) 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 one thirty-second 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 must also 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 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 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 agreed to sell (deliver) the bonds have taken a *short position*.

To make our understanding of this 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 but 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 is the same as 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 June 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 the fact that a futures contract at expiration equals the price of the underlying asset makes it even easier to see who profits and who loses from such a contract when interest rates change. When 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 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 a profit of 5 points, or $5,000.

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[1]In actuality, futures contracts sometimes set conditions for 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.

APPLICATION Hedging with Financial Futures

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 2023. To see how, suppose that in March 2007, the 6s of 2023 are the long-term bonds that would be delivered in the Chicago Board of Trade's T-bond futures contract expiring one year in the future, in March 2008. 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 2023 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 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 is 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 2023 are the long-term bonds that would 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 2023 and the futures contract are selling at par, how many contracts must First National sell to remove its interest-rate exposure from its \$5 million holdings of the 6s of 2023?[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, interest rates increase to 8% due to an increased threat of inflation. The value of the 6s of 2023 that the First National Bank is holding will then fall to \$4,039,640 in March 2008.[3] Thus the loss from the long position in these bonds is \$960,360:

Value on March 2008 @ 8% interest rate	\$4,144,052
Value on March 2007 @ 6% interest rate	−\$5,000,000
Loss	−\$ 855,948

However, the short position in the 50 futures contracts that obligate you to deliver \$5 million of the 6s of 2023 on March 2007 has a value equal to \$4,144,052, the value of the \$5 million of bonds after the interest rate has risen to 8%, as we have seen 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 \$855,948:

[2] In the real world, designing a hedge is somewhat more complicated than the example here, because the bond that is most likely to be delivered might not be a 6s of 2023.

[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 = 15, PV = \$4,144,052.

Amount paid to you on March 2008, agreed upon in March 2007	$5,000,000
Value of bonds delivered on March 2008 @ 8% interest rate	−$4,144,052
Gain	$ 855,948

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 have seen 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 future 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.

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, the Chicago Mercantile Exchange, the New York Futures Exchange, the MidAmerica Commodity Exchange, and the Kansas City Board of Trade. These exchanges are highly competitive with one another, and each organization tries to design contracts and set rules that will increase the amount of futures trading on its 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. The most widely traded financial futures contracts listed in the *Wall Street Journal* and the exchanges where they are traded (along with the number of contracts outstanding, called **open interest**, on March 20, 2006) are listed in Table 1.

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 American futures exchanges were the first to develop financial futures, they 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 resulting high profits made by the American exchanges, foreign exchanges saw a profit opportunity and began to enter this business. By the 1990s, Eurodollar contracts traded on the London International

TABLE 1 Widely Traded Financial Futures Contracts

Type of Contract	Contract Size	Exchange*	Open Interest March 20, 2006 Reflects March 2006 Futures
Interest Rate Contracts			
Treasury bonds	$100,000	CBT	20,263
Treasury notes	$100,000	CBT	35,929
Five-year Treasury notes	$100,000	CBT	11,765
Two-year Treasury notes	$200,000	CBT	17,989
Thirty-day Fed funds rate	$5 million	CBT	90,122
One-month LIBOR	$3 million	CME	22,068
Eurodollar	$4 million	CME	139,936
Euroyen	$100 million	CME	11,539
Sterling	£500,000	LIFFE	44,698
Long Gilt	£100,000	LIFFE	28,189
Three-month Euribor	€ 1 million	LIFFE	53,416
Euroswiss franc	SF 1 million	LIFFE	93,232
Stock Index Contracts			
Standard & Poor's 500 Index	$250 × index	CME	646,296
Standard & Poor's MIDCAP 400	$500 × index	CME	38,575
NASDAQ 100	$100 × index	CME	55,342
Nikkei 225 Stock Average	$5 × index	CME	53,435
Financial Times Stock Exchange 100 Index	£10 per index point	LIFFE	455,905
Currency Contracts			
Yen	12,500,000 yen	CME	159,182
Euro	125,000 euros	CME	132,925
Canadian dollar	100,000 Canadian $	CME	83,061
British pound	100,000 pounds	CME	69,774
Swiss franc	125,000 francs	CME	76,630
Mexican peso	500,000 new pesos	CME	52,803

*Exchange abbreviations: CBT, Chicago Board of Trade; CME, Chicago Mercantile Exchange; LIFFE, London International Financial Futures Exchange.

Source: Wall Street Journal, March 21, 2006, p. C11; www.wsj.com/free.

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, and Nikkei 225 contracts traded on the Osaka Securities Exchange all became among the most widely traded futures contracts in the world.

Foreign competition has also spurred knockoffs of the most popular financial futures contracts initially developed in the United States. These contracts 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 has thus 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 is evident from the fact that the total open interest of Treasury bond contracts exceeded 20,000 on March 20, 2006, for a total value of more than \$2 billion (20,000 × \$100,000). There are several differences between financial futures and forward contracts and in the organization of their markets that help explain why financial futures markets such as those for Treasury bonds have been so successful.

Several features of futures contracts were designed to overcome the liquidity problem inherent in forward contracts. The first feature is that, 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 up 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 day of March, June, September, and December. The second feature is that after the futures contract has been bought or sold, it can be traded (bought or sold) again at any time until the delivery date. In contrast, once a forward contract is agreed on, it typically cannot be traded. The third feature is that in a futures contract, not just one specific type of Treasury bond is deliverable on the delivery date, as 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. Allowing continuous trading also increases the liquidity of the futures market, as does the ability to deliver a range of Treasury bonds rather than one specific 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 many different securities to be delivered, the futures contract makes it harder for anyone to corner the market, because a much larger amount of securities would have to be purchased to establish the corner. Corners are a 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 arising in forward contracts. In both types, 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 the buyer of the futures contract does not need to worry about the financial health or trustworthiness of the seller, and vice versa, as in the forward market. 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. What this means is that 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 the 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 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 would 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 result 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 in that a futures trader can avoid the costs of physical delivery, which is not so easy 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 they 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 up 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 does this using forward and 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 at that time Sam would hold a long position in euros, Mona knows that the basic principle of hedging indicates that she should offset this long position by a short position. Thus she just 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 it is 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 up 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 could have used the currency futures market to hedge the foreign exchange risk. In this case, she would see 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 do the hedge, Mona must sell euros as with the forward 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,

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

Thus Mona does the hedge by selling 80 of the CME euro contracts. Given the $1-per-euro price, the sale of the contract yields 80 × 125,000 euros = $10 million. This

[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 may not be equal. In that case, as we will see in Equation 2 in Chapter 20, 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.

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, the bank manager may 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 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 for it called a **premium**. There are two types of option contracts: **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 you saw earlier in the chapter, at the expiration date, the price of the futures contract and 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. That explains why the most popular futures options are written on many of the same futures contracts listed in Table 1.

The regulation of option 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 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.

STUDY GUIDE

Remembering which 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.

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 buy this futures contract at a price of 115 (that is, $115,000), you have 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 are the same as in 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 through the expiration date of this contract at the end of June. Similarly, when for $2,000 you buy 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 on the call option on the June Treasury bond futures contract occur. 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 assume that if Irving exercises the option, it is on the expiration date at the end of June and not before.) On the expiration date at the end of June, suppose that the underlying Treasury bond for the futures contract has a price of 110. 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 it too 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.

On the expiration date, if the price of the futures contract is 115, the call option is "at the money," and Irving is indifferent whether he exercises 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 would 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 rose to 125, the option contract would yield a net profit of $8,000 ($10,000 from exercising the option minus the $2,000 premium), plotted as point D. Plotting 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 would have a zero profit on the futures contract, plotted as point B′. At a price of 120, Irving would have a profit on the contract of 5 points, or $5,000 (point C′), and at a price of 125, the profit would be 10 percentage points, or $10,000 (point D′). Plotting these points, we get the linear (straight-line) profit curve for the futures contract that appears in panel (a).

Now we can see the major difference between a futures contract and an option contract. As the profit curve for the futures contract in panel (a) indicates, 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 the same amount for a given change in the price of the underlying financial instrument. The reason for this nonlinearity is that the call option protects Irving from having 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,

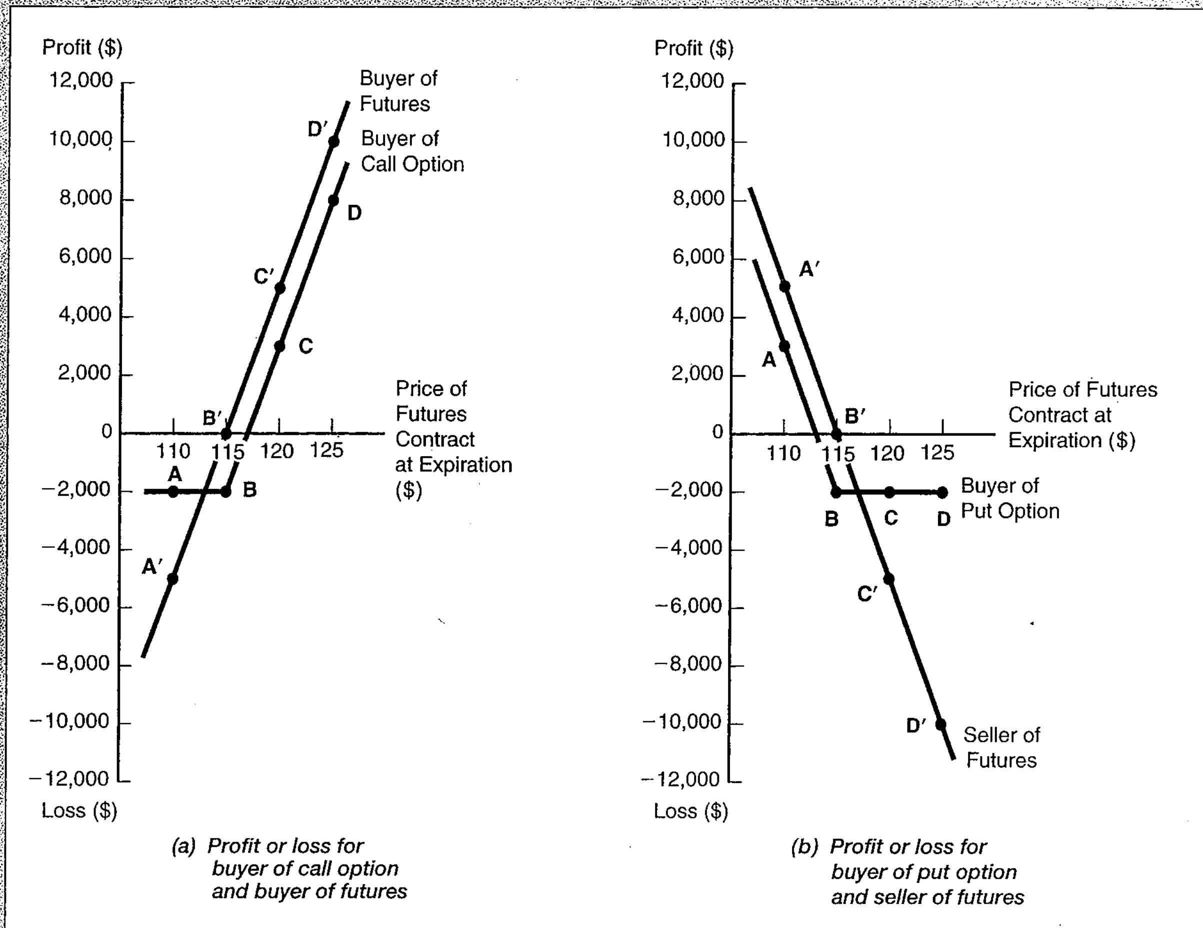


FIGURE 1 Profits and Losses on Options Versus Futures Contracts

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.

Irving's profits 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 that 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 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 one. 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 would not want to exercise the put option and then have to sell the futures contract he owns as a result at a price below the market price and lose money. He would not exercise his option, and he would 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 below this. 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 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.

STUDY GUIDE

To make sure you understand how profits and losses on option and futures contracts are generated, calculate the net profits on the put option and the short position in the futures contract at prices on the expiration day of 110, 115, 120, and 125. Then verify that your calculations correspond to the points plotted in panel (b) of Figure 1.

Two other differences between futures and option contracts must be mentioned. The first is that the initial investment on the contracts differs. As we saw earlier in the chapter, when a futures contract is purchased, the investor must put up a fixed amount, the margin requirement, in a margin account. But when an option contract is purchased, the initial investment is the premium that must be paid for the contract. The second important difference between the contracts is that the futures contract requires money to change hands daily when the contract is marked to market, whereas the option contract requires money to change hands only when it 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 2023 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 2023 the bank is holding.

As panel (b) of Figure 1 suggests, 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 panel (b) of Figure 1 indicates, 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 using options rather than futures to conduct the micro hedge allows the bank to protect itself from rises in interest rates but still allows the bank to benefit from interest-rate declines (although the profit is 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, the strategy of using options rather than futures has the disadvantage that the First National Bank has to pay the premiums on these contracts up front. By contrast, using 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 unrealized changes in the value of the rest of the bank's portfolio. Consider what happens when interest rates fall. If First National sells futures contracts to conduct the macro hedge, then when interest rates fall and the prices of the Treasury bond futures contracts rise, it will have large losses on these contracts. Of course, these losses are offset by unrealized profits in the rest of the bank's portfolio, 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 would experience large accounting losses when interest rates fall. Indeed, bank managers have lost their jobs when perfectly sound hedges with interest-rate futures have led to large accounting losses. Not surprisingly, bank managers might shrink from using financial futures to conduct macro hedges for this reason.

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

Factors Affecting the Prices of Option Premiums

There are several interesting facts about how the premiums on option contracts are priced. The first fact is that 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 115, the premium for a call option for the month of March might fall from 1 45/64 to 16/64, and the premium for the March put option might rise from 19/64 to 1 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 higher price for the underlying financial instrument (in this case a Treasury bond futures contract) relative to the option's exercise price results in higher profits on the call (buy) option. Thus, the lower the strike price, the higher the profits on the call option contract and the greater the premium that investors like Irving are willing to pay. Similarly, we saw in panel (b) that a higher price for the underlying financial instrument relative to the exercise price lowers profits on the put (sell) option, so that a higher strike price increases profits and thus causes the premium to increase.

The second fact is that as the period of time over which the option can be exercised (the term to expiration) gets longer, 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 45/64 in March to 1 50/64 in April and to 2 28/64 in May. Similarly, the premium on a put option might increase from 19/64 in March to 1 43/64 in April and to 2 22/64 in May. The fact that premiums increase with 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 by 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 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 will become 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 produce substantial losses for the put option, because the owner will again just decide not to exercise the option.

Another way of thinking about this reasoning is to recognize that option contracts have an element of "Heads, I win; tails, I don't lose too badly." The greater variability of where the prices might be by the expiration date increases the value of both kinds of options. Because a longer term to the expiration date leads to greater variability of where the prices might be by the expiration date, a longer term to expiration raises the value of the option contract.

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

Summary

Our analysis of how profits on options are affected by price movements for the underlying financial instrument leads 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 for 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 for both call and put options.

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

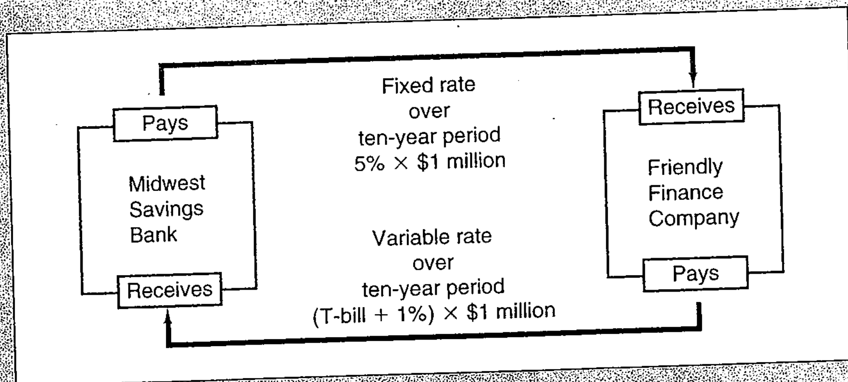
SWAPS

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) it owns for another set of payments owned by another party. There are two basic kinds of swaps. **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, and they first appeared in the United States in 1982, when, as we have seen, there was an increase in the demand 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 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 would be paying the Friendly Finance Company 5% on $1 million, while Friendly Finance would be paying Midwest Savings the one-year T-bill rate plus 1% on $1 million.

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 pays 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 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 the 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) is greater than the increase in interest payments it receives on its assets, many of which are fixed-rate. The result of rising interest rates is thus 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 rate-sensitive liabilities, thereby eliminating the gap. This is exactly what happens when it 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 its assets exactly matches 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 that it is in exactly the opposite situation to 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 doing the interest-rate swap, it 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. The first is that financial institutions incur substantial transaction costs when they rearrange their balance sheets. Second, different financial institutions have informational advantages in making loans to certain customers who may prefer certain maturities. Thus adjusting the balance sheet to eliminate interest-rate risk might result in a loss of these informational advantages, which the financial institution is 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 make loans where they have an informational advantage.

We have seen 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 hedging with 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, 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 disadvantages that limit their usefulness. Swap markets, like forward markets, can suffer from a lack of liquidity. Let's return to looking at the swap between the Midwest Savings Bank and the Friendly Finance Company. As 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 could find a counterparty like the Friendly Finance Company, it might not be able to negotiate a good deal because it cannot find any other institution with which to negotiate.

Swap contracts also are subject to the same default risk that we encountered for 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 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 could 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 have the ability to acquire information cheaply about the creditworthiness and reliability of parties to swap contracts and are also able to match up 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 derivatives has come on the scene to hedge credit risk. Like other derivatives, **credit derivatives** offer payoffs on previously issued securities, but ones 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 5, 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 that occurred 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 minus 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%] × $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 loans.

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 who 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 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 Are Financial Derivatives a Worldwide Time Bomb?

In recent years, politicians, the media, and regulators have become very concerned about the dangers of derivatives. Indeed, Warren Buffet has called financial derivatives "financial weapons of mass destruction." This concern is international and has spawned a slew of reports issued by such organizations as the Bank for International Settlements (BIS), the Bank of England, the Group of Thirty, the Office of the U.S. Comptroller of the Currency (OCC), the Commodity Futures Trading Commission (CFTC), and the Government Accounting Office (GAO). Particularly scary are the notional amounts of derivatives contracts—more than $100 trillion worldwide—and the facts that banks, which are subject to bank panics, are major players in the derivatives markets. As a result of these fears, some politicians have called for restrictions on banks' involvement in the derivatives markets. Are financial derivatives a time bomb that could bring down the world financial system?

There are three major concerns about financial derivatives. First is that financial derivatives allow financial institutions to increase their leverage; that is, they can in effect hold an amount of the underlying asset that is many times greater than the amount of money they have had to put up. Increasing their leverage enables them to take huge bets on currency and interest-rate movements, which if they are wrong can bring down the bank, as was the case for Barings in 1995. This concern is valid. As we saw earlier in the chapter, the amount of money placed in margin accounts is only a small fraction of the price of the futures contract, meaning that small movements in the price of a contract can produce losses that are many times the size of the initial amount put in the margin account. Thus, although financial derivatives can be used to hedge risk, they can also be used by financial institutions to take on excessive risk.

The second concern is that financial derivatives are too sophisticated for managers of financial institutions because they are so complicated. Although it is true that some financial derivatives can be so complex that some financial managers are not sophisticated enough to use them, this seems unlikely to apply to the big international financial institutions that are the major players in the derivatives markets. The Barings Bank collapse discussed in Chapter 9, which was due to trading in derivatives, looks like it might have been an exception, but recall that the bank was brought down not by trades in complex derivatives but rather by trades in one of the simplest derivatives, stock index futures. Furthermore, Barings's problem was more a lack of internal controls at the bank than a problem with derivatives per se.

A third concern is that banks have holdings of huge notional amounts of financial derivatives, particularly swaps, that greatly exceed the amount of bank capital, and so these derivatives expose the banks to serious risk of failure. Banks are indeed major players in the financial derivatives markets, particularly the swaps market, where our earlier analysis has shown that they are the natural market-makers because they can act as intermediaries between two counterparties who would not make the swap without their involvement. However, looking at the notional amount of swaps at banks gives a very misleading picture of their risk exposure. Because banks act as intermediaries in the swap markets, they are typically exposed only to credit risk—a default by one of their counterparties. Furthermore, swaps, unlike loans, do not involve payments of the notional amount but rather the much smaller interest payments based on the notional amounts. For example, in the case of a 7% interest rate, the payment is only $70,000 for the $1 million swap. Estimates of the credit exposure from swap contracts indicate that they are on the order of only 1% of the notional value of the contracts and that credit exposure at banks from derivatives is generally less than a quarter of their total credit exposure from loans. Banks' credit exposures from their derivatives activities are thus not out of line with other credit exposures they face. Furthermore, an analysis by the GAO indicates that actual credit losses incurred by banks in their derivatives contracts have been very small, on the order of 0.2% of their gross credit exposure.

The conclusion is that financial derivatives have their dangers for financial institutions, but some of these dangers have been overplayed. The biggest danger occurs in trading activities of financial institutions, and as discussed in Chapter 11, regulators have been paying increased attention to this danger and have issued new disclosure requirements and regulatory guidelines for how derivatives trading should be done. The credit risk exposure posed by derivatives, by contrasts, seems to be manageable with standard methods of dealing with credit risk, both by managers of financial institutions and by their 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 interest-rate risk. The advantage of forward contracts is that they are flexible, but 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 (protect) against 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 the same amount for 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 related 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 prices 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 for macro hedges because they suffer from fewer accounting problems than financial futures.

4. Interest-rate swaps involve the exchange of one set of interest payments for another set of interest payments and 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 thatinterest-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 derivatives that offer 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 three concerns about the dangers of 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), they are too complex for managers of financial institutions to understand, 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 two dangers seem to be overplayed, but the danger from increased leverage using derivatives is real.

KEY TERMS

QUESTIONS AND PROBLEMS

Questions marked with an asterisk are answered at the end of the book in an appendix, "Answers to Selected Questions and Problems." Questions marked with a blue circle indicate the question is available in MyEconLab at www.myeconlab.com/mishkin.

1. 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?

*2. If the portfolio you manage is holding $25 million of 6s of 2023 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?

3. If at 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.

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

5. Suppose that 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?

*6. How would you use the options market to accomplish the same thing as in Problem 5? What are the advantages and disadvantages of using an options contract rather than a futures contract?

7. 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?

*8. 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 on expiration the futures contract has a price of 111, what is your profit or loss on the contract?

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

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

11. 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.

*12. 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.

13. 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?

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

15. Suppose that 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 would you want to enter into?

WEB EXERCISES

1. We have discussed the various stock markets in detail throughout this text. Another market that is less well known is the New York Mercantile Exchange. Here contracts on a wide variety of commodities are traded on a daily basis. Go to www.nymex.com/faq.aspx and read the discussion explaining the origin and purpose of the mercantile exchange. Write a one-page summary discussing this material.

2. The following site can be used to demonstrate how the features of an option affect the option's prices. Go to www.intrepid.com/~robertl/option-pricer4.html. 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

www.rmahq.org

The web site of the Risk Management Association reports useful information such as annual statement studies, on-line publications, and so on.

www.usafutures.com/stockindexfutures.htm

Detailed information about stock index futures.