

# 8

## CHAPTER

# Mechanics of Options Markets

We introduced options in Chapter 1. This chapter explains how options markets are organized, what terminology is used, how the contracts are traded, how margin requirements are set, and so on. Later chapters will examine such topics as trading strategies involving options, the determination of option prices, and the ways in which portfolios of options can be hedged. This chapter is concerned primarily with stock options. It presents some introductory material on currency options, index options, and futures options. More details concerning these instruments can be found in Chapter 14.

Options are fundamentally different from forward and futures contracts. An option gives the holder of the option the right to do something, but the holder does not have to exercise this right. By contrast, in a forward or futures contract, the two parties have committed themselves to some action. It costs a trader nothing (except for the margin requirements) to enter into a forward or futures contract, whereas the purchase of an option requires an up-front payment.

## 8.1 TYPES OF OPTIONS

As mentioned in Chapter 1, there are two basic types of options. A *call option* gives the holder of the option the right to buy an asset by a certain date for a certain price. A *put option* gives the holder the right to sell an asset by a certain date for a certain price. The date specified in the contract is known as the *expiration date* or the *maturity date*. The price specified in the contract is known as the *exercise price* or the *strike price*.

Options can be either American or European, a distinction that has nothing to do with geographical location. *American options* can be exercised at any time up to the expiration date, whereas *European options* can be exercised only on the expiration date itself. Most of the options that are traded on exchanges are American. However, European options are generally easier to analyze than American options, and some of the properties of an American option are frequently deduced from those of its European counterpart.

### Call Options

Consider the situation of an investor who buys a European call option with a strike price of \$100 to purchase 100 eBay shares. Suppose that the current stock price is \$98,

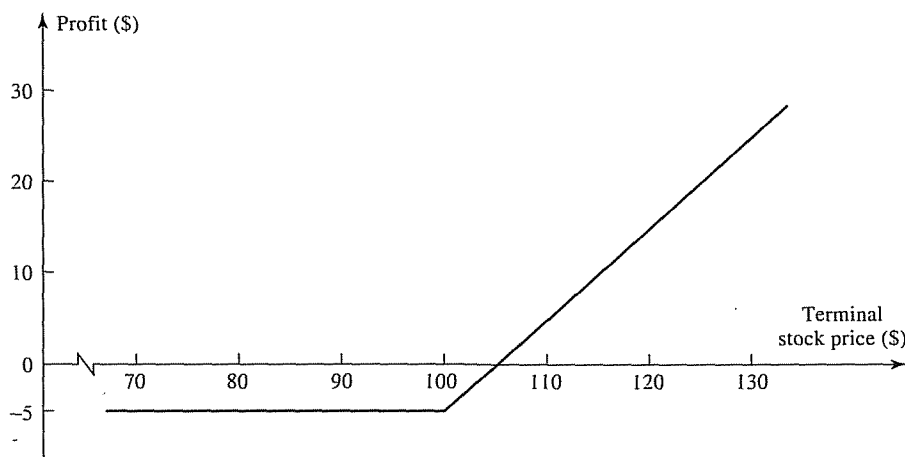
the expiration date of the option is in 4 months, and the price of an option to purchase one share is \$5. The initial investment is \$500. Because the option is European, the investor can exercise only on the expiration date. If the stock price on this date is less than \$100, the investor will clearly choose not to exercise. (There is no point in buying for \$100 a share that has a market value of less than \$100.) In these circumstances, the investor loses the whole of the initial investment of \$500. If the stock price is above \$100 on the expiration date, the option will be exercised. Suppose, for example, that the stock price is \$115. By exercising the option, the investor is able to buy 100 shares for \$100 per share. If the shares are sold immediately, the investor makes a gain of \$15 per share, or \$1,500, ignoring transactions costs. When the initial cost of the option is taken into account, the net profit to the investor is \$1,000.

Figure 8.1 shows how the investor's net profit or loss on an option to purchase one share varies with the final stock price in the example. It is important to realize that an investor sometimes exercises an option and makes a loss overall. Suppose that, in the example, eBay's stock price is \$102 at the expiration of the option. The investor would exercise the option for a gain of  $100 \times (\$102 - \$100) = \$200$  and realize a loss overall of \$300 when the initial cost of the option is taken into account. It is tempting to argue that the investor should not exercise the option in these circumstances. However, not exercising would lead to an overall loss of \$500, which is worse than the \$300 loss when the investor exercises. In general, call options should always be exercised at the expiration date if the stock price is above the strike price.

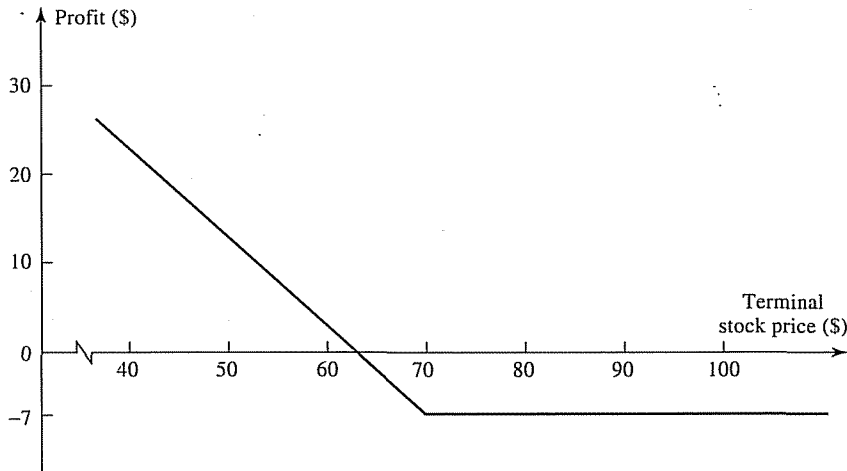
## Put Options

Whereas the purchaser of a call option is hoping that the stock price will increase, the purchaser of a put option is hoping that it will decrease. Consider an investor who buys a European put option to sell 100 shares in IBM with a strike price of \$70. Suppose that the current stock price is \$65, the expiration date of the option is in 3 months, and the

**Figure 8.1** Profit from buying a European call option on one eBay share. Option price = \$5; strike price = \$100.



**Figure 8.2** Profit from buying a European put option on one IBM share. Option price = \$7; strike price = \$70.



price of an option to sell one share is \$7. The initial investment is \$700. Because the option is European, it will be exercised only if the stock price is below \$70 on the expiration date. Suppose that the stock price is \$55 on this date. The investor can buy 100 shares for \$55 per share and, under the terms of the put option, sell the same shares for \$70 to realize a gain of \$15 per share, or \$1,500. (Again, transactions costs are ignored.) When the \$700 initial cost of the option is taken into account, the investor's net profit is \$800. There is no guarantee that the investor will make a gain. If the final stock price is above \$70, the put option expires worthless, and the investor loses \$700. Figure 8.2 shows the way in which the investor's profit or loss on an option to sell one share varies with the terminal stock price in this example.

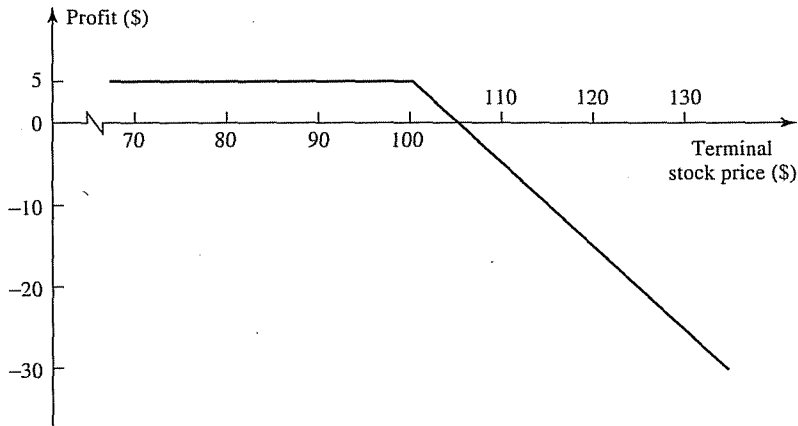
### Early Exercise

As already mentioned, exchange-traded stock options are generally American rather than European. That is, the investor in the foregoing examples would not have to wait until the expiration date before exercising the option. We will see later that there are some circumstances under which it is optimal to exercise American options prior to maturity.

## 8.2 OPTION POSITIONS

There are two sides to every option contract. On one side is the investor who has taken the long position (i.e., has bought the option). On the other side is the investor who has taken a short position (i.e., has sold or *written* the option). The writer of an option receives cash up front, but has potential liabilities later. The writer's profit or loss is the reverse of that for the purchaser of the option. Figures 8.3 and 8.4 show the variation of the profit or loss with the final stock price for writers of the options considered in Figures 8.1 and 8.2.

**Figure 8.3** Profit from writing a European call option on one eBay share. Option price = \$5; strike price = \$100.

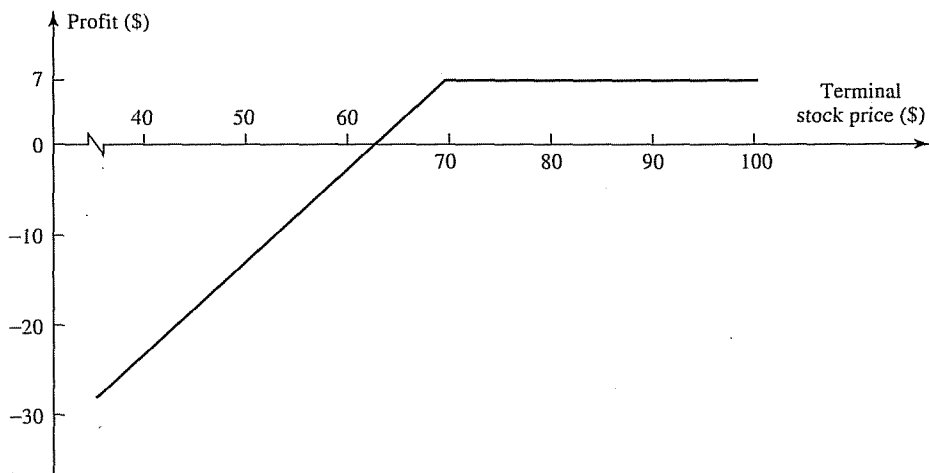


There are four types of option positions:

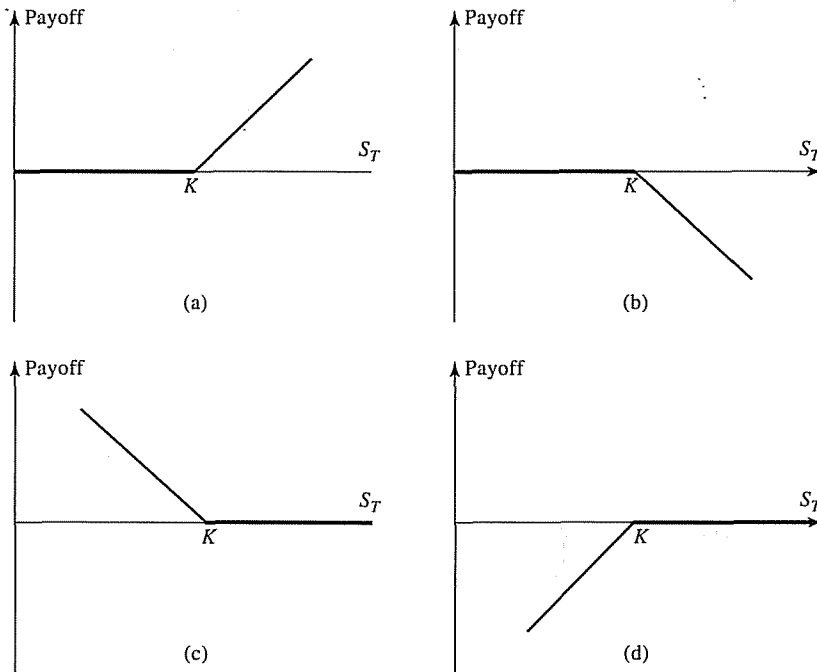
1. A long position in a call option
2. A long position in a put option
3. A short position in a call option
4. A short position in a put option

It is often useful to characterize European option positions in terms of the terminal value or payoff to the investor at maturity. The initial cost of the option is then not included in the calculation. If  $K$  is the strike price and  $S_T$  is the final price of the

**Figure 8.4** Profit from writing a European put option on one IBM share. Option price = \$7; strike price = \$70.



**Figure 8.5** Payoffs from positions in European options: (a) long call; (b) short call; (c) long put; (d) short put. Strike price =  $K$ ; price of asset at maturity =  $S_T$ .



underlying asset, the payoff from a long position in a European call option is

$$\max(S_T - K, 0)$$

This reflects the fact that the option will be exercised if  $S_T > K$  and will not be exercised if  $S_T \leq K$ . The payoff to the holder of a short position in the European call option is

$$-\max(S_T - K, 0) = \min(K - S_T, 0)$$

The payoff to the holder of a long position in a European put option is

$$\max(K - S_T, 0)$$

and the payoff from a short position in a European put option is

$$-\max(K - S_T, 0) = \min(S_T - K, 0)$$

Figure 8.5 illustrates these payoffs.

### 8.3 UNDERLYING ASSETS

This section provides a first look at options on stocks, currencies, stock indices, and futures.

## Stock Options

Most trading in stock options is on exchanges. In the United States the exchanges trading stock options are the Chicago Board Options Exchange ([www.cboe.com](http://www.cboe.com)), the Philadelphia Stock Exchange ([www.phlx.com](http://www.phlx.com)), the American Stock Exchange ([www.amex.com](http://www.amex.com)), the Pacific Exchange ([www.pacifex.com](http://www.pacifex.com)), and the International Securities Exchange ([www.iseoptions.com](http://www.iseoptions.com)). Options trade on more than 1,000 different stocks. One contract gives the holder the right to buy or sell 100 shares at the specified strike price. This contract size is convenient because the shares themselves are normally traded in lots of 100.

## Foreign Currency Options

Most currency options trading is now in the over-the-counter market, but there is some exchange trading. The major exchange for trading foreign currency options in the United States is the Philadelphia Stock Exchange. It offers both European and American contracts on a variety of different currencies. The size of one contract depends on the currency. For example, in the case of the British pound, one contract gives the holder the right to buy or sell £31,250; in the case of the Japanese yen, one contract gives the holder the right to buy or sell 6.25 million yen. Foreign currency options contracts are discussed further in Chapter 14.

## Index Options

Many different index options currently trade throughout the world in both the over-the-counter market and the exchange-traded market. The most popular exchange-traded contracts in the United States are those on the S&P 500 Index (SPX), the S&P 100 Index (OEX), the Nasdaq 100 Index (NDX), and the Dow Jones Industrial Index (DJX). All of these trade on the Chicago Board Options Exchange. Most of the contracts are European. An exception is the contract on the S&P 100, which is American. One contract is usually to buy or sell 100 times the index at the specified strike price. Settlement is always in cash, rather than by delivering the portfolio underlying the index. Consider, for example, one call contract on the S&P 100 with a strike price of 980. If it is exercised when the value of the index is 992, the writer of the contract pays the holder  $(992 - 980) \times 100 = \$1,200$ . This cash payment is based on the index value at the end of the day on which exercise instructions are issued. Not surprisingly, investors usually wait until the end of a day before issuing these instructions. Index options are discussed further in Chapter 14.

## Futures Options

When an exchange trades a particular futures contract it often also trades options on that contract. A futures option normally matures just before the delivery period in the futures contract. When a call option is exercised, the holder acquires from the writer a long position in the underlying futures contract plus a cash amount equal to the excess of the futures price over the strike price. When a put option is exercised, the holder acquires a short position in the underlying futures contract plus a cash amount equal to the excess of the strike price over the futures price. Futures options contracts are discussed further in Chapter 14.

## 8.4 SPECIFICATION OF STOCK OPTIONS

In the rest of this chapter, we will focus on stock options. As already mentioned, an exchange-traded stock option in the United States is an American-style option contract to buy or sell 100 shares of the stock. Details of the contract—the expiration date, the strike price, what happens when dividends are declared, how large a position investors can hold, and so on—are specified by the exchange.

### Expiration Dates

One of the items used to describe a stock option is the month in which the expiration date occurs. Thus, a January call trading on IBM is a call option on IBM with an expiration date in January. The precise expiration date is the Saturday immediately following the third Friday of the expiration month. The last day on which options trade is the third Friday of the expiration month. An investor with a long position in an option normally has until 4:30 p.m. Central Time on that Friday to instruct a broker to exercise the option. The broker then has until 10:59 p.m. the next day to complete the paperwork notifying the exchange that exercise is to take place.

Stock options are on a January, February, or March cycle. The January cycle consists of the months of January, April, July, and October. The February cycle consists of the months of February, May, August, and November. The March cycle consists of the months of March, June, September, and December. If the expiration date for the current month has not yet been reached, options trade with expiration dates in the current month, the following month, and the next two months in the cycle. If the expiration date of the current month has passed, options trade with expiration dates in the next month, the next-but-one month, and the next two months of the expiration cycle. For example, IBM is on a January cycle. At the beginning of January, options are traded with expiration dates in January, February, April, and July; at the end of January, they are traded with expiration dates in February, March, April, and July; at the beginning of May, they are traded with expiration dates in May, June, July, and October; and so on. When one option reaches expiration, trading in another is started. Longer-term options, known as LEAPS (long-term equity anticipation securities), also trade on about 500 stocks in the United States. These have expiration dates up to 3 years into the future. The expiration dates for LEAPS on stocks are always in January.

### Strike Prices

The exchange normally chooses the strike prices at which options can be written so that they are spaced \$2.50, \$5, or \$10 apart. Typically the spacing is \$2.50 when the stock price is between \$5 and \$25, \$5 when the stock price is between \$25 and \$200, and \$10 for stock prices above \$200. As will be explained shortly, stock splits and stock dividends can lead to nonstandard strike prices.

When a new expiration date is introduced, the two or three strike prices closest to the current stock price are usually selected by the exchange. If the stock price moves outside the range defined by the highest and lowest strike price, trading is usually introduced in an option with a new strike price. To illustrate these rules, suppose that the stock price is \$84 when trading begins in the October options. Call and put options would probably first be offered with strike prices of \$80, \$85, and \$90. If the stock price rose

above \$90, it is likely that a strike price of \$95 would be offered; if it fell below \$80, it is likely that a strike price of \$75 would be offered; and so on.

## Terminology

For any given asset at any given time, many different option contracts may be trading. Consider a stock that has four expiration dates and five strike prices. If call and put options trade with every expiration date and every strike price, there are a total of 40 different contracts. All options of the same type (calls or puts) are referred to as an *option class*. For example, IBM calls are one class, whereas IBM puts are another class. An *option series* consists of all the options of a given class with the same expiration date and strike price. In other words, an option series refers to a particular contract that is traded. The IBM 50 October calls are an option series.

Options are referred to as *in the money*, *at the money*, or *out of the money*. If  $S$  is the stock price and  $K$  is the strike price, a call option is in the money when  $S > K$ , at the money when  $S = K$ , and out of the money when  $S < K$ . A put option is in the money when  $S < K$ , at the money when  $S = K$ , and out of the money when  $S > K$ . Clearly, an option will be exercised only when it is in the money. In the absence of transactions costs, an in-the-money option will always be exercised on the expiration date if it has not been exercised previously.

The *intrinsic value* of an option is defined as the maximum of zero and the value the option would have if it were exercised immediately. For a call option, the intrinsic value is therefore  $\max(S - K, 0)$ . For a put option, it is  $\max(K - S, 0)$ . An in-the-money American option must be worth at least as much as its intrinsic value because the holder can realize a positive intrinsic value by exercising immediately. Often it is optimal for the holder of an in-the-money American option to wait rather than exercise immediately. The option is then said to have *time value*. The total value of an option can be thought of as the sum of its intrinsic value and its time value.

## FLEX Options

The Chicago Board Options Exchange offers FLEX (short for flexible) options on equities and equity indices. These are options where the traders on the floor of the exchange agree to nonstandard terms. These nonstandard terms can involve a strike price or an expiration date that is different from what is usually offered by the exchange. It can also involve the option being European rather than American. FLEX options are an attempt by option exchanges to regain business from the over-the-counter markets. The exchange specifies a minimum size (e.g., 100 contracts) for FLEX option trades.

## Dividends and Stock Splits

The early over-the-counter options were dividend protected. If a company declared a cash dividend, the strike price for options on the company's stock was reduced on the ex-dividend day by the amount of the dividend. Exchange-traded options are not usually adjusted for cash dividends. In other words, when a cash dividend occurs, there are no adjustments to the terms of the option contract. An exception is sometimes made for large cash dividends (see the Gucci Group example in Business Snapshot 8.1).

Exchange-traded options are adjusted for stock splits. A stock split occurs when the existing shares are "split" into more shares. For example, in a 3-for-1 stock split, three



**Business Snapshot 8.1** Gucci Group's Large Dividend

When there is a large cash dividend (typically one more than 10% of the stock price), a committee of the Options Clearing Corporation (OCC) at the Chicago Board Options Exchange can decide to make adjustments to the terms of options traded on the exchange.

On May 28, 2003, Gucci Group NV (GUC) declared a cash dividend of 13.50 euros (approximately \$15.88) per common share and this was approved at the GUC annual shareholders meeting on July 16, 2003. The dividend was about 16% of the share price at the time it was declared. In this case, the OCC committee decided to adjust the terms of options. As a result, exercise of an option contract required the delivery of 100 shares plus  $100 \times 15.88 = \$1,588$  of cash. The holder of a call contract paid 100 times the strike price on exercise and received \$1,588 of cash in addition to 100 shares. The holder of a put contract received 100 times the strike price on exercise and delivered \$1,588 of cash in addition to 100 shares. These adjustments had the effect of reducing the strike price by \$15.88.

Adjustments for large dividends are not always made. For example, Deutsche Terminbörse chose not to adjust the terms of options traded on that exchange when Daimler-Benz surprised the market on March 10, 1998, with a dividend equal to about 12% of its stock price.

new shares are issued to replace each existing share. Because a stock split does not change the assets or the earning ability of a company, we should not expect it to have any effect on the wealth of the company's shareholders. All else being equal, the 3-for-1 stock split should cause the stock price to go down to one-third of its previous value. In general, an  $n$ -for- $m$  stock split should cause the stock price to go down to  $m/n$  of its previous value. The terms of option contracts are adjusted to reflect expected changes in a stock price arising from a stock split. After an  $n$ -for- $m$  stock split, the strike price is reduced to  $m/n$  of its previous value, and the number of shares covered by one contract is increased to  $n/m$  of its previous value. If the stock price declines in the way expected, the positions of both the writer and the purchaser of a contract remain unchanged.

**Example 8.1**

Consider a call option to buy 100 shares of a company for \$30 per share. Suppose that the company makes a 2-for-1 stock split. The terms of the option contract are then changed so that it gives the holder the right to purchase 200 shares for \$15 per share.

Stock options are adjusted for stock dividends. A stock dividend involves a company issuing more shares to its existing shareholders. For example, a 20% stock dividend means that investors receive one new share for each five already owned. A stock dividend, like a stock split, has no effect on either the assets or the earning power of a company. The stock price can be expected to go down as a result of a stock dividend. The 20% stock dividend referred to is essentially the same as a 6-for-5 stock split. All else being equal, it should cause the stock price to decline to  $5/6$  of its previous value. The terms of an option are adjusted to reflect the expected price decline arising from a stock dividend in the same way as they are for that arising from a stock split.

**Example 8.2**

Consider a put option to sell 100 shares of a company for \$15 per share. Suppose that the company declares a 25% stock dividend. This is equivalent to a 5-for-4 stock split. The terms of the option contract are changed so that it gives the holder the right to sell 125 shares for \$12.

Adjustments are also made for rights issues. The basic procedure is to calculate the theoretical price of the rights and then to reduce the strike price by this amount.

**Position Limits and Exercise Limits**

The Chicago Board Options Exchange often specifies a *position limit* for option contracts. This defines the maximum number of option contracts that an investor can hold on one side of the market. For this purpose, long calls and short puts are considered to be on the same side of the market. Also considered to be on the same side are short calls and long puts. The *exercise limit* usually equals the position limit. It defines the maximum number of contracts that can be exercised by any individual (or group of individuals acting together) in any period of five consecutive business days. Options on the largest and most frequently traded stocks have position limits of 75,000 contracts. Smaller capitalization stocks have position limits of 60,000, 31,500, 22,500, or 13,500 contracts.

Position limits and exercise limits are designed to prevent the market from being unduly influenced by the activities of an individual investor or group of investors. However, whether the limits are really necessary is a controversial issue.

**8.5 NEWSPAPER QUOTES**

Many newspapers carry options prices. Table 8.1 shows the prices as they appeared in the *Wall Street Journal* of Thursday February 5, 2004. They refer to the last trade on the previous day (Wednesday February 4, 2004).

The first part of the table shows the 40 most actively traded option contract listed according to their volume of trading. The most active contract was the February 2004 contract on the Nasdaq 100 index. From the table we see that a call option contract on Cisco expiring in February 2004 with a strike price of \$25 traded for \$0.40 down \$1.60 from the previous day. The closing price of Cisco's stock was \$24.08. Similarly, a put option on Peoplesoft expiring in April 2004 with a strike price 20 traded for \$0.50 down \$0.35 from the previous day. Peoplesoft's stock price closed at \$22.70. The second part of the table shows quotes for long-term options (LEAPS). For example, a Cisco call with a strike price of \$30 expiring in January 2006 traded for \$2.75, while the corresponding put traded for \$7.20.

As mentioned earlier, one contract is for the purchase or sale of 100 shares. One contract therefore costs 100 times the price shown. Because most options are priced at less than \$10 and some are priced at less than \$1, investors do not have to be extremely wealthy to trade options.

The *Wall Street Journal* also shows at the end of the first part of the table the total call volume, put volume, call open interest, and put open interest for each exchange. As in the case of futures contracts, the volume is the total number of contracts traded on a day and the open interest is the number of contracts outstanding.

Table 8.1 Stock option quotes from the *Wall Street Journal* on February 5, 2004.

MOST ACTIVE LISTED OPTIONS																							
Wednesday, February 4, 2004																							
Composite volume and close for actively traded equity and LEAPS, or long-term options, with results for the corresponding put or call contract. Volume figures are unofficial. Open interest is total outstanding for all exchanges and reflects previous trading day: Close when possible is shown for the underlying stock or primary market. XC-Composite. p-Put. o-Strike price adjusted for split.																							
OPTION/STRIKE		VOL EXCH		LAST		NET CHG		CLOSE		OPEN INT		OPTION/STRIKE		VOL EXCH		LAST		NET CHG		CLOSE		OPEN INT	

## 8.6 TRADING

Traditionally, exchanges have had to provide a large open area for individuals to meet and trade options. This is changing. Eurex, the large European derivatives exchange, is fully electronic, so traders do not have to physically meet.<sup>1</sup> The International Securities Exchange ([www.iseoptions.com](http://www.iseoptions.com)) launched the first all-electronic options market for equities in the United States in May 2000. The Chicago Board Options Exchange has CBOEdirect, and the CME has GLOBEX. Both are electronic systems that run side by side with their floor-based open-outcry markets.

### Market Makers

Most options exchanges use market makers to facilitate trading. A market maker for a certain option is an individual who, when asked to do so, will quote both a bid and an offer price on the option. The bid is the price at which the market maker is prepared to buy, and the offer is the price at which the market maker is prepared to sell. At the time the bid and offer prices are quoted, the market maker does not know whether the trader who asked for the quotes wants to buy or sell the option. The offer is always higher than the bid, and the amount by which the offer exceeds the bid is referred to as the *bid-offer spread*. The exchange sets upper limits for the bid-offer spread. For example, it might specify that the spread be no more than \$0.25 for options priced at less than \$0.50, \$0.50 for options priced between \$0.50 and \$10, \$0.75 for options priced between \$10 and \$20, and \$1 for options priced over \$20.

The existence of the market maker ensures that buy and sell orders can always be executed at some price without any delays. Market makers therefore add liquidity to the market. The market makers themselves make their profits from the bid-offer spread. They use some of the schemes discussed later in this book to hedge their risks.

### Offsetting Orders

An investor who has purchased an option can close out the position by issuing an offsetting order to sell the same option. Similarly, an investor who has written an option can close out the position by issuing an offsetting order to buy the same option. (In this respect options markets are similar to futures markets.) If, when an options contract is traded, neither investor is closing an existing position, the open interest increases by one contract. If one investor is closing an existing position and the other is not, the open interest stays the same. If both investors are closing existing positions, the open interest goes down by one contract.

## 8.7 COMMISSIONS

The types of orders that can be placed with a broker for options trading are similar to those for futures trading (see Section 2.7). A market order is to be executed immediately; a limit order specifies the least favorable price at which the order can be executed; and so on.

<sup>1</sup> Eurex has set up an all-electronic exchange in Chicago.

For a retail investor, commissions vary significantly from broker to broker. Discount brokers generally charge lower commissions than full-service brokers. The actual amount charged is often calculated as a fixed cost plus a proportion of the dollar amount of the trade. Table 8.2 shows the sort of schedule that might be offered by a discount broker. Thus, the purchase of eight contracts when the option price is \$3 would cost  $\$20 + (0.02 \times \$2,400) = \$68$  in commissions.

If an option position is closed out by entering into an offsetting trade, the commission must be paid again. If the option is exercised, the commission is the same as it would be if the investor placed an order to buy or sell the underlying stock. Typically, this is 1% to 2% of the stock's value.

Consider an investor who buys one call contract with a strike price of \$50 when the stock price is \$49. We suppose the option price is \$4.50, so that the cost of the contract is \$450. Under the schedule in Table 8.2, the purchase or sale of one contract always costs \$30 (both the maximum and minimum commission is \$30 for the first contract). Suppose that the stock price rises and the option is exercised when the stock reaches \$60. Assuming that the investor pays 1.5% commission on stock trades, the commission payable when the option is exercised is

$$0.015 \times \$60 \times 100 = \$90$$

The total commission paid is therefore \$120, and the net profit to the investor is

$$\$1,000 - \$450 - \$120 = \$430$$

Note that selling the option for \$10 instead of exercising it would save the investor \$60 in commissions. (The commission payable when an option is sold is only \$30 in our example.) In general, the commission system tends to push retail investors in the direction of selling options rather than exercising them.

A hidden cost in option trading (and in stock trading) is the market maker's bid-offer spread. Suppose that, in the example just considered, the bid price was \$4.00 and the offer price was \$4.50 at the time the option was purchased. We can reasonably assume that a "fair" price for the option is halfway between the bid and the offer price, or \$4.25. The cost to the buyer and to the seller of the market maker system is the difference between the fair price and the price paid. This is \$0.25 per option, or \$25 per contract.

**Table 8.2** A typical commission schedule for a discount broker.

<i>Dollar amount of trade</i>	<i>Commission*</i>
< \$2,500	\$20 + 2% of dollar amount
\$2,500 to \$10,000	\$45 + 1% of dollar amount
> \$10,000	\$120 + 0.25% of dollar amount

\* Maximum commission is \$30 per contract for the first five contracts plus \$20 per contract for each additional contract. Minimum commission is \$30 per contract for the first contract plus \$2 per contract for each additional contract.

## 8.8 MARGINS

When shares are purchased in the United States, an investor can either pay cash or borrow using a margin account. (This is known as *buying on margin*.) The initial margin is usually 50% of the value of the shares, and the maintenance margin is usually 25% of the value of the shares. The margin account operates like that for a futures contract (see Chapter 2).

When call and put options with maturities less than 9 months are purchased, the option price must be paid in full. Investors are not allowed to buy these options on margin because options already contain substantial leverage and buying on margin would raise this leverage to an unacceptable level. For options with maturities greater than 9 months investors can buy on margin, borrowing up to 25% of the option value.

An investor who writes options is required to maintain funds in a margin account. Both the investor's broker and the exchange want to be satisfied that the investor will not default if the option is exercised. The size of the margin required depends on the circumstances.

### Writing Naked Options

A *naked option* is an option that is not combined with an offsetting position in the underlying stock. The initial margin required by the CBOE for a written naked call option is the greater of the following two calculations:

1. A total of 100% of the proceeds of the sale plus 20% of the underlying share price less the amount, if any, by which the option is out of the money
2. A total of 100% of the option proceeds plus 10% of the underlying share price

For a written naked put option, it is the greater of

1. A total of 100% of the proceeds of the sale plus 20% of the underlying share price less the amount, if any, by which the option is out of the money
2. A total of 100% of the option proceeds plus 10% of the exercise price

The 20% in the preceding calculations is replaced by 15% for options on a broadly based stock index because a stock index is usually less volatile than the price of an individual stock.

#### Example 8.3

An investor writes four naked call option contracts on a stock. The option price is \$5, the strike price is \$40, and the stock price is \$38. Because the option is \$2 out of the money, the first calculation gives

$$400 \times (5 + 0.2 \times 38 - 2) = \$4,240$$

The second calculation gives

$$400 \times (5 + 0.1 \times 38) = \$3,520$$

The initial margin requirement is therefore \$4,240. Note that, if the option had

been a put, it would be \$2 in the money and the margin requirement would be

$$400 \times (5 + 0.2 \times 38) = \$5,040$$

In both cases the proceeds of the sale, \$2,000, can be used to form part of the margin account.

A calculation similar to the initial margin calculation (but with the current market price replacing the proceeds of sale) is repeated every day. Funds can be withdrawn from the margin account when the calculation indicates that the margin required is less than the current balance in the margin account. When the calculation indicates that a significantly greater margin is required, a margin call will be made.

## Other Rules

In Chapter 10, we will examine option trading strategies such as covered calls, protective puts, spreads, combinations, straddles, and strangles. The CBOE has special rules for determining the margin requirements when these trading strategies are used. These are described in the *CBOE Margin Manual*, which is available on the CBOE website ([www.cboe.com](http://www.cboe.com)).

As an example of the rules, consider an investor who writes a covered call. This is a written call option when the shares that might have to be delivered are already owned. Covered calls are far less risky than naked calls, because the worst that can happen is that the investor is required to sell shares already owned at below their market value. No margin is required on the written option. However, the investor can borrow an amount equal to  $0.5 \min(S, K)$ , rather than the usual  $0.5S$ , on the stock position.

## 8.9 THE OPTIONS CLEARING CORPORATION

The Options Clearing Corporation (OCC) performs much the same function for options markets as the clearinghouse does for futures markets (see Chapter 2). It guarantees that options writers will fulfill their obligations under the terms of options contracts and keeps a record of all long and short positions. The OCC has a number of members, and all options trades must be cleared through a member. If a brokerage house is not itself a member of an exchange's OCC, it must arrange to clear its trades with a member. Members are required to have a certain minimum amount of capital and to contribute to a special fund that can be used if any member defaults on an option obligation.

The writer of the option maintains a margin account with a broker, as described earlier.<sup>2</sup> The broker maintains a margin account with the OCC member that clears its trades. The OCC member in turn maintains a margin account with the OCC.

### Exercising an Option

When an investor notifies a broker to exercise an option, the broker in turn notifies the OCC member that clears its trades. This member then places an exercise order with

<sup>2</sup> The margin requirements described in the previous section are the minimum requirements specified by the OCC. A brokerage house may require higher margins from its clients. However, it cannot require lower margins. Some brokerage houses do not allow their retail clients to write uncovered options at all.

the OCC. The OCC randomly selects a member with an outstanding short position in the same option. The member, using a procedure established in advance, selects a particular investor who has written the option. If the option is a call, this investor is required to sell stock at the strike price. If it is a put, the investor is required to buy stock at the strike price. The investor is said to be *assigned*. When an option is exercised, the open interest goes down by one.

At the expiration of the option, all in-the-money options should be exercised unless the transactions costs are so high as to wipe out the payoff from the option. Some brokerage firms will automatically exercise options for a client at expiration when it is in their client's interest to do so. Many exchanges also have rules for exercising options that are in the money at expiration.

## 8.10 REGULATION

Options markets are regulated in a number of different ways. Both the exchange and its Options Clearing Corporation have rules governing the behavior of traders. In addition, there are both federal and state regulatory authorities. In general, options markets have demonstrated a willingness to regulate themselves. There have been no major scandals or defaults by OCC members. Investors can have a high level of confidence in the way the market is run.

The Securities and Exchange Commission is responsible for regulating options markets in stocks, stock indices, currencies, and bonds at the federal level. The Commodity Futures Trading Commission is responsible for regulating markets for options on futures. The major options markets are in the states of Illinois and New York. These states actively enforce their own laws on unacceptable trading practices.

## 8.11 TAXATION

Determining the tax implications of options strategies can be tricky, and an investor who is in doubt about this should consult a tax specialist. In the United States, the general rule is that (unless the taxpayer is a professional trader) gains and losses from the trading of stock options are taxed as capital gains or losses. The way that capital gains and losses are taxed in the United States was discussed in Section 2.9. For both the holder and the writer of a stock option, a gain or loss is recognized when (a) the option expires unexercised or (b) the option position is closed out. If the option is exercised, the gain or loss from the option is rolled into the position taken in the stock and recognized when the stock position is closed out. For example, when a call option is exercised, the party with a long position is deemed to have purchased the stock at the strike price plus the call price. This is then used as a basis for calculating this party's gain or loss when the stock is eventually sold. Similarly, the party with the short call position is deemed to have sold the stock at the strike price plus the call price. When a put option is exercised, the seller of the option is deemed to have bought the stock for the strike price less the original put price and the purchaser of the option is deemed to have sold the stock for the strike price less the original put price.



## Wash Sale Rule

One tax consideration in option trading in the United States is the wash sale rule. To understand this rule, imagine an investor who buys a stock when the price is \$60 and plans to keep it for the long term. If the stock price drops to \$40, the investor might be tempted to sell the stock and then immediately repurchase it, so that the \$20 loss is realized for tax purposes. To prevent this sort of thing, the tax authorities have ruled that when the repurchase is within 30 days of the sale (i.e., between 30 days before the sale and 30 days after the sale), any loss on the sale is not deductible. The disallowance also applies where, within the 61-day period, the taxpayer enters into an option or similar contract to acquire the stock. Thus, selling a stock at a loss and buying a call option within a 30-day period will lead to the loss being disallowed. The wash sale rule does not apply if the taxpayer is a dealer in stocks or securities and the loss is sustained in the ordinary course of business.

## Constructive Sales

Prior to 1997, if a United States taxpayer shorted a security while holding a long position in a substantially identical security, no gain or loss was recognized until the short position was closed out. This means that short positions could be used to defer recognition of a gain for tax purposes. The situation was changed by the Tax Relief Act of 1997. An appreciated property is now treated as “constructively sold” when the owner does one of the following:

1. Enters into a short sale of the same or substantially identical property
2. Enters into a futures or forward contract to deliver the same or substantially identical property
3. Enters into one or more positions that eliminate substantially all of the loss and opportunity for gain

It should be noted that transactions reducing only the risk of loss or only the opportunity for gain should not result in constructive sales. Therefore an investor holding a long position in a stock can buy in-the-money put options on the stock without triggering a constructive sale.

Tax practitioners sometimes use options to minimize tax costs or maximize tax benefits (see Business Snapshot 8.2). Tax authorities in many jurisdictions have proposed legislation designed to combat the use of derivatives for tax purposes. Before entering into any tax-motivated transaction, a corporate treasurer or private individual should explore in detail how the structure could be unwound in the event of legislative change and how costly this process could be.

## 8.12 WARRANTS, EXECUTIVE STOCK OPTIONS, AND CONVERTIBLES

Usually, when a call option on a stock is exercised, the party with the short position acquires shares that have already been issued and sells them to the party with the long position for the strike price. The company whose stock underlies the option is not involved in any way. Warrants and executive stock options are call options that work slightly differently. They are written by a company on its own stock. When they are

**Business Snapshot 8.2 Tax Planning Using Options**

As a simple example of a possible tax planning strategy using options, suppose that Country A has a tax regime where the tax is low on interest and dividends and high on capital gains, while Country B has a tax regime where tax is high on interest and dividends and low on capital gains. It is advantageous for a company to receive the income from a security in Country A and the capital gain, if there is one, in Country B. The company would like to keep capital losses in Country A, where they can be used to offset capital gains on other items. All of this can be accomplished by arranging for a subsidiary company in Country A to have legal ownership of the security and for a subsidiary company in Country B to buy a call option on the security from the company in Country A, with the strike price of the option equal to the current value of the security. During the life of the option, income from the security is earned in Country A. If the security price rises sharply, the option will be exercised and the capital gain will be realized in Country B. If it falls sharply, the option will not be exercised and the capital loss will be realized in Country A.

exercised, the company satisfies the option holder by issuing more of its own stock and selling it to the option holder for the strike price. The exercise of a warrant or executive stock option therefore leads to an increase in the number of shares of the company's stock that are outstanding.

*Warrants* are call options that often come into existence as a result of a bond issue. They are added to the bond issue to make it more attractive to investors. Typically, a warrant lasts for a number of years. Once they have been created, they sometimes trade separately from the bonds to which they were originally attached.

*Executive stock options* are call options issued to executives to motivate them to act in the best interests of the company's shareholders (see Business Snapshot 8.3). Recently there has been a great deal of controversy about whether executive stock options should be expensed by companies on their income statements. Some companies and their accountants argue that there is no reliable way of doing this. Options experts contend that executive stock options can be valued at least as precisely as other items in financial statements. The valuation of warrants and executive stock options is discussed in Chapter 13.

A *convertible bond* is a bond issued by a company that can be converted into equity at certain times using a predetermined exchange ratio. It is therefore a bond with an embedded call option on the company's stock. Convertibles are like warrants and executive stock options in that their exercise leads to more shares being issued by the company. Convertible bonds are discussed in more detail in Chapter 21.

## 8.13 OVER-THE-COUNTER MARKETS

Most of this chapter has focused on exchange-traded options markets. The over-the-counter market for options has become increasingly important since the early 1980s and is now larger than the exchange-traded market. As explained in Chapter 1, in the over-the-counter market, financial institutions, corporate treasurers, and fund managers trade over the phone. There is a wide range of assets underlying the options. Over-the-counter

**Business Snapshot 8.3** Executive Stock Options

Stock options became an increasingly popular type of compensation for executives and other employees in the 1990s and early 2000s. In a typical arrangement, an executive is granted a certain number of call options on the stock of the company for which he or she works. The options are at the money on the grant date. They often last for 10 years or even longer and there is a vesting period of up to 5 years. The options cannot be exercised during the vesting period, but can be exercised any time after the vesting period ends. If the executive leaves the company during the vesting period, the options are forfeited. If the executive leaves the company after the end of the vesting period, in-the-money options are exercised immediately while out-of-the-money options are forfeited. Options cannot be sold to another party by the executive.

One reason why executive stock options have been so attractive has been their accounting treatment. The compensation cost charged to the income statement for an employee stock option in the United States and other countries used to be its intrinsic value. Because most executive stock options are at the money when they are issued, this compensation cost was usually zero. In 1995, accounting standard FAS 123 was issued. This encouraged, but did not require, companies to expense the “fair value” of the options on their income statement. (If the fair value was not expensed on the income statement, it had to be reported in a footnote to the company’s accounts.) At first very few companies chose to expense stock options voluntarily, but as the cost to the company of these options began to receive more publicity in the early 2000s more did so.

Accounting standards have now changed to require the expensing of stock options at their fair value on the income statement. In February 2004, the International Accounting Standards Board issued IAS 2, which required companies to start expensing stock options in 2005. In December 2004, FAS 123 was revised to require the expensing of executive stock options in the United States starting in 2005.

Executive stock options tend to be exercised earlier than similar exchange-traded or over-the-counter options because the executive is not allowed to sell the options. If an executive wants to realize cash from the options, he or she has to exercise the options and sell the stock. For this reason, valuing executive stock options is not as easy as valuing regular options. It requires a model of the executives’ early exercise behavior.

options on foreign exchange and interest rates are particularly popular. The chief potential disadvantage of the over-the-counter market is that option writer may default. This means that the purchaser is subject to some credit risk. In an attempt to overcome this disadvantage, market participants are adopting a number of measures such as requiring counterparties to post collateral. This was discussed in Section 2.4.

The instruments traded in the over-the-counter market are often structured by financial institutions to meet the precise needs of their clients. Sometimes this involves choosing exercise dates, strike prices, and contract sizes that are different from those traded by the exchange. In other cases the structure of the option is different from standard calls and puts. The option is then referred to as an *exotic option*. Chapter 22 describes a number of different types of exotic options.

## SUMMARY

There are two types of options: calls and puts. A call option gives the holder the right to buy the underlying asset for a certain price by a certain date. A put option gives the holder the right to sell the underlying asset by a certain date for a certain price. There are four possible positions in options markets: a long position in a call, a short position in a call, a long position in a put, and a short position in a put. Taking a short position in an option is known as writing it. Options are currently traded on stocks, stock indices, foreign currencies, futures contracts, and other assets.

An exchange must specify the terms of the option contracts it trades. In particular, it must specify the size of the contract, the precise expiration time, and the strike price. In the United States one stock option contract gives the holder the right to buy or sell 100 shares. The expiration of a stock option contract is 10:59 p.m. Central Time on the Saturday immediately following the third Friday of the expiration month. Options with several different expiration months trade at any given time. Strike prices are at \$2 $\frac{1}{2}$ , \$5, or \$10 intervals, depending on the stock price. The strike price is generally fairly close to the stock price when trading in an option begins.

The terms of a stock option are not normally adjusted for cash dividends. However, they are adjusted for stock dividends, stock splits, and rights issues. The aim of the adjustment is to keep the positions of both the writer and the buyer of a contract unchanged.

Most options exchanges use market makers. A market maker is an individual who is prepared to quote both a bid price (at which he or she is prepared to buy) and an offer price (at which he or she is prepared to sell). Market makers improve the liquidity of the market and ensure that there is never any delay in executing market orders. They themselves make a profit from the difference between their bid and offer prices (known as their bid-offer spread). The exchange has rules specifying upper limits for the bid-offer spread.

Writers of options have potential liabilities and are required to maintain margins with their brokers. If it is not a member of the Options Clearing Corporation, the broker will maintain a margin account with a firm that is a member. This firm will in turn maintain a margin account with the Options Clearing Corporation. The Options Clearing Corporation is responsible for keeping a record of all outstanding contracts, handling exercise orders, and so on.

Not all options are traded on exchanges. Many options are traded by phone in the over-the-counter market. An advantage of over-the-counter options is that they can be tailored by a financial institution to meet the particular needs of a corporate treasurer or fund manager.

## FURTHER READING

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Hull, J. C., and A. White, "How to Value Employee Stock Options," *Financial Analysts Journal*, 60, 1 (January/February 2004): 114–19.

Rubinstein, M. "On the Accounting Valuation of Employee Stock Options," *Journal of Derivatives*, 3, 1 (Fall 1995): 8–24.

## Questions and Problems (Answers in Solutions Manual)

- 8.1. An investor buys a European put on a share for \$3. The stock price is \$42 and the strike price is \$40. Under what circumstances does the investor make a profit? Under what circumstances will the option be exercised? Draw a diagram showing the variation of the investor's profit with the stock price at the maturity of the option.
- 8.2. An investor sells a European call on a share for \$4. The stock price is \$47 and the strike price is \$50. Under what circumstances does the investor make a profit? Under what circumstances will the option be exercised? Draw a diagram showing the variation of the investor's profit with the stock price at the maturity of the option.
- 8.3. An investor sells a European call option with strike price of  $K$  and maturity  $T$  and buys a put with the same strike price and maturity. Describe the investor's position.
- 8.4. Explain why brokers require margins when clients write options but not when they buy options.
- 8.5. A stock option is on a February, May, August, and November cycle. What options trade on (a) April 1 and (b) May 30?
- 8.6. A company declares a 2-for-1 stock split. Explain how the terms change for a call option with a strike price of \$60.
- 8.7. How is an executive stock option different from a regular exchange-traded or over-the-counter American-style stock option?
- 8.8. A corporate treasurer is designing a hedging program involving foreign currency options. What are the pros and cons of using (a) the Philadelphia Stock Exchange and (b) the over-the-counter market for trading?
- 8.9. Suppose that a European call option to buy a share for \$100.00 costs \$5.00 and is held until maturity. Under what circumstances will the holder of the option make a profit? Under what circumstances will the option be exercised? Draw a diagram illustrating how the profit from a long position in the option depends on the stock price at maturity of the option.
- 8.10. Suppose that a European put option to sell a share for \$60 costs \$8 and is held until maturity. Under what circumstances will the seller of the option (the party with the short position) make a profit? Under what circumstances will the option be exercised? Draw a diagram illustrating how the profit from a short position in the option depends on the stock price at maturity of the option.
- 8.11. Describe the terminal value of the following portfolio: a newly entered-into long forward contract on an asset and a long position in a European put option on the asset with the same maturity as the forward contract and a strike price that is equal to the forward price of the asset at the time the portfolio is set up. Show that the European put option has the same value as a European call option with the same strike price and maturity.
- 8.12. A trader buys a call option with a strike price of \$45 and a put option with a strike price of \$40. Both options have the same maturity. The call costs \$3 and the put costs \$4. Draw a diagram showing the variation of the trader's profit with the asset price.

- 8.13. Explain why an American option is always worth at least as much as a European option on the same asset with the same strike price and exercise date.
- 8.14. Explain why an American option is always worth at least as much as its intrinsic value.
- 8.15. Explain carefully the difference between writing a put option and buying a call option.
- 8.16. The treasurer of a corporation is trying to choose between options and forward contracts to hedge the corporation's foreign exchange risk. Discuss the advantages and disadvantages of each.
- 8.17. Consider an exchange-traded call option contract to buy 500 shares with a strike price of \$40 and maturity in 4 months. Explain how the terms of the option contract change when there is: (a) a 10% stock dividend; (b) a 10% cash dividend; and (c) a 4-for-1 stock split.
- 8.18. "If most of the call options on a stock are in the money, it is likely that the stock price has risen rapidly in the last few months." Discuss this statement.
- 8.19. What is the effect of an unexpected cash dividend on (a) a call option price and (b) a put option price?
- 8.20. Options on General Motors stock are on a March, June, September, and December cycle. What options trade on (a) March 1, (b) June 30, and (c) August 5?
- 8.21. Explain why the market maker's bid-offer spread represents a real cost to options investors.
- 8.22. A United States investor writes five naked call option contracts. The option price is \$3.50, the strike price is \$60.00, and the stock price is \$57.00. What is the initial margin requirement?

### Assignment Questions

- 8.23. The price of a stock is \$40. The price of a 1-year European put option on the stock with a strike price of \$30 is quoted as \$7 and the price of a 1-year European call option on the stock with a strike price of \$50 is quoted as \$5. Suppose that an investor buys 100 shares, shorts 100 call options, and buys 100 put options. Draw a diagram illustrating how the investor's profit or loss varies with the stock price over the next year. How does your answer change if the investor buys 100 shares, shorts 200 call options, and buys 200 put options?
- 8.24. "If a company does not do better than its competitors but the stock market goes up, executives do very well from their stock options. This makes no sense." Discuss this viewpoint. Can you think of alternatives to the usual executive stock option plan that take the viewpoint into account.
- 8.25. Use DerivaGem to calculate the value of an American put option on a non-dividend-paying stock when the stock price is \$30, the strike price is \$32, the risk-free rate is 5%, the volatility is 30%, and the time to maturity is 1.5 years. (Choose binomial American for the "option type" and 50 time steps.)
- What is the option's intrinsic value?
  - What is the option's time value?
  - What would a time value of zero indicate? What is the value of an option with zero time value?
  - Using a trial and error approach, calculate how low the stock price would have to be for the time value of the option to be zero.

8.26. On July 20, 2004, Microsoft surprised the market by announcing a \$3 dividend. The ex-dividend date was November 17, 2004, and the payment date was December 2, 2004. Its stock price at the time was about \$28. It also changed the terms of its employee stock options so that each exercise price was adjusted downward to

$$\text{Predividend exercise price} \times \frac{\text{Closing price} - \$3.00}{\text{Closing price}}$$

The number of shares covered by each stock option outstanding was adjusted upward to

$$\text{Number of shares predividend} \times \frac{\text{Closing price}}{\text{Closing price} - \$3.00}$$

“Closing Price” means the official NASDAQ closing price of a share of Microsoft common stock on the last trading day before the ex-dividend date. Evaluate this adjustment. Compare it with the system used by exchanges to adjust for extraordinary dividends (see Business Snapshot 8.1).