

CHAPTER

Mechanics of Options Markets

Most of the rest of this book is concerned with options. 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. Details on the markets for currency options, index options, and futures options are provided in Chapters 12 and 13.

Options are fundamentally different from forward and futures contracts. An option gives the holder of the option the right to do something. 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.

7.1 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*, the *exercise date*, the *strike date*, or the *maturity*. The price specified in the contract is known as the *exercise price* or *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 Microsoft shares. Suppose that the current stock price is \$98, the expiration date of the option is in four 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.

Table 7.1 summarizes this example. Figure 7.1 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 Microsoft'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

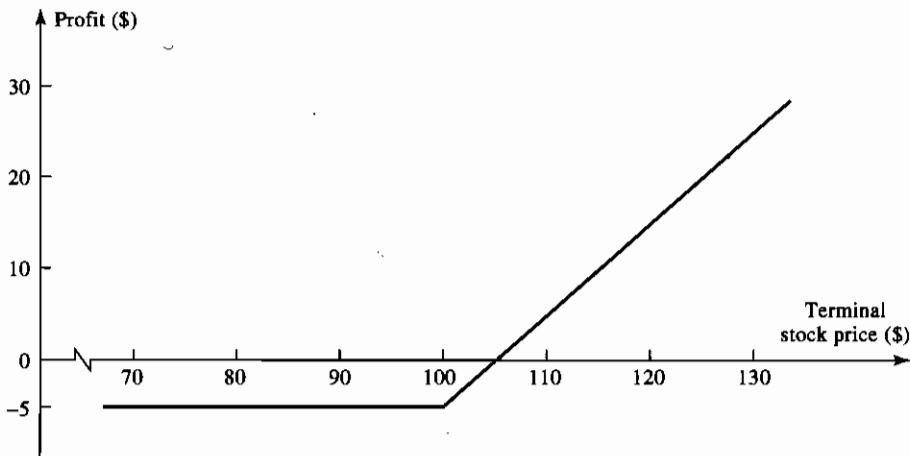


Figure 7.1 Profit from buying a European call option on one Microsoft share. Option price = \$5; strike price = \$100

Table 7.1 Profit from call option*From the Trader's Desk*

An investor buys a call option to purchase 100 Microsoft shares.

Strike price = \$100

Current share price = \$98

Price of an option to buy one share = \$5

The initial investment is $100 \times \$5 = \500 .

The Outcome

At the expiration of the option, Microsoft's share price is \$115. At this time, the option is exercised for a gain of

$$(\$115 - \$100) \times 100 = \$1,500$$

When the initial cost of the option is taken into account, the net gain is

$$\$1,500 - \$500 = \$1,000$$

a European put option to sell 100 shares in Oracle with a strike price of \$70. Suppose that the current stock price is \$65, the expiration date of the option is in three months, and the 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 at 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. Table 7.2 summarizes this example. Figure 7.2 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.

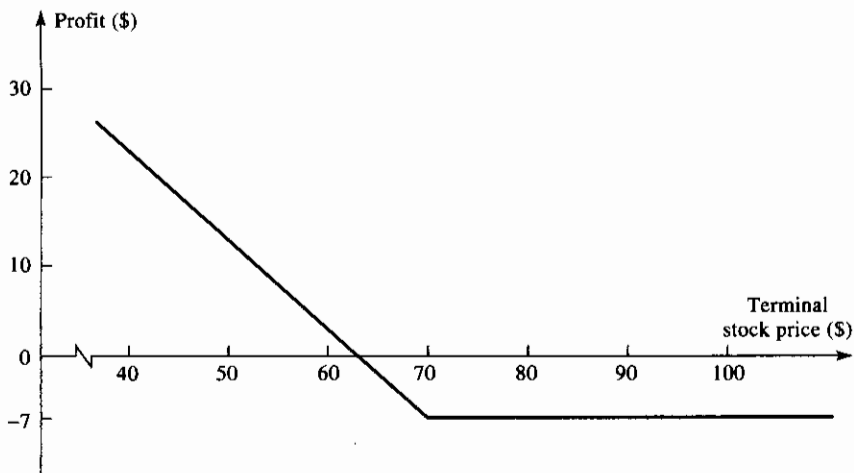


Figure 7.2 Profit from buying a European put option on one Oracle share. Option price = \$7; strike price = \$70

Table 7.2 Profit from put option
<p><i>From the Trader's Desk</i></p> <p>An investor buys a put option to sell 100 Oracle shares. Strike price = \$70 Current share price = \$65 Price of put option to sell one share = \$7 The initial investment is $100 \times \\$7 = \\700.</p> <p><i>The Outcome</i></p> <p>At the expiration of the option, Oracle's share price is \$55. At this time, the investor buys 100 Oracle shares and, under the terms of the put option, sells them for \$70 per share to realize a gain of \$15 per share, or \$1,500 in total. When the initial cost of the option is taken into account, the net gain is</p> <p style="text-align: center;">$\\$1,500 - \\$700 = \\$800$</p>

Early Exercise

As already mentioned, 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.

7.2 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

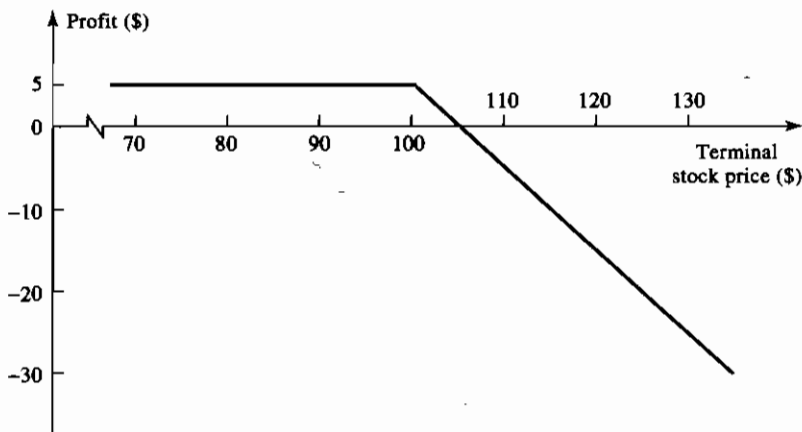


Figure 7.3 Profit from writing a European call option on one Microsoft share. Option price = \$5; strike price = \$100

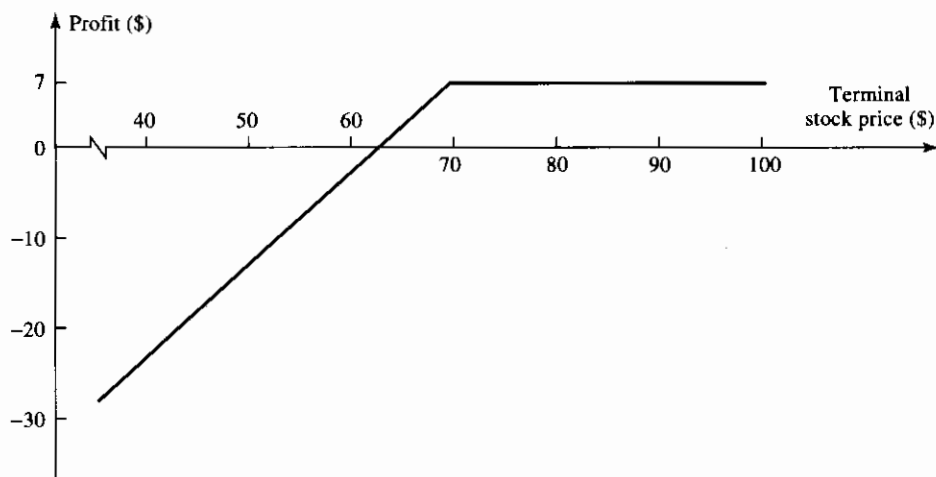


Figure 7.4 Profit from writing a European put option on one Oracle share. Option price = \$7; strike price = \$70

reverse of that for the purchaser of the option. Figures 7.3 and 7.4 show the variation of the profit or loss with the final stock price for writers of the options considered in Figures 7.1 and 7.2.

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 X is the strike price and S_T is the final price of the underlying asset, the payoff from a long position in a European call option is

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

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

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

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

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

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

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

Figure 7.5 illustrates these payoffs graphically.

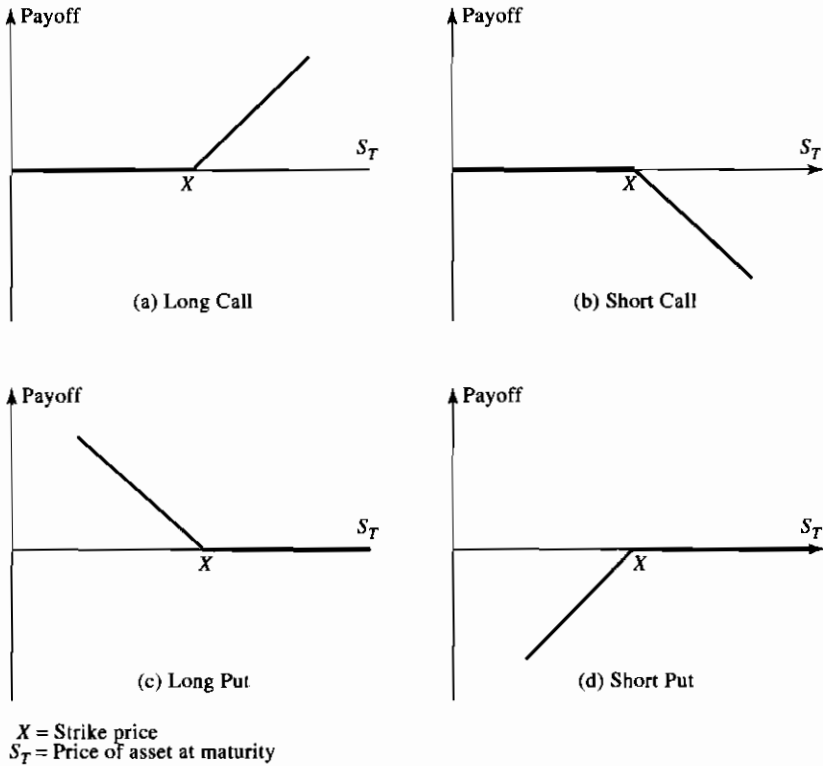


Figure 7.5 Payoffs from positions in European options: (a) long call, (b) short call, (c) long put, (d) short put

7.3 THE UNDERLYING ASSETS

Exchange-traded options are currently actively traded on stocks, stock indices, foreign currencies, and futures contracts.

Stock Options

The exchanges trading stock options in the United States are the Chicago Board Options Exchange (www.cboe.com), the Philadelphia Stock Exchange (www.phlx.com), the American Stock Exchange (www.amex.com), and the Pacific Exchange (www.pacifex.com). Options trade on more than 500 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

The major exchange for trading foreign currency options 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 12.

Index Options

Many different index options currently trade throughout the world. The most popular 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. Index options may be European or American. For example, the contract on the S&P 500 is European, whereas that on the S&P 100 is American. One contract is 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 12.

Futures Options

In a futures option (or options on futures), the underlying asset is a futures contract. The futures contract normally matures shortly after the expiration of the option. Futures options are now available for most of the assets on which futures contracts are traded and normally trade on the same exchange as 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 13.

7.4 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 10:59 p.m. Central Time on 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 some stocks. These have expiration dates up to three years into the future. The expiration dates for LEAPS on stocks are always in January.

Strike Prices

The Chicago Board Options Exchange normally chooses the strike prices at which options can be written so that they are spaced \$2.50, \$5, or \$10 apart. When the price of a stock is \$12, we might see options trading with strike prices of \$10, \$12.50, and \$15; when the stock price is \$100, we might see strike prices of \$90, \$95, \$100, \$105, and \$110. 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*. An in-the-money option would give the holder a positive cash flow if it were exercised immediately. Similarly, an at-the-money option would lead to zero cash flow if it were exercised immediately, and an out-of-the-money option would lead to a negative cash flow if it

were exercised immediately. If S is the stock price and X is the strike price, a call option is in the money when $S > X$, at the money when $S = X$, and out of the money when $S < X$. A put option is in the money when $S < X$, at the money when $S = X$, and out of the money when $S > X$. 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 $\max(S - X, 0)$. For a put option, it is $\max(X - S, 0)$. 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 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 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 generally adjusted for cash dividends. In other words, when a cash dividend occurs, there are no adjustments to the terms of the option contract. As we will see in Chapter 11, this has significant implications for the way in which options are valued.

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 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

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

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, short calls and long puts are considered to be on the same side of the market. The *exercise limit* 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.

7.5 NEWSPAPER QUOTES

Many newspapers carry options quotations. In the *Wall Street Journal*, stock option quotations can currently be found under the heading "Listed Options" in the Money and Investing section. Table 7.3 shows an extract from the quotations as they appeared in the *Wall Street Journal* of Friday March 16, 2001. The quotations refer to trading that took place on the previous day (Thursday March 15, 2001).

The company on whose stock the option is written together with the closing stock price is listed in the first column of Table 7.3. The strike price and maturity month appear in the second and third columns. If a call option traded with a given strike price and maturity month, the next two columns show the volume of trading and the

Table 7.3 Stock option quotations from the *Wall Street Journal* on March 16, 2001

LISTED OPTIONS QUOTATIONS

OPTION/STRIKE	EXP	-CALL-		-PUT-		OPTION/STRIKE	EXP	-CALL-		-PUT-		OPTION/STRIKE	EXP	-CALL-		-PUT-				
		VOL	LAST	VOL	LAST			VOL	LAST	VOL	LAST			VOL	LAST	VOL	LAST	VOL	LAST	
ADC Tel	10	May	25	208	1035	131	2396	25	Oct	1004	590	...	6343	65	May	505	480	34	590	
AmOnline	30	Mar	608	1070	...	...	Agilent	35	Apr	700	340	22	255	6343	70	Mar	...	2201	720	
4059	3750	Mar	505	320	220	085	3485	40	Apr	2754	150	...	...	6343	70	Apr	223	145	2101	770
4059	40	Mar	3071	108	820	080	Alamosa	1250	Apr	500	063	...	...	6343	75	Mar	1	025	975	1150
4059	40	Apr	2302	090	977	310	AlbanyMtc	35	Aug	525	1025	...	...	Analog	40	Mar	532	186	564	075
4059	4250	Mar	1270	090	487	2	Albtsn	2750	Mar	18	040	476	045	AndrxPp	45	Apr	532	244	1325	613
4059	45	Mar	758	095	1456	450	AllegTel	20	Apr	...	2580	388	3931	50	Apr	787	138	180	8	
4059	45	Apr	1136	170	597	610	AltWaste	20	Mar	...	2128	520	3931	68	Apr	490	060	...	...
4059	50	Apr	593	070	170	990	Altsie	40	Apr	1086	190	142	150	ansthink	5	Mar	507	031	...	...
4059	50	Jul	885	245	282	1080	4007	4250	Mar	2750	010	...	...	528	5	Apr	510	113	...	...
ASM Intl	1250	Jun	650	363	770	123	4007	4250	Apr	2080	125	30	290	Apache	65	Mar	23	018	2800	320
ATT Writs	20	Mar	15	015	525	170	Alphalnd	1750	Apr	1052	169	...	...	6106	65	Apr	24	235	2804	590
1890	20	Apr	1267	120	70	290	Altera	25	Mar	777	1	122	056	AppleC	15	Apr	36	588	3003	050
1890	2250	Apr	...	...	620	430	2525	2750	Mar	121	013	645	244	1989	1750	Apr	47	388	3254	113
1890	25	Mar	...	...	635	650	Amazon	750	Apr	255	413	1040	044	1989	20	Mar	1868	031	430	044
AT&T	20	Apr	390	390	742	045	11	45	Mar	...	1347	3375	1989	2250	Apr	5387	131	82	393	
2335	2250	Apr	1194	108	52	010	Amdocs	65	Apr	20	3	2124	970	1989	25	Apr	870	075	98	563
2335	2250	Apr	2933	2	12689	110	AmExpr	40	Mar	1186	050	430	060	1989	30	Jul	1429	119	10	988
2335	25	Mar	800	095	265	240	3990	40	Apr	622	250	234	250	1989	4750	Apr	...	1500	119	
2335	25	Apr	2011	090	3891	250	3990	4250	Apr	2181	165	140	428	AppleMar	30	Apr	499	1925	492	050
2335	40	Apr	9	010	582	1670	AmGenl	3750	Jul	525	490	20	2	4613	40	Mar	6	8	678	006
AT&T Inc	20	Sep	...	...	1000	413	3933	40	Mar	494	020	20	075	4613	40	Apr	76	9	1330	350
Abbl L	4250	Apr	...	...	321	025	Am Hom	55	Mar	2696	140	50	060	4613	4250	Mar	672	390	507	025
4639	45	Apr	2228	280	324	180	5656	55	Jul	2603	6	5	430	4613	4250	Apr	162	983	2864	350
AberFitch	35	May	534	285	...	...	AmIntOp	95	May	...	1700	1710	...	4613	45	Mar	1003	175	1618	091
Actel	2250	Apr	1046	150	...	...	AmStd	45	Jul	...	1000	1	...	4613	45	Apr	769	538	1467	425
Adelph	35	Apr	2700	5	1441	156	Amypen	55	Apr	510	1263	99	188	4613	4750	Mar	675	063	1733	206
AdobeS	25	Mar	612	158	095	537	6513	60	Mar	716	6	172	013	4613	50	Mar	2448	050	798	388
25	30	Apr	987	095	...	...	6513	65	Mar	455	125	634	125	4613	50	Apr	3002	3	1564	7
AdvFlicCm	25	Apr	685	031	...	...	6513	70	Apr	737	313	225	7	4613	55	Apr	704	188	1837	913
A W D	20	Mar	181	360	600	005	6513	75	Apr	524	183	300	1050	4613	20	Apr	504	538	826	206
2335	2250	Apr	1164	120	232	020	6513	80	Apr	1299	086	2	15	2363	35	Mar	6	096	557	1113
2335	25	Mar	1164	015	83	175	Anadit	55	May	...	500	2	180	2363	4750	Apr	...	510	1	
2335	25	Apr	3338	185	148	310	6343	65	Mar	788	040	1020	220	Arba	1750	Apr	3080	063	10	6
2335	25	Jul	1150	370	6343	65	Apr	1113	320	1106	110	May	...	800	9883	

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price at last trade for the call option. The final two columns show the same for a put option.

The quoted price is the price of an option to buy or sell one share. As mentioned earlier, one contract is for the purchase or sale of 100 shares. A 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 the total call volume, put volume, call open interest, and put open interest for each exchange. The numbers reported in the newspaper on March 16, 2001, are shown in Table 7.4. The volume is the total number of contracts traded on the day. The open interest is the number of contracts outstanding.

Table 7.4 Volume and open interest reported in the *Wall Street Journal* on March 16, 2001

Exchange	Call volume	Call open interest	Put volume	Put open interest
Chicago Board	777,845	46,667,872	757,275	26,436,611
American	481,780	17,343,487	371,031	9,331,586
Philadelphia	261,970	27,454,323	226,953	14,051,375
Pacific	253,995	41,893,009	200,690	22,910,071
Total	1,775,590	133,358,691	1,555,949	72,729,643

From Table 7.3 it appears that there were arbitrage opportunities on March 15, 2001. For example, a March put on Amazon.com with a strike price of 45 is shown to have a price of 33.75. Because the stock price was 11, it appears that this put and the stock could have been purchased and the put exercised immediately for a profit of 0.25. In fact, these types of arbitrage opportunities almost certainly did not exist. For both options and stocks, Table 7.3 gives the prices at which the last trade took place on March 15, 2001. The last trade for the March Amazon.com put with a strike price of 45 probably occurred much earlier in the day than the last trade on the stock. If an option trade had been attempted at the time of the last trade on the stock, the put price would have been higher than 33.75.

7.6 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 that traders do not have to physically meet. The Chicago Board Options Exchange launched CBOEdirect in 2001. Initially it will be used to trade certain options outside regular trading hours, but it is likely that eventually it will be used for all trading.

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 the offer 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 in later chapters of 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. If, when an options contract is traded, neither investor is offsetting an existing position, the open interest increases by one contract. If one investor is offsetting an existing position and the other is not, the open interest stays the same. If both investors are offsetting existing positions, the open interest goes down by one contract.

7.7 COMMISSIONS

The types of orders that can be placed with a broker for option trading are similar to those for futures trading (see Section 2.8). 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.

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 7.5 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 7.5, 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

Table 7.5 A typical commission schedule for a discount broker

Dollar amount of trade	Commission*
< \$2,500	\$20 + 0.02 of dollar amount
\$2,500 to \$10,000	\$45 + 0.01 of dollar amount
> \$10,000	\$120 + 0.0025 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.

price, or \$4.25. The cost to an option buyer or 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.

7.8 MARGINS

In the United States, when shares are purchased, 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 similarly to that for a futures contract (see Chapter 2).

When call and put options are purchased, the option price must be paid in full. Investors are not allowed to buy options on margin, because options already contain substantial leverage. Buying on margin would raise this leverage to an unacceptable level. 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 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

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

$$400[5 + 0.2 \times 38 - 2] = \$4,240$$

The second calculation gives

$$400[5 + 0.1 \times 38] = \$3,520$$

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

$$400[5 + 0.2 \times 38] = \$5,040$$

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.

Writing Covered Calls

Writing covered calls involves writing call options 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. If covered call options are out of the money, no margin is required. The shares owned can be purchased using a margin account, as described previously, and the price received for the option can be used to partially fulfill this margin requirement. If the options are in the money, no margin is required for the options. However, for the purposes of calculating the investor's equity position, the share price is reduced by the extent, if any, to which the option is in the money. This may limit the amount that the investor can withdraw from the margin account if the share price increases.

Example

An investor in the United States decides to buy 200 shares of a certain stock on margin and to write two call option contracts on the stock. The stock price is \$63, the strike price is \$60, and the price of the option is \$7. The margin account allows the investor to borrow 50% of the price of the stock, or \$6,300. The investor is also able to use the price received for the option, $7 \times 200 = \$1,400$, to finance the purchase of the shares. The shares cost $63 \times 200 = \$12,600$. The minimum cash initially required from the investor for the trades is, therefore,

$$\$12,600 - \$6,300 - \$1,400 = \$4,900$$

In Chapter 9, we will examine more complicated option trading strategies such as spreads, combinations, straddles, and strangles. There are special rules for determining the margin requirements when these trading strategies are used.

7.9 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.

When purchasing an option, the buyer must pay for it in full by the morning of the next business day. The funds are deposited with the OCC. The writer of the option maintains a margin account with a broker, as described earlier. 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. The margin requirements described in the previous section are the margin requirements imposed by the OCC on its members. A brokerage house may require higher margins from its clients. However, it cannot require lower margins.

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 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 their clients at expiration when it is in their clients' interest to do so. Many exchanges also have rules for exercising options that are in the money at expiration.

7.10 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.

7.11 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 2.10. 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 position is deemed to have sold at the call price plus the strike price. When a put option is exercised, the writer is deemed to have bought stock for the strike price less the original put price and the purchaser is deemed to have sold the stock for this 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 Planning Using Options

Tax practitioners sometimes use options to minimize tax costs or maximize tax benefits. For example, it is sometimes advantageous to receive the income from a security in

Country A and the capital gain/loss in country B. This could be the case if Country A has a tax regime that provides for a low effective tax rate on interest and dividends and a relatively high tax rate on capital gains. One can accomplish this by arranging for a company in Country A to have legal ownership of the security and for a related 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. As another example, consider the position of a company with a large holding in a particular stock whose price has risen fast during the holding period. Suppose the company wants to sell the stock. If it does so in the usual way it will be subject to capital gains. An alternative strategy is to borrow funds for 20 years under an agreement where the company has the option at the end of the 20 years to repay the loan with the stock. This delays the recognition of the capital gains.

Tax authorities in many jurisdictions have proposed legislation designed to combat the use of derivatives for tax purposes. Before entering into any tax-motivated transactions, a treasurer should explore in detail how the structure could be unwound in the event of legislative change and how costly this process could be.

7.12 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 exercised, the company issues more of its own stock and sells them 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. They are usually at the money when they are first issued. After a period of time they become vested and can be exercised. Executive stock options cannot be traded. They often last as long as 10 or 15 years.

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.

7.13 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 options on foreign exchange and interest rates are particularly popular. The chief potential disadvantage of the over-the-counter market is that the 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.

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 19 describes a number of different types of exotic options.

7.14 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 current 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.

Suggestions for Further Reading

Chance, D. M. *An Introduction to Derivatives*, 4th edn. Orlando, FL: Dryden Press, 1998.

Cox, J. C., and M. Rubinstein *Options Markets*. Upper Saddle River, NJ: Prentice Hall, 1985.

Kolb, R. *Futures, Options, and Swaps*, 3rd edn. Oxford: Blackwell, 1999.

McMillan, L. G. *Options as a Strategic Investment*. New York: New York Institute of Finance, 1992.

Quiz (Answers at End of Book)

- 7.1. 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.
- 7.2. 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.
- 7.3. An investor buys a call with strike price of X and writes a put with the same strike price. Describe the investor's position.
- 7.4. Explain why brokers require margins when clients write options but not when they buy options.
- 7.5. A stock option is on a February, May, August, and November cycle. What options trade on (a) April 1 and (b) May 30?
- 7.6. A company declares a 3-for-1 stock split. Explain how the terms change for a call option with a strike price of \$60.
- 7.7. 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?

Questions and Problems (Answers in Solutions Manual)

- 7.8. 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.

- 7.9. 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.
- 7.10. 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.
- 7.11. 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.
- 7.12. 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.
- 7.13. Explain why an American option is always worth at least as much as its intrinsic value.
- 7.14. Explain carefully the difference between writing a call option and buying a put option.
- 7.15. 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.
- 7.16. Suppose that sterling-U.S. dollar spot and forward exchange rates are as follows:
- | | |
|-----------------|--------|
| Spot | 1.8470 |
| 90-day forward | 1.8381 |
| 180-day forward | 1.8291 |
- What opportunities are open to an investor in the following situations?
- A 180-day European call option to buy £1 for \$1.80 costs \$0.0250.
 - A 90-day European put option to sell £1 for \$1.86 costs \$0.0200.
- 7.17. Consider an exchange-traded call option contract to buy 500 shares with a strike price of \$40 and maturity in four months. Explain how the terms of the option contract change when there is
- A 10% stock dividend
 - A 10% cash dividend
 - A 4-for-1 stock split
- 7.18. "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.
- 7.19. What is the effect of an unexpected cash dividend on (a) a call option price and (b) a put option price?
- 7.20. 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?
- 7.21. Explain why the market maker's bid-offer spread represents a real cost to options investors.
- 7.22. 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

- 7.23. A United States investor buys 500 shares of a stock and sells five call option contracts on the stock. The strike price is \$30. The price of the option is \$3. What is the investor's minimum cash investment (a) if the stock price is \$28 and (b) if it is \$32?
- 7.24. The price of a stock is \$40. The price of a one-year European put option on the stock with a strike price of \$30 is quoted as \$7 and the price of a one-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?
- 7.25. "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.