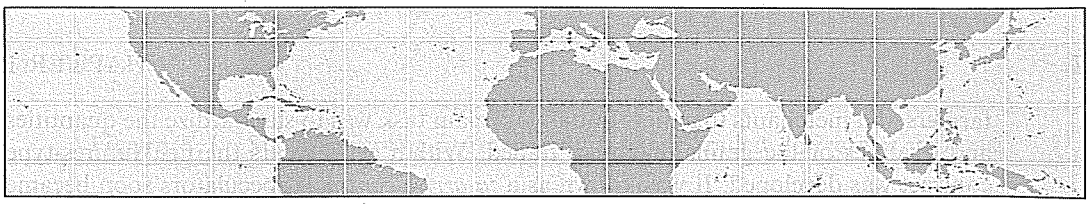


CHAPTER 1

Introduction

In the last 25 years derivatives have become increasingly important in the world of finance. Futures and options are now traded actively on many exchanges throughout the world. Many different types of forward contracts, swaps, options, and other derivatives are regularly traded by financial institutions, fund managers, and corporate treasurers in the over-the-counter market. Derivatives are added to bond issues, used in executive compensation plans, embedded in capital investment opportunities, and so on. We have now reached the stage where anyone who works in finance needs to understand how derivatives work, how they are used, and how they are priced.

A *derivative* can be defined as a financial instrument whose value depends on (or derives from) the values of other, more basic, underlying variables. Very often the variables underlying derivatives are the prices of traded assets. A stock option, for example, is a derivative whose value is dependent on the price of a stock. However, derivatives can be dependent on almost any variable, from the price of hogs to the amount of snow falling at a certain ski resort.

Since the first edition of this book was published in 1988 there have been many developments in derivatives markets. There is now active trading in credit derivatives, electricity derivatives, weather derivatives, and insurance derivatives. Many new types of interest rate, foreign exchange, and equity derivative products have been created. There have been many new ideas in risk management and risk measurement. Analysts have also become more aware of the need to analyze what are known as *real options*. (These are the options acquired by a company when it invests in real assets such as real estate, plant, and equipment.) This edition of the book reflects all these developments.

In this opening chapter we take a first look at forward, futures, and options markets and provide an overview of how they are used by hedgers, speculators, and arbitrageurs. Later chapters will give more details and elaborate on many of the points made here.

1.1 EXCHANGE-TRADED MARKETS

A derivatives exchange is a market where individuals trade standardized contracts that have been defined by the exchange. Derivatives exchanges have existed for a long time. The Chicago Board of Trade (CBOT, www.cbot.com) was established in 1848 to bring

farmers and merchants together. Initially its main task was to standardize the quantities and qualities of the grains that were traded. Within a few years the first futures-type contract was developed. It was known as a *to-arrive contract*. Speculators soon became interested in the contract and found trading the contract to be an attractive alternative to trading the grain itself. A rival futures exchange, the Chicago Mercantile Exchange (CME, www.cme.com), was established in 1919. Now futures exchanges exist all over the world.

The Chicago Board Options Exchange (CBOE, www.cboe.com) started trading call option contracts on 16 stocks in 1973. Options had traded prior to 1973, but the CBOE succeeded in creating an orderly market with well-defined contracts. Put option contracts started trading on the exchange in 1977. The CBOE now trades options on well over 1,000 stocks and many different stock indices. Like futures, options have proved to be very popular contracts. Many other exchanges throughout the world now trade options. The underlying assets include foreign currencies and futures contracts as well as stocks and stock indices.

Electronic Markets

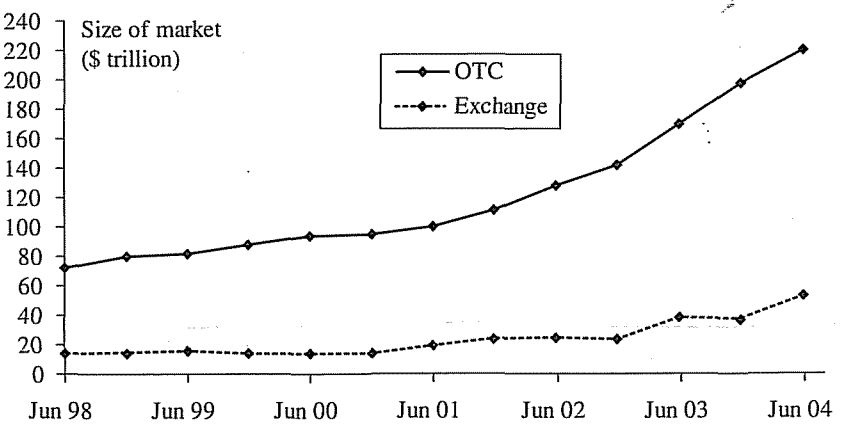
Traditionally derivatives traders have used what is known as the *open outcry system*. This involves traders physically meeting on the floor of the exchange, shouting, and using a complicated set of hand signals to indicate the trades they would like to carry out. Exchanges are increasingly replacing the open outcry system by *electronic trading*. This involves traders entering their desired trades at a keyboard and a computer being used to match buyers and sellers. The open outcry system has its advocates, but, as time passes, exchanges are increasingly turning to electronic trading.

1.2 OVER-THE-COUNTER MARKETS

Not all trading is done on exchanges. The *over-the-counter market* is an important alternative to exchanges and, measured in terms of the total volume of trading, has become much larger than the exchange-traded market. It is a telephone- and computer-linked network of dealers who do not physically meet. Trades are done over the phone and are usually between two financial institutions or between a financial institution and one of its clients (typically a corporate treasurer or fund manager). Financial institutions often act as market makers for the more commonly traded instruments. This means that they are always prepared to quote both a bid price (a price at which they are prepared to buy) and an offer price (a price at which they are prepared to sell).

Telephone conversations in the over-the-counter market are usually taped. If there is a dispute about what was agreed, the tapes are replayed to resolve the issue. Trades in the over-the-counter market are typically much larger than trades in the exchange-traded market. A key advantage of the over-the-counter market is that the terms of a contract do not have to be those specified by an exchange. Market participants are free to negotiate any mutually attractive deal. A disadvantage is that there is usually some credit risk in an over-the-counter trade (i.e., there is a small risk that the contract will not be honored). As we shall see in the next chapter, exchanges have organized themselves to eliminate virtually all credit risk.

Figure 1.1 Size of over-the-counter and exchange-traded derivatives markets.



Market Size

Both the over-the-counter and the exchange-traded market for derivatives are huge. Although the statistics that are collected for the two markets are not exactly comparable, it is clear that the over-the-counter market is much larger than the exchange-traded market. The Bank for International Settlements (www.bis.org) started collecting statistics on the markets in 1998. Figure 1.1 compares (a) the estimated total principal amounts underlying transactions that were outstanding in the over-the counter markets between June 1998 and June 2004 and (b) the estimated total value of the assets underlying exchange-traded contracts during the same period. Using these measures, we see that, by June 2004, the over-the-counter market had grown to $220.1 trillion (approximately five times the world gross domestic product) and the exchange-traded market had grown to $49.0 trillion.

In interpreting these numbers, we should bear in mind that the principal underlying an over-the-counter transaction is not the same as its value. An example of an over-the-counter contract is an agreement to buy 100 million US dollars with British pounds at a predetermined exchange rate in 1 year. The total principal amount underlying this transaction is $100 million. However, the value of the contract might be only $1 million. The Bank for International Settlements estimates the gross market value of all over-the-counter contracts outstanding in June 2004 to be about $6.4 trillion.[1]

1.3 FORWARD CONTRACTS

A relatively simple derivative is a *forward contract*. It is an agreement to buy or sell an asset at a certain future time for a certain price. It can be contrasted with a *spot*

[1] A contract that is worth $1 million to one side and −$1 million to the other side would be counted as having a gross market value of $1 million.

Table 1.1 Spot and forward quotes for the USD/GBP exchange rate, June 3, 2003 (GBP = British pound; USD = US dollar; quote is number of USD per GBP).

	Bid	*Offer*
Spot	1.6281	1.6285
1-month forward	1.6248	1.6253
3-month forward	1.6187	1.6192
6-month forward	1.6094	1.6100

contract, which is an agreement to buy or sell an asset today. A forward contract is traded in the over-the-counter market—usually between two financial institutions or between a financial institution and one of its clients.

One of the parties to a forward contract assumes a *long position* and agrees to buy the underlying asset on a certain specified future date for a certain specified price. The other party assumes a *short position* and agrees to sell the asset on the same date for the same price.

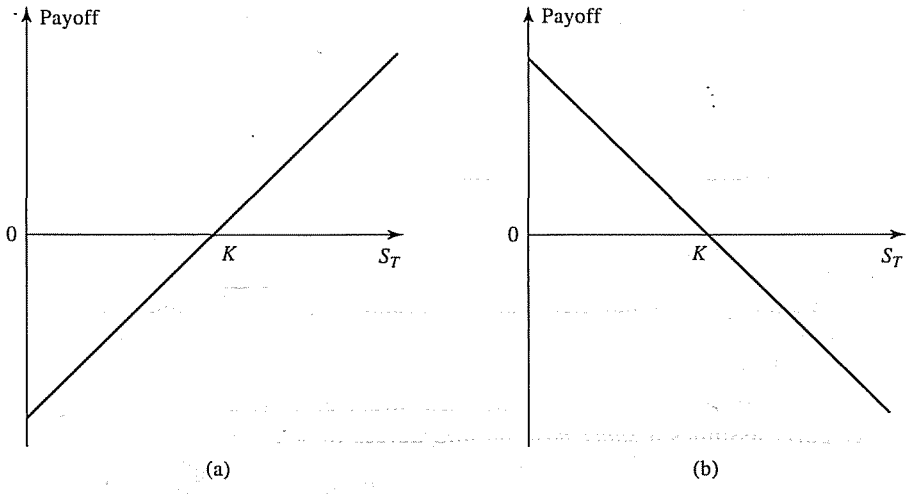
Forward contracts on foreign exchange are very popular. Most large banks employ both spot traders and forward traders. Spot traders are trading a foreign currency for almost immediate delivery. Forward traders are trading for delivery at a future time. Table 1.1 provides the quotes on the exchange rate between the British pound (GBP) and the US dollar (USD) that might be made by a large international bank on June 3, 2003. The quote is for the number of USD per GBP. The first row indicates that the bank is prepared to buy GBP (also known as sterling) in the spot market (i.e., for virtually immediate delivery) at the rate of $1.6281 per GBP and sell sterling in the spot market at $1.6285 per GBP. The second, third, and fourth rows indicate that the bank is prepared to buy sterling in 1, 3, and 6 months at $1.6248, $1.6187, and $1.6094 per GBP, respectively, and to sell sterling in 1, 3, and 6 months at $1.6253, $1.6192, and $1.6100 per GBP, respectively.

Forward contracts can be used to hedge foreign currency risk. Suppose that, on June 3, 2003, the treasurer of a US corporation knows that the corporation will pay £1 million in 6 months (i.e., on December 3, 2003) and wants to hedge against exchange rate moves. Using the quotes in Table 1.1, the treasurer can agree to buy £1 million 6 months forward at an exchange rate of 1.6100. The corporation then has a long forward contract on GBP. It has agreed that on December 3, 2003, it will buy £1 million from the bank for $1.61 million. The bank has a short forward contract on GBP. It has agreed that on December 3, 2003, it will sell £1 million for $1.61 million. Both sides have made a binding commitment.

Payoffs from Forward Contracts

Consider the position of the corporation in the trade we have just described. What are the possible outcomes? The forward contract obligates the corporation to buy £1 million for $1,610,000. If the spot exchange rate rose to, say, 1.7000, at the end of the 6 months, the forward contract would be worth $90,000 ($= \$1,700,000 - \$1,610,000$) to the corporation. It would enable $1 million pounds to be purchased at 1.6100 rather than

Figure 1.2 Payoffs from forward contracts: (a) long position, (b) short position. Delivery price = K; price of asset at contract maturity = S_T.



at \$1.7000. Similarly, if the spot exchange rate fell to 1.5000 at the end of the 6 months, the forward contract would have a negative value to the corporation of \$110,000 because it would lead to the corporation paying \$110,000 more than the market price for the sterling.

In general, the payoff from a long position in a forward contract on one unit of an asset is

$$S_T - K$$

where K is the delivery price and S_T is the spot price of the asset at maturity of the contract. This is because the holder of the contract is obligated to buy an asset worth S_T for K. Similarly, the payoff from a short position in a forward contract on one unit of an asset is

$$K - S_T$$

These payoffs can be positive or negative. They are illustrated in Figure 1.2. Because it costs nothing to enter into a forward contract, the payoff from the contract is also the trader's total gain or loss from the contract.

Forward Prices and Spot Prices

We shall be discussing in some detail the relationship between spot and forward prices in Chapter 5. For a quick preview of why the two are related, consider a stock that pays no dividend and is worth \$60. You can borrow or lend money for 1 year at 5%. What should the 1-year forward price of the stock be?

The answer is \$60 grossed up at 5% for 1 year, or \$63. If the forward price is more than this, say \$67, you could borrow \$60, buy one share of the stock, and sell it forward for \$67. After paying off the loan, you would net a profit of \$4 in 1 year. If the forward price is less than \$63, say \$58, an investor owning the stock as part of a portfolio would

sell the stock for $60 and enter into a forward contract to buy it back for $58 in 1 year. The proceeds of investment would be invested at 5% to earn $3. The investor would end up $5 better off than if the stock were kept in the portfolio for the year.

1.4 FUTURES CONTRACTS

Like a forward contract, a futures contract is an agreement between two parties to buy or sell an asset at a certain time in the future for a certain price. Unlike forward contracts, futures contracts are normally traded on an exchange. To make trading possible, the exchange specifies certain standardized features of the contract. As the two parties to the contract do not necessarily know each other, the exchange also provides a mechanism that gives the two parties a guarantee that the contract will be honored.

The largest exchanges on which futures contracts are traded are the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME). On these and other exchanges throughout the world, a very wide range of commodities and financial assets form the underlying assets in the various contracts. The commodities include pork bellies, live cattle, sugar, wool, lumber, copper, aluminum, gold, and tin. The financial assets include stock indices, currencies, and Treasury bonds. Futures prices are regularly reported in the financial press. Suppose that, on September 1, the December futures price of gold is quoted as $300. This is the price, exclusive of commissions, at which traders can agree to buy or sell gold for December delivery. It is determined on the floor of the exchange in the same way as other prices (i.e., by the laws of supply and demand). If more traders want to go long than to go short, the price goes up; if the reverse is true, then the price goes down.

Further details on issues such as margin requirements, daily settlement procedures, delivery procedures, bid–offer spreads, and the role of the exchange clearinghouse are given in Chapter 2.

1.5 OPTIONS

Options are traded both on exchanges and in the over-the-counter market. There are two basic types of option. A *call option* gives the holder the right to buy the underlying asset by a certain date for a certain price. A *put option* gives the holder the right to sell the underlying asset by a certain date for a certain price. The price in the contract is known as the *exercise price* or *strike price*; the date in the contract is known as the *expiration date* or *maturity*. *American options* can be exercised at any time up to the expiration date. *European options* can be exercised only on the expiration date itself.[2] Most of the options that are traded on exchanges are American. In the exchange-traded equity option market, one contract is usually an agreement to buy or sell 100 shares. 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.

It should be emphasized that an option gives the holder the right to do something.

[2] Note that the terms *American* and *European* do not refer to the location of the option or the exchange. Some options trading on North American exchanges are European.

Table 1.2 Prices of options on Intel, May 29, 2003; stock price = \$20.83.

	Calls			*Puts*		
Strike price (\$)	*June*	*July*	*Oct.*	*June*	*July*	*Oct.*
20.00	1.25	1.60	2.40	0.45	0.85	1.50
22.50	0.20	0.45	1.15	1.85	2.20	2.85

The holder does not have to exercise this right. This is what distinguishes options from forwards and futures, where the holder is obligated to buy or sell the underlying asset. However, whereas it costs nothing to enter into a forward or futures contract, there is a cost to acquiring an option.

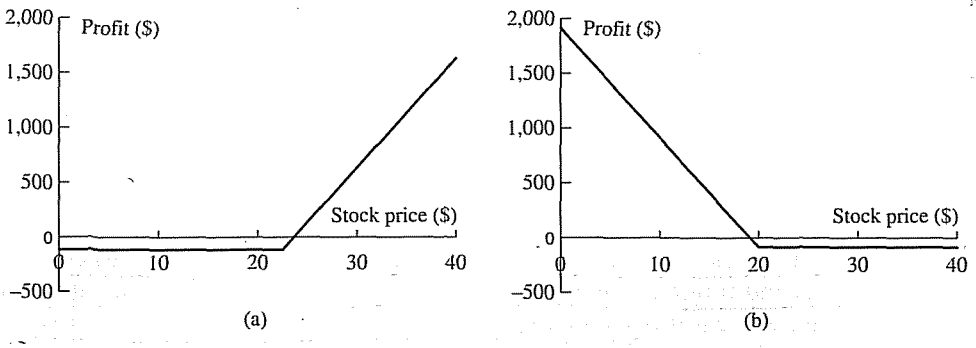
The largest exchange in the world for trading stock options is the Chicago Board Options Exchange (CBOE; www.cboe.com). Table 1.2 gives the closing prices of some of the American options trading on Intel on May 29, 2003. The option strike prices are \$20 and \$22.50. The maturities are June 2003, July 2003, and October 2003. The June options have an expiration date on June 21, 2003, the July options have an expiration date on July 19, 2003, and the October options have an expiration date on October 18, 2003. Intel's stock price at the close of trading on May 29, 2003, was \$20.83.

Suppose an investor instructs a broker to buy one October call option contract on Intel with a strike price of \$22.50. The broker will relay these instructions to a trader at the CBOE. This trader will then find another trader who wants to sell 1 October call contract on Intel with a strike price of \$22.50, and a price will be agreed. We assume that the price is \$1.15, as indicated in Table 1.2. This is the price for an option to buy one share. In the United States, one stock option contract is a contract to buy or sell 100 shares. Therefore the investor must arrange for \$115 to be remitted to the exchange through the broker. The exchange will then arrange for this amount to be passed on to the party on the other side of the transaction.

In our example the investor has obtained at a cost of \$115 the right to buy 100 Intel shares for \$22.50 each. The party on the other side of the transaction has received \$115 and has agreed to sell 100 Intel shares for \$22.50 per share if the investor chooses to exercise the option. If the price of Intel does not rise above \$22.50 before October 18, 2003, the option is not exercised and the investor loses \$115. But if the Intel share price does well and the option is exercised when it is \$30, the investor is able to buy 100 shares at \$22.50 per share when they are worth \$30 per share. This leads to a gain of \$750, or \$635 when the initial cost of the options is taken into account.

An alternative trade for the investor would be the purchase of one July put option contract with a strike price of \$20. From Table 1.2 we see that this would cost 100×0.85, or \$85. The investor would obtain at a cost of \$85 the right to sell 100 Intel shares for \$20 per share prior to July 19, 2003. If the Intel share price stays above \$20, the option is not exercised and the investor loses \$85. But if the investor exercises when the stock price is \$15, he or she makes a gain of \$500 by buying 100 Intel shares at \$15 and selling them for \$20. The net profit after the cost of the option is taken into account is \$415.

Figure 1.3 Net profit per share from (a) purchasing a contract consisting of 100 Intel October call options with a strike price of $22.50 and (b) purchasing a contract consisting of 100 Intel July put options with a strike price of $20.00.



The options trading on the CBOE are American. If we assume for simplicity that they are European, so that they can be exercised only at maturity, the investor's profit as a function of the final stock price is shown in Figure 1.3.

Further details about the operation of options markets and how prices such as those in Table 1.2 are determined by traders are given in later chapters. At this stage we note that there are four types of participants in options markets:

1. Buyers of calls
2. Sellers of calls
3. Buyers of puts
4. Sellers of puts

Buyers are referred to as having *long positions*; sellers are referred to as having *short positions*. Selling an option is also known as *writing the option*.

1.6 TYPES OF TRADERS

Derivatives markets have been outstandingly successful. The main reason is that they have attracted many different types of traders and have a great deal of liquidity. When an investor wants to take one side of a contract, there is usually no problem in finding someone that is prepared to take the other side.

Three broad categories of traders can be identified: hedgers, speculators, and arbitrageurs. Hedgers use derivatives to reduce the risk that they face from potential future movements in a market variable. Speculators use them to bet on the future direction of a market variable. Arbitrageurs take offsetting positions in two or more instruments to lock in a profit. As described in Business Snapshot 1.1, hedge funds have become big users of derivatives for all three purposes.

In the next few sections, we will consider the activities of each type of trader in more detail.

Business Snapshot 1.1 Hedge Funds

Hedge funds have become major users of derivatives for hedging, speculation, and arbitrage. A hedge fund is similar to a mutual fund in that it invests funds on behalf of clients. However, unlike mutual funds, hedge funds are not required to register under US federal securities law. This is because they accept funds only from financially sophisticated individuals and do not publicly offer their securities. Mutual funds are subject to regulations requiring that shares in the funds be fairly priced, that the shares be redeemable at any time, that investment policies be disclosed, that the use of leverage be limited, that no short positions are taken, and so on. Hedge funds are relatively free of these regulations. This gives them a great deal of freedom to develop sophisticated, unconventional, and proprietary investment strategies. The fees charged by hedge fund managers are dependent on the fund's performance and are relatively high—typically 1% to 2% of the amount invested plus 20% of the profits. Hedge funds have grown in popularity with about $1 trillion being invested throughout the world for clients in 2004. "Funds of funds" have been set up to invest in a portfolio of other hedge funds.

The investment strategy followed by a hedge fund manager often involves using derivatives to set up a speculative or arbitrage position. Once the strategy has been defined, the hedge fund manager must:

1. Evaluate the risks to which the fund is exposed
2. Decide which risks are acceptable and which will be hedged
3. Devise strategies (usually involving derivatives) to hedge the unacceptable risks

Here are some examples of the labels used for hedge funds together with the trading strategies followed:

Convertible arbitrage: Take a long position in a convertible bond combined with an actively managed short position in the underlying equity.

Distressed securities: Buy securities issued by companies in bankruptcy or close to bankruptcy.

Emerging markets: Invest in debt and equity of companies in developing or emerging countries and in the debt of the countries themselves.

Growth fund: Invest in growth stocks, hedging with the short sales of options.

Macro or global: Use derivatives to speculate on interest rate and foreign exchange rate moves.

Market neutral: Purchase securities considered to be overvalued and sell securities considered to be undervalued in such a way that the exposure to the overall direction of the market is zero.

1.7 HEDGERS

In this section we illustrate how hedgers can reduce their risks with forward contracts and options.

An Example of Hedging Using Forward Contracts

Suppose that it is June 3, 2003, and ImportCo, a company based in the United States, knows that it will have to pay £10 million on September 3, 2003, for goods it has purchased from a British supplier. The USD–GBP exchange rate quotes made by a financial institution are shown in Table 1.1. ImportCo could hedge its foreign exchange risk by buying pounds (GBP) from the financial institution in the 3-month forward market at 1.6192. This would have the effect of fixing the price to be paid to the British exporter at $16,192,000.

Consider next another US company, which we will refer to as ExportCo, that is exporting goods to the United Kingdom and, on June 3, 2003, knows that it will receive £30 million 3 months later. ExportCo can hedge its foreign exchange risk by selling £30 million in the 3-month forward market at an exchange rate of 1.6187. This would have the effect of locking in the US dollars to be realized for the sterling at $48,561,000.

Note that a company might do better if it chooses not to hedge than if it chooses to hedge. Alternatively, it might do worse. Consider ImportCo. If the exchange rate is 1.5000 on September 3 and the company has not hedged, the £10 million that it has to pay will cost $15,000,000, which is less than $16,192,000. On the other hand, if the exchange rate is 1.7000, the £10 million will cost $17,000,000—and the company will wish that it had hedged! The position of ExportCo if it does not hedge is the reverse. If the exchange rate in September proves to be less than 1.6187, the company will wish that it had hedged; if the rate is greater than 1.6187, it will be pleased that it had not done so.

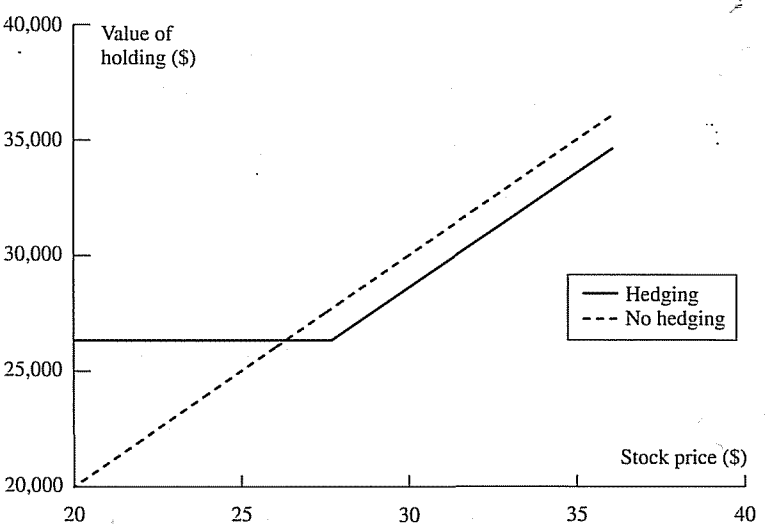
This example illustrates a key aspect of hedging. The cost of, or price received for, the underlying asset is assured. However, there is no guarantee that the outcome with hedging will be better than the outcome without hedging.

An Example of Hedging Using Options

Options can also be used for hedging. Consider an investor who in May 2003 owns 1,000 Microsoft shares. The current share price is $28 per share. The investor is concerned about a possible share price decline in the next 2 months and wants protection. The investor could buy ten July put option contracts on Microsoft on the Chicago Board Options Exchange with a strike price of $27.50. This would give the investor the right to sell a total of 1,000 shares for a price of $27.50. If the quoted option price is $1, then each option contract would cost $100 \times \$1 = \$100$ and the total cost of the hedging strategy would be $10 \times \$100 = \$1{,}000$.

The strategy costs $1,000 but guarantees that the shares can be sold for at least $27.50 per share during the life of the option. If the market price of Microsoft falls below $27.50, the options can be exercised, so that $27,500 is realized for the entire holding. When the cost of the options is taken into account, the amount realized is $26,500. If the market price stays above $27.50, the options are not exercised and expire worthless. However, in this case the value of the holding is always above $27,500 (or above $26,500 when the cost of the options is taken into account). Figure 1.4 shows the net value of the portfolio (after taking the cost of the options into account) as a function of Microsoft's stock price in 2 months. The dotted line shows the value of the portfolio assuming no hedging.

Figure 1.4 Value of Microsoft holding in 2 months with and without hedging.



A Comparison

There is a fundamental difference between the use of forward contracts and options for hedging. Forward contracts are designed to neutralize risk by fixing the price that the hedger will pay or receive for the underlying asset. Option contracts, by contrast, provide insurance. They offer a way for investors to protect themselves against adverse price movements in the future while still allowing them to benefit from favorable price movements. Unlike forwards, options involve the payment of an up-front fee.

1.8 SPECULATORS

We now move on to consider how futures and options markets can be used by speculators. Whereas hedgers want to avoid exposure to adverse movements in the price of an asset, speculators wish to take a position in the market. Either they are betting that the price of the asset will go up or they are betting that it will go down.

An Example of Speculation Using Futures

Consider a US speculator who in February thinks that the British pound will strengthen relative to the US dollar over the next 2 months and is prepared to back that hunch to the tune of £250,000. One thing the speculator can do is purchase £250,000 in the spot market in the hope that the sterling can be sold later at a higher price. (The sterling once purchased would be kept in an interest-bearing account.) Another possibility is to take a long position in four CME April futures contracts on sterling. (Each futures contract is for the purchase of £62,500.) Table 1.3 summarizes the two alternatives on the assumption that the current exchange rate is 1.6470 dollars per pound and the April

Table 1.3 Speculation using spot and futures contracts. One futures contract is on £62,500.

	February trade	
	Buy £250,000 Spot price = 1.6470	*Buy 4 futures contracts Futures price = 1.6410*
Investment	\$411,750	\$20,000
Profit if April spot = 1.7000	\$13,250	\$14,750
Profit if April spot = 1.6000	−\$11,750	−\$10,250

futures price is 1.6410 dollars per pound. If the exchange rate turns out to be 1.7000 dollars per pound in April, the futures contract alternative enables the speculator to realize a profit of $(1.7000 - 1.6410) \times 250{,}000 = \$14{,}750$. The spot market alternative leads to 250,000 units of an asset being purchased for \$1.6470 in February and sold for \$1.7000 in April, so that a profit of $(1.7000 - 1.6470) \times 250{,}000 = \$13{,}250$ is made. If the exchange rate falls to 1.6000 dollars per pound, the futures contract gives rise to a $(1.6410 - 1.6000) \times 250{,}000 = \$10{,}250$ loss, whereas the spot market alternative gives rise to a loss of $(1.6470 - 1.6000) \times 250{,}000 = \$11{,}750$. The alternatives appear to give rise to slightly different profits and losses. But these calculations do not reflect the interest that is earned or paid. As shown in Chapter 5, when the interest earned in sterling and the interest foregone on the dollars used to buy the sterling are taken into account, the profit or loss from the two alternatives is the same.

What then is the difference between the two alternatives? The first alternative of buying sterling requires an up-front investment of \$411,750. In contrast, the second alternative requires only a small amount of cash—perhaps \$20,000—to be deposited by the speculator in what is termed a "margin account". (Margin accounts are discussed in Chapter 2.) The futures market allows the speculator to obtain leverage. With a relatively small initial outlay, the investor is able to take a large speculative position.

An Example of Speculation Using Options

Options can also be used for speculation. Suppose that it is October and a speculator considers that Amazon.com is likely to increase in value over the next 2 months. The

Table 1.4 Comparison of profits (losses) from two alternative strategies for using \$2,000 to speculate on Amazon.com stock in October.

	December stock price	
Investor's strategy	*\$15*	*\$27*
Buy 100 shares	(\$500)	\$700
Buy 2,000 call options	(\$2,000)	\$7,000

stock price is currently \$20, and a 2-month call option with a \$22.50 strike price is currently selling for \$1. Table 1.4 illustrates two possible alternatives, assuming that the speculator is willing to invest \$2,000. One alternative is to purchase 100 shares; the other involves the purchase of 2,000 call options (i.e., 20 call option contracts). Suppose that the speculator's hunch is correct and the price of Amazon.com's shares rises to \$27 by December. The first alternative of buying the stock yields a profit of

$$100 \times (\$27 - \$20) = \$700$$

However, the second alternative is far more profitable. A call option on Amazon.com with a strike price of \$4.50 gives a payoff of \$12.50, because it enables something worth \$27 to be bought for \$22.50. The total payoff from the 2,000 options that are purchased under the second alternative is

$$2{,}000 \times \$4.50 = \$9{,}000$$

Subtracting the original cost of the options yields a net profit of

$$\$9{,}000 - \$2{,}000 = \$7{,}000$$

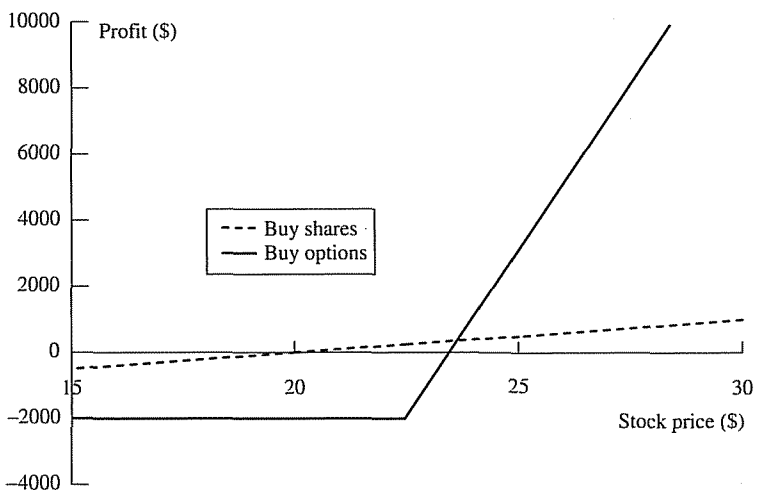
The options strategy is, therefore, 10 times more profitable than the strategy of buying the stock.

Options also give rise to a greater potential loss. Suppose the stock price falls to \$15 by December. The first alternative of buying stock yields a loss of

$$100 \times (\$20 - \$15) = \$500$$

Because the call options expire without being exercised, the options strategy would lead to a loss of \$2,000—the original amount paid for the options. Figure 1.5 shows the profit or loss from the two strategies as a function of the price of Amazon.com in 2 months.

Figure 1.5 Profit or loss from two alternative strategies for speculating on Amazon.com's stock price.



Options like futures provide a form of leverage. For a given investment, the use of options magnifies the financial consequences. Good outcomes become very good, while bad outcomes become very bad!

A Comparison

Futures and options are similar instruments for speculators in that they both provide a way in which a type of leverage can be obtained. However, there is an important difference between the two. When a speculator uses futures, the potential loss as well as the potential gain is very large. When options are used, no matter how bad things get, the speculator's loss is limited to the amount paid for the options.

1.9 ARBITRAGEURS

Arbitrageurs are a third important group of participants in futures, forward, and options markets. Arbitrage involves locking in a riskless profit by simultaneously entering into transactions in two or more markets. In later chapters we will see how arbitrage is sometimes possible when the futures price of an asset gets out of line with its spot price. We will also examine how arbitrage can be used in options markets. This section illustrates the concept of arbitrage with a very simple example.

Let us consider a stock that is traded on both the New York Stock Exchange (www.nyse.com) and the London Stock Exchange (www.stockex.co.uk). Suppose that the stock price is \$172 in New York and £100 in London at a time when the exchange rate is \$1.7500 per pound. An arbitrageur could simultaneously buy 100 shares of the stock in New York and sell them in London to obtain a risk-free profit of

$$100 \times [(\$1.75 \times 100) - \$172]$$

or \$300 in the absence of transactions costs. Transactions costs would probably eliminate the profit for a small investor. However, a large investment bank faces very low transactions costs in both the stock market and the foreign exchange market. It would find the arbitrage opportunity very attractive and would try to take as much advantage of it as possible.

Arbitrage opportunities such as the one just described cannot last for long. As arbitrageurs buy the stock in New York, the forces of supply and demand will cause the dollar price to rise. Similarly, as they sell the stock in London, the sterling price will be driven down. Very quickly the two prices will become equivalent at the current exchange rate. Indeed, the existence of profit-hungry arbitrageurs makes it unlikely that a major disparity between the sterling price and the dollar price could ever exist in the first place. Generalizing from this example, we can say that the very existence of arbitrageurs means that in practice only very small arbitrage opportunities are observed in the prices that are quoted in most financial markets. In this book most of the arguments concerning futures prices, forward prices, and the values of option contracts will be based on the assumption that no arbitrage opportunities exist.

Business Snapshot 1.2 The Barings Bank Disaster

Derivatives are very versatile instruments. They can be used for hedging, speculation, and arbitrage. One of the risks faced by a company that trades derivatives is that an employee who has a mandate to hedge or to look for arbitrage opportunities may become a speculator.

Nick Leeson, an employee of Barings Bank in the Singapore office in 1995, had a mandate to look for arbitrage opportunities between the Nikkei 225 futures prices on the Singapore exchange and those on the Osaka exchange. Over time Leeson moved from being an arbitrageur to being a speculator without anyone in the Barings London head office fully understanding that he had changed the way he was using derivatives. He began to make losses, which he was able to hide. He then began to take bigger speculative positions in an attempt to recover the losses, but only succeeded in making the losses worse.

By the time Leeson was found out, his total loss was close to 1 billion dollars. As a result, Barings—a bank that had been in existence for 200 years—was wiped out. One of the lessons from Barings is that it is important to define unambiguous risk limits for traders and then monitor carefully what they do to make sure that these limits are adhered to.

1.10 DANGERS

Derivatives are very versatile instruments. As we have seen, they can be used for hedging, for speculation, and for arbitrage. It is this very versatility that can cause problems. Sometimes traders who have a mandate to hedge risks or follow an arbitrage strategy become (consciously or unconsciously) speculators. The results can be disastrous. One example of this is provided by the activities of Nick Leeson at Barings Bank (see Business Snapshot 1.2).[3]

To avoid the sort of problems Barings encountered, it is very important for both financial and nonfinancial corporations to set up controls to ensure that derivatives are being used for their intended purpose. Risk limits should be set and the activities of traders should be monitored daily to ensure that these risk limits are adhered to.

SUMMARY

One of the exciting developments in finance over the last 25 years has been the growth of derivatives markets. In many situations, both hedgers and speculators find it more attractive to trade a derivative on an asset than to trade the asset itself. Some derivatives are traded on exchanges; others are traded by financial institutions, fund managers, and corporations in the over-the-counter market, or added to new issues of debt and equity securities. Much of this book is concerned with the valuation of derivatives. The aim is to present a unifying framework within which all derivatives—not just options or futures—can be valued.

[3] The movie *Rogue Trader* provides a good dramatization of the failure of Barings Bank.

In this chapter we have taken a first look at forward, futures, and options contracts. A forward or futures contract involves an obligation to buy or sell an asset at a certain time in the future for a certain price. There are two types of options: calls and puts. A call option gives the holder 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. Forwards, futures, and options trade on a wide range of different underlying assets.

Derivatives have been very successful innovations in capital markets. Three main types of traders can be identified: hedgers, speculators, and arbitrageurs. Hedgers are in the position where they face risk associated with the price of an asset. They use derivatives to reduce or eliminate this risk. Speculators wish to bet on future movements in the price of an asset. They use derivatives to get extra leverage. Arbitrageurs are in business to take advantage of a discrepancy between prices in two different markets. If, for example, they see the futures price of an asset getting out of line with the cash price, they will take offsetting positions in the two markets to lock in a profit.

FURTHER READING

Chancellor, E. *Devil Take the Hindmost—A History of Financial Speculation.* New York: Farra Straus Giroux, 1999.

Merton, R. C. "Finance Theory and Future Trends: The Shift to Integration," *Risk*, 12, 7 (July 1999): 48–51.

Miller, M. H. "Financial Innovation: Achievements and Prospects," *Journal of Applied Corporate Finance*, 4 (Winter 1992): 4–11.

Rawnsley, J. H. *Total Risk: Nick Leeson and the Fall of Barings Bank.* New York: Harper Collins, 1995.

Zhang, P. G. *Barings Bankruptcy and Financial Derivatives.* Singapore: World Scientific, 1995.

Questions and Problems (Answers in Solutions Manual)

1.1. What is the difference between a long forward position and a short forward position?

1.2. Explain carefully the difference between hedging, speculation, and arbitrage.

1.3. What is the difference between entering into a long forward contract when the forward price is $50 and taking a long position in a call option with a strike price of $50?

1.4. Explain carefully the difference between selling a call option and buying a put option.

1.5. An investor enters into a short forward contract to sell 100,000 British pounds for US dollars at an exchange rate of 1.5000 US dollars per pound. How much does the investor gain or lose if the exchange rate at the end of the contract is (a) 1.4900 and (b) 1.5200?

1.6. A trader enters into a short cotton futures contract when the futures price is 50 cents per pound. The contract is for the delivery of 50,000 pounds. How much does the trader gain or lose if the cotton price at the end of the contract is (a) 48.20 cents per pound and (b) 51.30 cents per pound?

1.7. Suppose that you write a put contract with a strike price of $40 and an expiration date in 3 months. The current stock price is $41 and the contract is on 100 shares. What have you committed yourself to? How much could you gain or lose?

1.8. What is the difference between the over-the-counter market and the exchange-traded market? What are the bid and offer quotes of a market maker in the over-the-counter market?

1.9. You would like to speculate on a rise in the price of a certain stock. The current stock price is $29, and a 3-month call with a strike price of $30 costs $2.90. You have $5,800 to invest. Identify two alternative investment strategies, one in the stock and the other in an option on the stock. What are the potential gains and losses from each?

1.10. Suppose that you own 5,000 shares worth $25 each. How can put options be used to provide you with insurance against a decline in the value of your holding over the next 4 months?

1.11. When first issued, a stock provides funds for a company. Is the same true of a stock option? Discuss.

1.12. Explain why a forward contract can be used for either speculation or hedging.

1.13. Suppose that a March call option to buy a share for $50 costs $2.50 and is held until March. 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.

1.14. Suppose that a June put option to sell a share for $60 costs $4 and is held until June. Under what circumstances will the seller of the option (i.e., 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.

1.15. It is May and a trader writes a September call option with a strike price of $20. The stock price is $18 and the option price is $2. Describe the trader's cash flows if the option is held until September and the stock price is $25 at that time.

1.16. A trader writes a December put option with a strike price of $30. The price of the option is $4. Under what circumstances does the trader make a gain?

1.17. A company knows that it is due to receive a certain amount of a foreign currency in 4 months. What type of option contract is appropriate for hedging?

1.18. A United States company expects to have to pay 1 million Canadian dollars in 6 months. Explain how the exchange rate risk can be hedged using (a) a forward contract and (b) an option.

1.19. A trader enters into a short forward contract on 100 million yen. The forward exchange rate is $0.0080 per yen. How much does the trader gain or lose if the exchange rate at the end of the contract is (a) $0.0074 per yen and (b) $0.0091 per yen?

1.20. The Chicago Board of Trade offers a futures contract on long-term Treasury bonds. Characterize the traders likely to use this contract.

1.21. "Options and futures are zero-sum games." What do you think is meant by this statement?

1.22. Describe the profit from the following portfolio: a long forward contract on an asset and a long 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.

1.23. In the 1980s, Bankers Trust developed *index currency option notes* (ICONs). These are bonds in which the amount received by the holder at maturity varies with a foreign exchange rate. One example was its trade with the Long Term Credit Bank of Japan. The ICON specified that if the yen–US dollar exchange rate, S_T, is greater than 169 yen per dollar at maturity (in 1995), the holder of the bond receives \$1,000. If it is less than 169 yen per dollar, the amount received by the holder of the bond is

$$1{,}000 \max\left[0,\ 1{,}000\left(\frac{169}{S_T} - 1\right)\right]$$

When the exchange rate is below 84.5, nothing is received by the holder at maturity. Show that this ICON is a combination of a regular bond and two options.

1.24. On July 1, 2005, a company enters into a forward contract to buy 10 million Japanese yen on January 1, 2006. On September 1, 2005, it enters into a forward contract to sell 10 million Japanese yen on January 1, 2006. Describe the payoff from this strategy.

1.25. Suppose that sterling/USD spot and forward exchange rates are as follows:

Spot	1.6080
90-day forward	1.6056
180-day forward	1.6018

What opportunities are open to an arbitrageur in the following situations?
(a) A 180-day European call option to buy £1 for \$1.57 costs 2 cents.
(b) A 90-day European put option to sell £1 for \$1.64 costs 2 cents.

Assignment Questions

1.26. The price of gold is currently \$500 per ounce. The forward price for delivery in 1 year is \$700. An arbitrageur can borrow money at 10% per annum. What should the arbitrageur do? Assume that the cost of storing gold is zero and that gold provides no income.

1.27. The current price of a stock is \$94, and 3-month European call options with a strike price of \$95 currently sell for \$4.70. An investor who feels that the price of the stock will increase is trying to decide between buying 100 shares and buying 2,000 call options (= 20 contracts). Both strategies involve an investment of \$9,400. What advice would you give? How high does the stock price have to rise for the option strategy to be more profitable?

1.28. On May 29, 2003, an investor owns 100 Intel shares. As indicated in Table 1.2, the share price is \$20.83 and an October put option with a strike price of \$20 costs \$1.50. The investor is comparing two alternatives to limit downside risk. The first is to buy 1 October put option contract with a strike price of \$20. The second involves instructing a broker to sell the 100 shares as soon as Intel's price reaches \$20. Discuss the advantages and disadvantages of the two strategies.

1.29. A bond issued by Standard Oil worked as follows. The holder received no interest. At the bond's maturity the company promised to pay \$1,000 plus an additional amount based on the price of oil at that time. The additional amount was equal to the product of 170 and the excess (if any) of the price of a barrel of oil at maturity over \$25. The maximum additional amount paid was \$2,550 (which corresponds to a price of \$40 per barrel). Show that the bond is a combination of a regular bond, a long position in call options on oil with a strike price of \$25, and a short position in call options on oil with a strike price of \$40.

1.30. Suppose that in the situation of Table 1.1 a corporate treasurer said: "I will have £1 million to sell in 6 months. If the exchange rate is less than 1.59, I want you to give me 1.59. If it is greater than 1.63, I will accept 1.63. If the exchange rate is between 1.59 and 1.63, I will sell the sterling for the exchange rate." How could you use options to satisfy the treasurer?

1.31. Describe how foreign currency options can be used for hedging in the situation considered in Section 1.7 so that (a) ImportCo is guaranteed that its exchange rate will be less than 1.4600, and (b) ExportCo is guaranteed that its exchange rate will be at least 1.4200. Use DerivaGem to calculate the cost of setting up the hedge in each case assuming that the exchange rate volatility is 12%, interest rates in the United States are 3%, and interest rates in Britain are 4.4%. Assume that the current exchange rate is the average of the bid and offer in Table 1.1.

1.32. A trader buys a European call option and sells a European put option. The options have the same underlying asset, strike price, and maturity. Describe the trader's position. Under what circumstances does the price of the call equal the price of the put?