

GLOBAL  
EDITION



# Fundamentals of Futures and Options Markets

EIGHTH EDITION

John C. Hull



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PEARSON

EIGHTH EDITION

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**FUNDAMENTALS OF  
FUTURES AND OPTIONS  
MARKETS**

GLOBAL EDITION

**John C. Hull**

*Maple Financial Group Professor of Derivatives and Risk Management  
Joseph L. Rotman School of Management  
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Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England  
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*Authorized adaptation from the United States edition, entitled *Fundamentals of Futures and Options Markets*, 8th edition, ISBN 978-0-13-299334-0, by John C. Hull, published by Pearson Education © 2014.*

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ISBN-10: 1-292-15503-5

ISBN-13: 978-1-292-15503-6

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

10 9 8 7 6 5 4 3 2 1

14 13 12 11 10

Printed and bound in Vivar, Malaysia.

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## **To My Students**

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# Preface

I was originally persuaded to write this book by colleagues who liked my book *Options, Futures, and Other Derivatives*, but found the material a little too advanced for their students. *Fundamentals of Futures and Options Markets* covers some of the same ground as *Options, Futures, and Other Derivatives*, but in a way that readers who have had limited training in mathematics find easier to understand. One important difference between the two books is that there is no calculus in this book. *Fundamentals* is suitable for undergraduate and graduate elective courses offered by business, economics, and other faculties. In addition, many practitioners who want to improve their understanding of futures and options markets will find the book useful.

Instructors can use this book in a many different ways. Some may choose to cover only the first 12 chapters, finishing with binomial trees. For those who want to do more, there are many different sequences in which chapters 13 to 25 can be covered. From Chapter 18 onward, each chapter has been designed so that it is independent of the others and can be included in or omitted from a course without causing problems. I recommend finishing a course with Chapter 25, which students always find interesting and entertaining.

## ***What's New in This Edition?***

Many changes have been made to update material and improve the presentation. For example:

1. The changes taking place in the way over-the-counter derivatives are traded are explained. These changes are significant and most instructors will want to talk about them in their classes.
2. Chapter 7 on swaps reflects the trend in the market toward OIS discounting. It explains how swaps can be valued using both LIBOR and OIS discounting. It is becoming increasingly important for students to understand this material.
3. New nontechnical explanations of the Black–Scholes–Merton formula are provided in Chapter 13 and an appendix to Chapter 12 outlines how the formula can be derived from binomial trees. Many users of the book have asked for these changes.
4. New material has been added on principal protected notes (Chapter 11) reflecting their importance in the market.
5. Products such as DOOM options and CEBOs offered by the CME Group are covered (Chapter 9) because I find students enjoy learning about them.
6. The material on exotic options (Chapter 22) has been expanded to include a discussion of cliquet and Parisian options. I find students also enjoy learning about these products.

7. The material on credit derivatives (Chapter 23) has been updated and expanded. Several instructors have asked for this.
8. Value at risk is explained with an example using real data (Chapter 20). The example and accompanying spread sheets have been improved for this edition. This makes the presentation more interesting and gives instructors the opportunity to use richer assignment questions.
9. Many new end-of-chapter problems have been added.
10. The Test Bank available to adopting instructors has been expanded and improved.

### ***Slides***

Several hundred PowerPoint slides can be downloaded from my website or from Pearson's Instructor Resource Center. Instructors adopting the book are welcome to adapt the slides to meet their own needs.

### ***Software***

DerivaGem, Version 2.01, is included with this book. This consists of two Excel applications: the *Options Calculator* and the *Applications Builder*. The Options Calculator consists of easy-to-use software for valuing a wide range of options. The Applications Builder consists of a number of Excel functions from which users can build their own applications. It includes some sample applications and enables students to explore the properties of options and numerical procedures. It also allows more interesting assignments to be designed.

A version of the software's functions that is compatible with Open Office for Mac and Linux users is provided. Users can now access the code for the functions underlying DerivaGem.

The software is described more fully at the end of the book and a "Getting Started" section is now included. Updates to the software can be downloaded from my website:

[www.rotman.utoronto.ca/~hull](http://www.rotman.utoronto.ca/~hull)

### ***End-of-Chapter Problems***

At the end of each chapter (except the last) there are seven quiz questions, which students can use to provide a quick test of their understanding of the key concepts. The answers to these are given at the end of the book. In addition, there are a multitude of practice questions and further questions in the book.

### ***Instructors Manual***

The *Instructors Manual* is made available online by Pearson to adopting instructors. It contains solutions to practice and further questions, notes on the teaching of each chapter and on course organization, and some relevant Excel worksheets.

### ***Test Bank***

The Test Bank has been greatly improved for this edition and is also available online from Pearson to adopting instructors.

### ***Acknowledgments***

Many people have played a part in the development of successive editions of this book. Indeed, the list of people who have provided me with feedback on the book is now so long that it is not possible to mention everyone. I have benefited from the advice of many academics who have taught from the book and from the comments of many derivatives practitioners. I would like to thank the students on my courses at the University of Toronto, who have made many suggestions on how the material can be improved. Eddie Mizzi of the Geometric Press did a fine job handling the page composition and Lorraine Lin provided excellent research assistance.

Alan White, a colleague at the University of Toronto, deserves a special acknowledgment. Alan and I have been carrying out joint research and consulting in the areas of derivatives and risk management for about 30 years. During that time, we have spent many hours discussing key issues. Many of the new ideas in this book, and many of the new ways used to explain old ideas, are as much Alan's as mine. Alan has done most of the development work on the DerivaGem software.

Special thanks are due to many people at Pearson for their enthusiasm, advice, and encouragement. I would particularly like to mention my editor Katie Rowland, the editor-in-chief Donna Battista, and the project managers Alison Eusden and Emily Biberger. I welcome comments on the book from readers. My email address is:

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# 1 CHAPTER

## Introduction

Derivatives markets have become increasingly important in the world of finance and investments. It is now essential for all finance professionals to understand how these markets work, how they can be used, and what determines prices in them. This book addresses these issues.

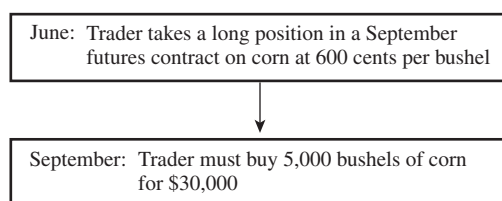
Derivatives are traded on exchanges and in what are termed “over-the-counter” (OTC) markets. The two main products trading on exchanges are futures and options. In the over-the-counter markets forwards, swaps, options, and a wide range of other derivatives transactions are agreed to. Prior to the crisis which started in 2007, the OTC derivatives market was relatively free from regulation. This has now changed. As we will explain, OTC market participants are now subject to rules specifying how trading must be done, how trades must be reported, and the collateral that must be provided.

This opening chapter starts by providing an introduction to futures markets and futures exchanges. It then compares exchange-traded derivatives markets with OTC derivatives markets and discusses forward contracts, which are the OTC counterpart of futures contracts. After that, it introduces options and outlines the activities of hedgers, speculators, and arbitrageurs in derivatives markets.

### 1.1 FUTURES CONTRACTS

A *futures contract* is an agreement to buy or sell an asset at a certain time in the future for a certain price. There are many exchanges throughout the world trading futures contracts. The Chicago Board of Trade, the Chicago Mercantile Exchange, and the New York Mercantile Exchange have merged to form the CME Group ([www.cmegroup.com](http://www.cmegroup.com)). Other large exchanges include NYSE Euronext ([www.euronext.com](http://www.euronext.com)), Eurex ([www.eurexchange.com](http://www.eurexchange.com)), BM&FBOVESPA ([www.bmfbovespa.com.br](http://www.bmfbovespa.com.br)), and the Tokyo Financial Exchange ([www.tfx.co.jp](http://www.tfx.co.jp)). A table at the end of this book gives a more complete list.

Futures exchanges allow people who want to buy or sell assets in the future to trade with each other. In June a trader in New York might contact a broker with instructions to buy 5,000 bushels of corn for September delivery. The broker would immediately communicate the client’s instructions to the CME Group. At about the same time,



**Figure 1.1** A futures contract (assuming it is held to maturity)

another trader in Kansas might instruct a broker to sell 5,000 bushels of corn for September delivery. These instructions would also be passed on to the CME Group. A price would be determined and the deal would be done.

The trader in New York who agreed to buy has what is termed a *long futures position*; the trader in Kansas who agreed to sell has what is termed a *short futures position*. The price is known as the *futures price*. We will suppose the price is 600 cents per bushel. This price, like any other price, is determined by the laws of supply and demand. If at a particular time more people wish to sell September corn than to buy September corn, the price goes down. New buyers will then enter the market so that a balance between buyers and sellers is maintained. If more people wish to buy September corn than to sell September corn, the price goes up—for similar reasons.

Issues such as margin requirements, daily settlement procedures, trading practices, commissions, bid–offer spreads, and the role of the exchange clearing house will be discussed in Chapter 2. For the time being, we can assume that the end result of the events just described is that the trader in New York has agreed to buy 5,000 bushels of corn for 600 cents per bushel in September and the trader in Kansas has agreed to sell 5,000 bushels of corn for 600 cents per bushel in September. Both sides have entered into a binding contract. The contract is illustrated in Figure 1.1.

A futures price can be contrasted with the *spot price*. The spot price is for immediate, or almost immediate, delivery. The futures price is the price for delivery at some time in the future. The two are not usually equal. As we will see in later chapters, the futures price may be greater than or less than the spot price.

## 1.2 HISTORY OF FUTURES MARKETS

Futures markets can be traced back to the Middle Ages. They were originally developed to meet the needs of farmers and merchants. Consider the position of a farmer in June of a certain year who will harvest a known amount of corn in September. There is uncertainty about the price the farmer will receive for the corn. In years of scarcity it might be possible to obtain relatively high prices, particularly if the farmer is not in a hurry to sell. On the other hand, in years of oversupply the corn might have to be disposed of at fire-sale prices. The farmer and the farmer's family are clearly exposed to a great deal of risk.

Consider next a company that has an ongoing requirement for corn. The company is also exposed to price risk. In some years an oversupply situation may create favorable prices; in other years scarcity may cause the prices to be exorbitant. It can make sense for the farmer and the company to get together in June (or even earlier) and agree on a

price for the farmer's production of corn in September. This involves them negotiating a type of futures contract. The contract provides a way for each side to eliminate the risk it faces because of the uncertain future price of corn.

We might ask what happens to the company's requirements for corn during the rest of the year. Once the harvest season is over, the corn must be stored until the next season. In undertaking this storage, the company does not bear any price risk, but does incur the costs of storage. If the farmer or some other person stores the corn, the company and the storer both face risks associated with the future corn price, and again there is a clear role for futures contracts.

## The Chicago Board of Trade

The Chicago Board of Trade (CBOT) 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. The CBOT developed futures contracts on many different underlying assets, including corn, oats, soybeans, soybean meal, soybean oil, wheat, Treasury bonds, and Treasury notes. It is now part of the CME Group.

## The Chicago Mercantile Exchange

In 1874 the Chicago Produce Exchange was established, providing a market for butter, eggs, poultry, and other perishable agricultural products. In 1898 the butter and egg dealers withdrew from the exchange to form the Chicago Butter and Egg Board. In 1919, this was renamed the Chicago Mercantile Exchange (CME) and was reorganized for futures trading. Since then, the exchange has provided a futures market for many commodities, including pork bellies (1961), live cattle (1964), live hogs (1966), and feeder cattle (1971). In 1982 it introduced a futures contract on the Standard & Poor's (S&P) 500 Stock Index.

The Chicago Mercantile Exchange started futures trading in foreign currencies in 1972. The currency futures traded now include the euro, British pound, Canadian dollar, Japanese yen, Swiss franc, Australian dollar, Mexican peso, Brazilian real, South African rand, New Zealand dollar, Russian rouble, Chinese renminbi, Swedish krona, Czech koruna, Hungarian forint, Israeli shekel, Korean won, Polish złoty, and Turkish lira. The Chicago Mercantile Exchange developed the very popular Eurodollar futures contract. (As later chapters will explain, this is a contract on the future value of a short-term interest rate.) It has also introduced futures contracts on weather and real estate.

## Electronic Trading

Traditionally futures have been traded using what is known as the *open-outcry system*. This involves traders physically meeting on the floor of the exchange, known as the "trading pit," and using a complicated set of hand signals to indicate the trades they would like to carry out. In the example we considered earlier, one floor trader would represent the investor in New York who wanted to buy September corn and another floor trader would represent the investor in Kansas who wanted to sell September corn.

**Business Snapshot 1.1** The Lehman Bankruptcy

On September 15, 2008, Lehman Brothers filed for bankruptcy. This was the largest bankruptcy filing in US history and its ramifications were felt throughout derivatives markets. Almost until the end, it seemed as though there was a good chance that Lehman would survive. A number of companies (e.g., the Korean Development Bank, Barclays Bank in the UK, and Bank of America) expressed interest in buying it, but none of these was able to close a deal. Many people thought that Lehman was “too big to fail” and that the US government would have to bail it out if no purchaser could be found. This proved not to be the case.

How did this happen? It was a combination of high leverage, risky investments, and liquidity problems. Commercial banks that take deposits are subject to regulations on the amount of capital they must keep. Lehman was an investment bank and not subject to these regulations. By 2007, its leverage ratio had increased to 31:1, which means that a 3–4% decline in the value of its assets would wipe out its capital. Dick Fuld, Lehman’s Chairman and Chief Executive, encouraged an aggressive deal-making, risk-taking culture. He is reported to have told his executives: “Every day is a battle. You have to kill the enemy.” The Chief Risk Officer at Lehman was competent, but did not have much influence and was even removed from the executive committee in 2007. The risks taken by Lehman included large positions in the instruments created from subprime mortgages, which will be described in Chapter 8. Lehman funded much of its operations with short-term debt. When there was a loss of confidence in the company, lenders refused to roll over this funding, forcing it into bankruptcy.

Lehman was very active in the over-the-counter derivatives markets. It had hundreds of thousands of transactions outstanding with about 8,000 different counterparties. Lehman’s counterparties were often required to post collateral and this collateral had in many cases been used by Lehman for various purposes. It is easy to see that sorting out who owes what to whom in this type of situation is a nightmare!

Exchanges have largely replaced the open outcry system by *electronic trading*. This involves traders entering their required trades at a keyboard and a computer being used to match buyers and sellers. Most futures exchanges throughout the world are entirely electronic. Electronic trading has led to a growth in algorithmic trading, also known as black-box, automated, high-frequency, or robo trading. This involves the use of computer programs to initiate trades, often without human intervention.

### 1.3 THE OVER-THE-COUNTER MARKET

Futures contracts are very popular exchange-traded contracts. Options, which are introduced later in this chapter, also trade very actively on exchanges. But not all trading of derivatives is on exchanges. Many trades take place in the *over-the-counter* (OTC) market. Banks, other large financial institutions, fund managers, and corporations are the main participants in OTC derivatives markets. The number of derivatives transactions per year in OTC markets is smaller than in exchange-traded markets, but the average size of the transactions is much greater.

Traditionally, participants in the OTC derivatives markets have contacted each other

**Business Snapshot 1.2 Systemic risk**

Systemic risk is the risk that a default by one financial institution will create a “ripple effect” that leads to defaults by other financial institutions and threatens the stability of the financial system. There are huge numbers of over-the-counter transactions between banks. If Bank A fails, Bank B may take a huge loss on the transactions it has with Bank A. This in turn could lead to Bank B failing. Bank C that has many outstanding transactions with both Bank A and Bank B might then take a large loss and experience severe financial difficulties; and so on.

The financial system has survived defaults such as Drexel in 1990 and Lehman Brothers in 2008, but regulators continue to be concerned. During the market turmoil of 2007 and 2008, many large financial institutions were bailed out, rather than being allowed to fail, because governments were concerned about systemic risk.

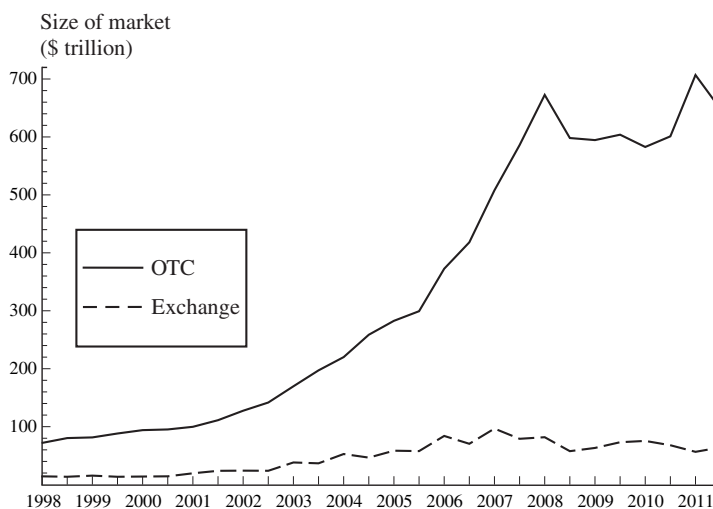
directly or have found counterparties for their trades using an interdealer broker. Banks often act as market makers for the more commonly traded instruments. This means that they are always prepared to quote a bid price (at which they are prepared to take one side of a derivatives transaction) and an offer price (at which they are prepared to take the other side). When they start trading with each other, two market participants often sign an agreement covering all transactions they might enter into in the future. The issues covered in the agreement include the circumstances under which outstanding transactions can be terminated, how settlement amounts are calculated in the event of a termination, and how the collateral (if any) that must be posted by each side is calculated.

Prior to the credit crisis, which started in 2007 and is discussed in some detail in Chapter 8, OTC derivatives markets were largely unregulated. Following the credit crisis and the failure of Lehman Brothers (see Business Snapshot 1.1), we have seen the development of many new regulations affecting the operation of OTC markets. The purpose of the regulations is to improve the transparency of OTC markets, improve market efficiency, and reduce systemic risk (see Business Snapshot 1.2 for a discussion of systemic risk). The over-the-counter market in some respects is being forced to become more like the exchange-traded market. Three important changes are:

1. Standardized OTC derivatives in the United States must whenever possible be traded on what are referred to as *swap execution facilities* (SEFs). These are platforms where market participants can post bid and offer quotes and where they can choose to trade by accepting the quotes of other market participants.
2. There is a requirement in most parts of the world that a central clearing party (CCP) be used for most standardized derivatives transactions. The CCP's role is to stand between the two sides in an over-the-counter derivatives transaction in much the same way that an exchange does in the exchange-traded derivatives market. CCPs are discussed in more detail in Chapter 2.
3. All trades must be reported to a central registry.

## 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,



**Figure 1.2** Size of over-the-counter and exchange-traded derivatives markets

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](http://www.bis.org)) started collecting statistics on the markets in 1998. Figure 1.2 compares (a) the estimated total principal amounts underlying transactions that were outstanding in the over-the-counter markets between 1998 and 2011 and (b) the estimated total value of the assets underlying exchange-traded contracts during the same period. Using these measures, the size of the over-the-counter market was \$648 trillion in December 2011 and that of the exchange-traded market was \$64 trillion at this time.

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 transaction is an agreement to buy 100 million U.S. dollars with British pounds at a predetermined exchange rate in one year. The total principal amount underlying this transaction is \$100 million. However, the value of the transaction at a particular point in time might be only \$1 million. The Bank for International Settlements estimates the gross market value of all OTC contracts outstanding in December 2011 to be about \$27 trillion.<sup>1</sup>

## 1.4 FORWARD CONTRACTS

A forward contract is similar to a futures contract in that it is an agreement to buy or sell an asset at a certain time in the future for a certain price. But, whereas futures contracts are traded on exchanges, forward contracts trade in the over-the-counter market.

Forward contracts on foreign exchange are very popular. Most large banks employ both spot and forward foreign exchange traders. Spot traders are trading a foreign currency for almost immediate delivery. Forward traders are trading for delivery at a

<sup>1</sup> 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 22, 2012  
(GBP = British pound; USD = U.S. dollar;  
quote is number of USD per GBP)

	<i>Bid</i>	<i>Offer</i>
Spot	1.5585	1.5589
1-month forward	1.5582	1.5587
3-month forward	1.5579	1.5585
6-month forward	1.5573	1.5580

future time. Table 1.1 provides the quotes for the exchange rate between the British pound (GBP) and the U.S. dollar (USD) that might be made by a large international bank on June 22, 2012. 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 \$1.5585 per GBP and sell sterling in the spot market at \$1.5589 per GBP. The second row indicates that the bank is prepared to buy sterling in one month at \$1.5582 per GBP and sell sterling in one month at \$1.5587 per GBP; the third row indicates that it is prepared to buy sterling in three months at \$1.5579 per GBP and sell sterling in three months at \$1.5585 per GBP; and so on.

The quotes are for very large transactions. (As anyone who has traveled abroad knows, retail customers face much larger spreads between bid and offer quotes than those in Table 1.1.) After examining the quotes in Table 1.1, a large corporation might agree to sell £100 million in six months for \$155.73 million to the bank as part of its hedging program.

There is a relationship between the forward price of a foreign currency, the spot price of the foreign currency, domestic interest rates, and foreign interest rates. This is explained in Chapter 5.

## 1.5 OPTIONS

Options are traded both on exchanges and in the over-the-counter markets. There are two types of option: 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. The price in the contract is known as the *exercise price* or the *strike price*; the date in the contract is known as the *expiration date* or the *maturity date*. A *European option* can be exercised only on the maturity date; an *American option* can be exercised at any time during its life.

It should be emphasized that an option gives the holder the right to do something. The holder does not have to exercise this right. This fact distinguishes options from futures (or forward) contracts. The holder of a long futures contract is committed to buying an asset at a certain price at a certain time in the future. By contrast, the holder of a call option has a choice as to whether to buy the asset at a certain price at a certain time in the future. It costs nothing (except for margin requirements, which will be discussed in Chapter 2) to enter into a futures contract. By contrast, an



**Table 1.2.** Prices of call options on Google, June 25, 2012; stock price: bid \$561.32; offer \$561.51

Strike price (\$)	July 2012		Sept. 2012		Dec. 2012	
	Bid	Offer	Bid	Offer	Bid	Offer
520	46.50	47.20	55.40	56.80	67.70	70.00
540	31.70	32.30	41.60	42.50	55.30	56.20
560	20.00	20.40	30.20	30.70	44.20	45.00
580	11.30	11.60	20.70	21.20	34.50	35.30
600	5.60	5.90	13.50	13.90	26.30	27.10

investor must pay an up-front price, known as the *option premium*, for an option contract.

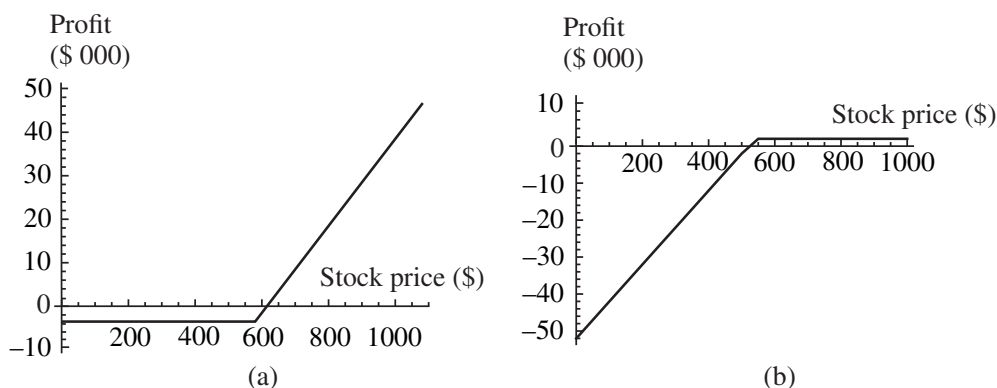
The largest exchange in the world for trading stock options is the Chicago Board Options Exchange (CBOE; [www.cboe.com](http://www.cboe.com)). Table 1.2 gives the bid and offer quotes for some of the call options trading on Google (ticker symbol: GOOG) on June 25, 2012. Table 1.3 does the same for put options trading on Google on that date. The tables have been constructed from data on the CBOE web site. The Google stock price at the time of the quotes was bid 561.32, offer 561.51. The bid–offer spread on an option, as a percentage of its price, is greater than that on the underlying stock and depends on the volume of trading. The option strike prices in the tables are \$520, \$540, \$560, \$580, and \$600. The maturities are July 2012, September 2012, and December 2012. The July options have a maturity date of July 21, 2012, the September options have a maturity date of September 22, 2012, and the December options have a maturity date of December 22, 2012.

The tables illustrate a number of properties of options. The price of a call option decreases as the strike price increases; the price of a put option increases as the strike price increases. Both types of options tend to become more valuable as their time to maturity increases. These properties of options will be discussed further in Chapter 10.

Suppose an investor instructs a broker to buy one December call option contract on Google with a strike price of \$580. The broker will relay these instructions to a trader at the CBOE and the deal will be done. The (offer) price is \$35.30, as indicated in Table 1.2. This is the price for an option to buy one share. In the United States, an

**Table 1.3** Prices of put options on Google, June 25, 2012; stock price: bid \$561.32; offer \$561.51

Strike price (\$)	July 2012		Sept. 2012		Dec. 2012	
	Bid	Offer	Bid	Offer	Bid	Offer
520	5.00	5.30	13.60	14.00	25.30	26.10
540	10.20	10.50	19.80	20.30	32.80	33.50
560	18.30	18.70	28.10	28.60	41.50	42.30
580	29.60	30.00	38.40	39.10	51.80	52.60
600	43.80	44.40	51.10	52.10	63.50	64.90



**Figure 1.3** Net profit from (a) purchasing a contract consisting of 100 Google December call options with a strike price of \$580 and (b) selling a contract consisting of 100 Google September put options with a strike price of \$540

option contract is an agreement to buy or sell 100 shares. Therefore, the investor must arrange for \$3,530 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 \$3,530 the right to buy 100 Google shares for \$580 each. If the price of Google does not rise above \$580.00 by December 22, 2012, the option is not exercised and the investor loses \$3,530.<sup>2</sup> But if Google does well and the option is exercised when the bid price for the stock is \$650, the investor is able to buy 100 shares at \$580 and immediately sell them for \$650 for a profit of \$7,000—or \$3,470 when the initial cost of the options is taken into account.<sup>3</sup>

An alternative trade would be to sell one September put option contract with a strike price of \$540 at the bid price of \$19.80. This would lead to an immediate cash inflow of  $100 \times 19.80 = \$1,980$ . If the Google stock price stays above \$540, this option is not exercised and the investor makes a \$1,980 profit. However, if stock price falls and the option is exercised when the stock price is \$500 there is a loss. The investor must buy 100 shares at \$540 when they are worth only \$500. This leads to a loss of \$4,000, or \$2,020 when the initial amount received for the option contract is taken into account.

The stock options trading on the CBOE are American (i.e., they can be exercised at any time). 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 for the two trades we have considered is shown in Figure 1.3.

Further details about the operation of options markets and how prices such as those in Tables 1.2 and 1.3 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

<sup>2</sup> The calculations here ignore commissions paid by the investor.

<sup>3</sup> The calculations here ignore the effect of discounting. Theoretically, the \$7,000 should be discounted from the time of exercise to June 25, 2012 when calculating the payoff.

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 HISTORY OF OPTIONS MARKETS

The first trading in put and call options began in Europe and in the United States as early as the eighteenth century. In the early years the market got a bad name because of certain corrupt practices. One of these involved brokers being given options on a certain stock as an inducement for them to recommend the stock to their clients.

### Put and Call Brokers and Dealers Association

In the early 1900s a group of firms set up the Put and Call Brokers and Dealers Association. The aim of this association was to provide a mechanism for bringing buyers and sellers together. Investors who wanted to buy an option would contact one of the member firms. This firm would attempt to find a seller or writer of the option from either its own clients or those of other member firms. If no seller could be found, the firm would undertake to write the option itself in return for what was deemed to be an appropriate price.

The options market of the Put and Call Brokers and Dealers Association suffered from two deficiencies. First, there was no secondary market. The buyer of an option did not have the right to sell it to another party prior to expiration. Second, there was no mechanism to guarantee that the writer of the option would honor the contract. If the writer did not live up to the agreement when the option was exercised, the buyer had to resort to costly lawsuits.

### The Formation of Options Exchanges

In April 1973 the Chicago Board of Trade set up a new exchange, the Chicago Board Options Exchange, specifically for the purpose of trading stock options. Since then options markets have become increasingly popular with investors. By the early 1980s the volume of trading had grown so rapidly that the number of shares underlying the stock option contracts traded each day in United States exceeded the daily volume of shares traded on the New York Stock Exchange.

The exchanges trading options in the United States now include the Chicago Board Options Exchange ([www.cboe.com](http://www.cboe.com)), NASDAQ OMX ([www.nasdaqtrader.com](http://www.nasdaqtrader.com)), NYSE Euronext ([www.euronext.com](http://www.euronext.com)), the International Securities Exchange ([www.i-seoptions.com](http://www.i-seoptions.com)), and the Boston Options Exchange ([www.bostonoptions.com](http://www.bostonoptions.com)). Options trade on several thousand different stocks as well as stock indices, foreign currencies, and other assets.

Most exchanges offering futures contracts also offer options on these contracts. Thus, the CME Group offers options on corn futures, live cattle futures, and so on. Options exchanges exist all over the world (see the table at the end of this book).

## The Over-the-Counter Market for Options

The over-the-counter market for options has grown very rapidly since the early 1980s and is now bigger than the exchange-traded market. One advantage of options traded in the over-the-counter market is that they can be tailored to meet the particular needs of a corporate treasurer or fund manager. For example, a corporate treasurer who wants a European call option to buy 1.6 million British pounds at an exchange rate of 1.5580 may not find exactly the right product trading on an exchange. However, it is likely that many derivatives dealers would be pleased to provide a quote for an over-the-counter contract that meets the treasurer's precise needs.

### 1.7 TYPES OF TRADER

Futures, forward, and options markets have been outstandingly successful. The main reason is that they have attracted many different types of trader 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 who is prepared to take the other side.

Three broad categories of trader can be identified: hedgers, speculators, and arbitrageurs. Hedgers use futures, forwards, and options 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 1.3, hedge funds have become big users of derivatives for all three purposes.

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

### 1.8 HEDGERS

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

#### Hedging Using Forward Contracts

Suppose that it is June 22, 2012, and ImportCo, a company based in the United States, knows that it will have to pay £10 million on September 22, 2012, 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 three-month forward market at 1.5585. This would have the effect of fixing the price to be paid to the British exporter at \$15,585,000.

Consider next another U.S. company, which we will refer to as ExportCo, that is exporting goods to the United Kingdom and on June 22, 2012, knows that it will receive £30 million three months later. ExportCo can hedge its foreign exchange risk by selling £30 million in the three-month forward market at an exchange rate of 1.5579. This would have the effect of locking in the U.S. dollars to be realized for the pounds at \$46,737,000.

### Business Snapshot 1.3 Hedge funds

Hedge funds have become major users of derivatives for hedging, speculation, and arbitrage. They are similar to mutual funds in that they invest funds on behalf of clients. However, they accept funds only from financially sophisticated individuals and do not publicly offer their securities. Mutual funds are subject to regulations requiring that the shares be redeemable at any time, that investment policies be disclosed, that the use of leverage be limited, 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 2 plus 20%, i.e., 2% of the amount invested plus 20% of the profits. Hedge funds have grown in popularity, with about \$2 trillion being invested in them throughout the world. “Funds of funds” have been set up to invest in a portfolio of 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:

*Long/Short Equities:* Purchase securities considered to be undervalued and short those considered to be overvalued in such a way that the exposure to the overall direction of the market is small.

*Convertible Arbitrage:* Take a long position in a thought-to-be-undervalued convertible bond combined with an actively managed short position in the underlying equity.

*Distressed Securities:* Buy securities issued by companies in, 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.

*Global Macro:* Carry out trades that reflect anticipated global macroeconomic trends.

*Merger Arbitrage:* Trade after a possible merger or acquisition is announced so that a profit is made if the announced deal takes place.

Example 1.1 summarizes the hedging strategies open to ImportCo and ExportCo. 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 22 and the company has not hedged, the £10 million that it has to pay will cost \$15,000,000, which is less than \$15,585,000. On the other hand, if the exchange rate is 1.6000, the £10 million will cost \$16,000,000—and the company will wish 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 1.5579, the company will wish it had hedged; if the rate is greater than 1.5579, it will be pleased it has not done so.

**Example 1.1** Hedging with forward contracts

It is June 22, 2012. ImportCo must pay £10 million on September 22, 2012, for goods purchased from Britain. Using the quotes in Table 1.1, it buys £10 million in the three-month forward market to lock in an exchange rate of 1.5585 for the pounds it will pay.

ExportCo will receive £30 million on September 22, 2012, from a customer in Britain. Using quotes in Table 1.1, it sells £30 million in the three-month forward market to lock in an exchange rate of 1.5579 for the pounds it will receive.

This example illustrates a key aspect of hedging. Hedging reduces the risk, but it is not necessarily the case that the outcome with hedging will be better than the outcome without hedging.

## Hedging Using Options

Options can also be used for hedging. Example 1.2 considers an investor who in May of a particular year owns 1,000 shares of a company. The share price is \$28 per share. The investor is concerned about a possible share price decline in the next two months and wants protection. The investor could buy 10 July put option contracts on the company's stock 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, 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 the stock falls below \$27.50, the options will 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 the stock price in two months. The dotted line shows the value of the portfolio assuming no hedging.

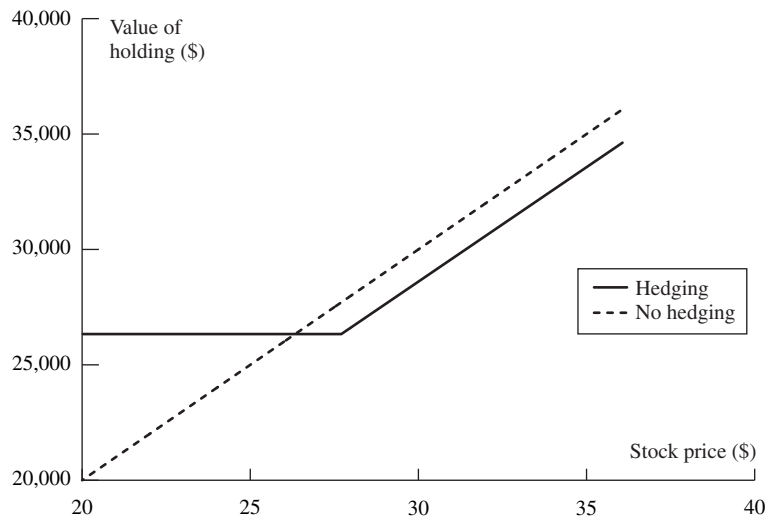
**Example 1.2** Hedging with options

It is May. An investor who owns 1,000 shares of a company and wants protection against a possible decline in the share price over the next two months. Market quotes are as follows:

Current share price: \$28

July 27.50 put price: \$1

The investor buys 10 put option contracts for a total cost of \$1,000. This gives the investor the right to sell 1,000 shares for \$27.50 per share during the next two months.



**Figure 1.4** Value in Example 1.2 of the investor's holding in two months

## 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.

## 1.9 SPECULATORS

We now move on to consider how futures and options markets can be used by speculators. Whereas hedgers want to avoid an 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.

### Speculation Using Futures

Consider a U.S. speculator who in February thinks that the British pound will strengthen relative to the U.S. dollar over the next two 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 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 1.4 summarizes the two alternatives on the assumption that the current exchange rate is 1.5470 dollars