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Futures and Options

Second Edition

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To

The loving memory of my mother,
Jamuna Devi Bagri

B R Bagri

Foreword

Indian Capital Market has undergone dramatic changes over the last several years. SEBI's endeavour has been to make the Indian Capital Market efficient, effective, transparent and investor friendly. Some initiatives of SEBI in the last few years like introduction of equity derivatives (index futures, index options, individual stock futures and options), reduction of settlement cycle, compulsory rolling settlement in all the scrips and dematerialization bear testimony to it.

Introduction of equity derivatives was essentially the beginning of a new era in the Indian Capital Market. With the launch of Index Futures in June 2000, as the first derivative product, SEBI expanded the portfolio by quickly adding index options, individual stock options and individual stock futures. The growth of this market has been quite significant. With these products in place, Indian Capital Market is at par with any other Capital Market across the globe.

Derivative products serve the vitally important economic functions of price discovery and risk management. The transparency, which emerges from their trading mechanism, ensures the price discovery in the underlying market. Further, they serve as risk management tools by facilitating the trading of risks among the market participants. These products enable market participants to take the desired risks and jettison the undesirable undertones.

To facilitate the development of the derivatives market, it is necessary to educate the market participants and investors on the nuances of these new age products and their strategic uses. This book is a comprehensive work on the subject and presents the complicated terminology of the derivatives in a simplified and lucid manner. I sincerely believe that it would make meaningful contributions to the Capital Market by sharing the required knowledge to its various participants.

G.N. Bajpai
Chairman,
Securities and
Exchange Board of India,
(Mumbai, India)

Preface to the Second Edition

We are pleased to present the second edition of *Futures and Options* to our esteemed readers. The overwhelming response to the first edition has been a highly motivating experience to us. Since the publication of the first edition, the Indian Capital Market has witnessed many significant changes. Physical securities have given way to dematerialization and the concept of market lot has been abolished. Similarly, rolling settlement has replaced the weekly/fortnightly settlements and the age-old *Badla* has been abolished. However, the most notable change in the capital market scenario has been the introduction of derivatives trading since the last two-and-a-half years. After the introduction of such trading in the year 2000 with stock index futures, other products including options on stock indices, options on individual stocks and futures on individual stocks were introduced subsequently. At the time of the publication of the first edition of this book, trading of derivative instruments in the Indian market was not instituted. Now that derivatives have become an integral part of the Indian Capital Market, it became necessary to update the contents of the book.

CHANGES IN THIS EDITION

The book has been virtually recast—some portions have been rewritten, chapter contents have been rearranged, additions have been made to the chapters and new chapters have been written in an attempt to make the flow of the subject matter more logical. Use of futures contracts by various market players is illustrated in more detail and futures on stock indices and on individual stocks have been discussed in a separate chapter now. The discussion of the Black and Scholes' model for valuation of stock options has been made crisp and a detailed account of implied volatility and derivatives of the model has been provided. A new chapter, Chapter 6, on options on stock indices and options on futures contracts is included. Another new chapter included in this edition gives an overview of the Indian Securities Market (Chapter 8), while the past and present of futures and options in India is included in Chapter 9. In this edition, a large number of *Review Illustrations* have been included with the aim of providing the reader with an opportunity to refresh his computational skills involved in the pricing of various derivatives instruments and review other concepts related to them. The book retains the all-important feature of short true–false questions to help the reader reinforce understanding of the concepts and ideas discussed in the book.

THE SOFTWARE

Like the first edition, a CD-ROM, titled FUTOP (version 2.0.0) accompanies this edition. The tutorial diskette provided with the previous edition evoked very encouraging response. With this edition, a highly improved version of the software has been added. The newly designed software comprises several modules including Valuation of Options, Valuation of Futures, Strategies, Quiz, and Reports of the L.C. Gupta and J.R. Varma Committees established by the Securities and Exchange Board of India (SEBI). More details about the contents of the software are given at the end of the book and are available in the CD-ROM.

We wish to acknowledge with gratitude the help that we have received from several people in ways more than one. At the outset, we are obliged to Shri G N Bajpai, the Chairman of the Securities and Exchange Board of India (SEBI), for having written Foreword to the book. We gratefully acknowledge the help and comments of Shri Ravi Narain, Managing Director and Chief Executive Officer, National Stock Exchange of India Limited (NSE), and Dr. Manoj Vaish, Director—Corporate Development, The Stock Exchange, Mumbai (BSE).

We are grateful to Prof. Ramesh Bhat of the Indian Institute of Management, Ahmedabad for his comments and suggestions on the previous edition of the book. Prof. Y P Singh of the Department of Commerce, Delhi School of Economics, provided us with useful

suggestions for improving upon the first edition of the book. We profusely thank him for this. We also gratefully acknowledge the comments of Dr. V K Vasal of the Department of Financial Studies, South Campus, University of Delhi.

FUTOP has been designed by Shri Sarvesh Sharma, at the BLB Limited. Our heartfelt thanks to him for designing the software program in an elegant form. Thanks are also due to Shri Rahul Kaushik for his comments and suggestions in the development of the software. We owe a special word of thanks to Shri Naveen Mathur for his constructive criticism of several chapters of the book and his contribution to shaping the contents and looks of the software program.

Valuable contribution has been made by Shri Ranjit Singh Minhas and Shri Ashish Pandey of the BLB Limited in writing about the Indian Capital Market. We are thankful to them too.

At Tata McGraw-Hill Publishing Company Limited, the entire team has worked on this project very diligently and professionally. We are grateful to them.

While several individuals have helped us in the course of our work, we remain responsible for any errors/omissions etc. We look forward to constructive comments, observations and suggestions from our valuable readers for further improving the book at:

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Preface to the First Edition

The world financial markets have undergone qualitative changes in the last three decades due to phenomenal growth of derivatives. An increasingly large number of organisations now consider derivatives to play a significant role in implementing their financial policies. Derivatives are used for a variety of purposes, but, perhaps, the most important is hedging. Hedging involves transfer of market risk—the possibility of sustaining losses due to unforeseen unfavourable price changes. A derivatives transaction allows a firm to alter its market risk profile by transferring to a counter-party some type of risk for a price. Hedging is the prime reason for the advent of derivatives and continues to be a significant factor driving financial managers to deal in derivatives.

With the world embracing the derivatives trading on a large scale, the Indian market obviously cannot remain aloof, especially after liberalisation has been set in motion. Now we are on the threshold of introducing trading in derivatives, beginning with stock index futures. However, opinions seem to be divided on the desirability of introduction of such trading. On the one hand, the National Stock Exchange of India (NSE), seems to be well set for the introduction of derivatives trading. On the other, however, it is apprehended in several quarters that the present conditions in India do not warrant the introduction of derivatives. It is held that derivatives, being highly levered instruments, can be explosive. In any case, since derivatives are speculative in nature, precautionary measures need to be taken with proper control mechanisms being invoked. And the conditions required, including infrastructure, for a successful introduction of such trading need to be created. With the L C Gupta Committee having recently submitted its report on the subject, SEBI is engaged in the process of assessing the feasibility and desirability of introducing such trading.

In a way, derivatives trading is not new to India. It has been prevalent for long in the form of *teji, mandi, nazrana, fatak,* etc. However, these concepts do not exactly match with those associated with the futures and options trading as practised in the world markets and are likely to be introduced here. This transition calls for a better understanding of the underlying concepts. Further, knowledge and appreciation of the risks associated with derivatives is highly desirable, before venturing into it. This is what this book proposes to address. It gives a fairly detailed account of the nature of forward, futures and options contracts, and their valuation. Of the many types of derivatives, this book focuses on two:

- futures and
- options on stock price indices; and equities, which are the basic ones.

Futures and Options is divided into six chapters. The text in each chapter is followed by objective exercises to ascertain better understanding of various concepts and ideas given in the text. Beginning with an introduction to derivatives in Chapter 1, futures and options contracts are discussed in the next three chapters. Chapter 5 presents a discussion on trading in futures and options. It gives an account of risks that traders in these contracts are exposed to, and some regulatory aspects of such trading. Finally, Chapter 6 is devoted to the Indian scenario. It describes the *badla* system prevalent in the Indian market and the form of trading involving *teji, mandi,* etc. It is followed by a comparison of *badla* on one hand and futures and options on the other. The concluding part of the chapter contains a note on the introduction of futures and options trading in India.

The book is supplemented with a diskette which contains FUTOP, a tutorial on various concepts and software for calculating the futures and options values with user's data. More details about FUTOP are provided at the end of this book.

This book is a product of the vision of Late Shri Babu Lal Bagri, the founding father of the BLB House, who foresaw, more than a decade ago, the introduction of derivatives trading in India and wished that a project of this kind be undertaken. We feel proud that we have been able to give it a form, albeit moderate.

In writing this book, help has been taken from the works of numerous experts in the field. We have received encouragement from several quarters in the course of this project. We are grateful to Mr D R Mehta, Chairman, Securities and Exchange Board of India for having consented to write the Foreword to the book, and Mr O P Gahrotra, Senior Executive Director, SEBI, who has been very encouraging and motivating throughout this venture. We are thankful to Dr R H Patil, Mr Ravi Narain and Mr Amit Chauhan of the National Stock Exchange of India for their cooperation and support.

Our sincere thanks are due to Mr Anil Makhija, who was earlier with the research division, and who designed the software tutorial to accompany this book. At BLB, Mr P K Vijay has contributed a great deal in the successful completion of this project. Thanks to him. We have also benefitted from the help we received from Mr Vishal Malik of the Jagan Institute of Management Studies, for which we are thankful.

We shall look forward to constructive criticism and suggestions for improvements from our esteemed readers.

August 1998

N D Vohra
B R Bagri

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CHAPTER

1

Introduction

Risk is a characteristic feature of all commodity and capital markets. Prices of all commodities—be they agricultural like wheat, cotton, rice, coffee or tea, or non-agricultural like silver, gold etc.—are subject to fluctuation over time in keeping with prevailing demand and supply conditions. Producers or possessors of these commodities obviously cannot be sure of the prices that their produce or possession may fetch when they have to sell them, in the same way as the buyers and the processors are not sure what they would have to pay for their buy. Similarly, prices of shares and debentures or bonds and other securities are also subject to continuous change. Those who are charged with the responsibility of managing money, their own or of others, are therefore constantly exposed to the threat of risk. In the same way, the foreign exchange rates are also subject to continuous change. Thus, an importer of a certain piece of machinery is not sure of the amount he would have to pay in rupee terms when the payment becomes due.

While examples where risk is seen to exist, can be easily multiplied, it may be observed that parties involved in all such cases may see the benefits of, and are likely to desire, having some contractual form whereby forward prices may be fixed and the price risk facing them is eliminated. Derivatives came into being primarily for the reason of the need to eliminate price risk.

WHAT ARE DERIVATIVES ?

A derivative instrument, broadly, is a financial contract whose payoff structure is determined by the value of an underlying commodity, security, interest rate, share price index, exchange rate, oil price, and the like. Thus, a derivative instrument derives its value from some underlying variable. A derivative instrument by itself does not constitute ownership. It is, instead, a promise to convey ownership.

All derivatives are based on some 'cash' products. The underlying basis of a derivative instrument may be any product including

(i) commodities including grain, coffee beans, orange juice etc.
(ii) precious metals like gold and silver
(iii) foreign exchange rate
(iv) bonds of different types, including medium to long-term negotiable debt securities issued by governments, companies, etc.
(v) short-term debt securities such as T-bills; and
(vi) over-the-counter (OTC) money market products such as loans or deposits.

Derivatives are specialized contracts which are employed for a variety of purposes including reduction of funding costs by borrowers, enhancing the yield on assets, modifying the payment structure of assets to correspond to the investor's market view, etc. However, the most important use of derivatives is in transferring market risk, called *hedging*, which is a protection against losses resulting from unforeseen price or volatility changes. Thus, derivatives are a very important tool of risk management. As awareness about the usefulness of derivatives as a risk management tool has increased, the markets for derivatives too have grown. Of late, derivatives have assumed a very significant place in the field of finance and they seem to be driving global financial markets.

There are many kinds of derivatives including futures, options, interest rate swaps, and mortgage derivatives. This book seeks to discuss the nature of futures and options and their trading in the market.

To understand the nature of futures and options, let us begin with the idea of forward contracts.

FORWARD CONTRACTS

A deal for the purchase or sale of a commodity, security or other asset can be in the spot or forward markets. A *spot* or *cash* market is the most commonly used for trading. A majority of our day-to-day transactions are in the cash market, where we pay cash and get the delivery of the goods. In addition to a cash purchase, another way to acquire or sell assets is by entering into a *forward contract.* In a forward contract, the buyer agrees to pay cash at a later date when the seller delivers the goods. As an analogy of a forward contract, suppose a patient calls a doctor for an appointment and sees him after two days at the appointed hour. After his examination, the patient pays the doctor. Similarly, if a car is booked with a dealer and the delivery 'matures', the car is delivered after its price has been paid.

Usually no money changes hands when forward contracts are entered into, but sometimes one or both the parties to a contract may like to ask for some initial, good faith deposit to ensure that the contract is honoured by the other party.

Typically, in a forward contract, the price at which the underlying commodity or asset will be traded, is decided at the time of entering into the contract. The essential idea of entering into a forward contract is to peg the price and thereby avoid the price risk. Thus, by entering into a forward contract, one is assured of the price at which one can buy/sell goods or other assets. A manufacturer using a certain raw material whose price is subject to variation, can avoid the risk of the price moving adversely by entering into a forward contract and plan his operations better. Similarly, by entering into a forward contract, a farmer can ensure the price he can get for his crop and not worry about what price would prevail at the time of maturity of the contract. Of course, at the maturity of a contract, if the market price of the commodity is greater than the price agreed, then the buyer stands to gain while the seller is in a losing position. The opposite holds when the market price happens to be lower than the agreed price.

Forward contracts have been in existence for quite some time. The organized commodities exchanges, on which forward contracts are traded, probably started in Japan in the early eighteenth century, while the establishment of the Chicago Board of Trade (CBOT) in 1848 led to the start of a formal commodities exchange in the USA.

A forward contract is evidently a good means of avoiding price risk, but it entails an element of risk in that a party to the contract may not honour its part of the obligation. Thus, each party faces the risk of default. There is another problem. Once a position of buy or sell is taken in a forward contract, an investor cannot retreat except through mutual consent with the other party or by entering into an identical contract and taking a position that is the reverse of the earlier position. The alternatives are by no means very easy. With forward contracts entered on a one-to-one basis and with no standardization, the forward contracts have virtually no liquidity. These problems of credit risk and no-liquidity associated with forward contracts led to the emergence of futures contracts. The futures contracts are thus refined forward contracts.

FUTURES CONTRACTS

As indicated, the futures contracts represent an improvement over the forward contracts in terms of standardization, performance guarantee and liquidity. A futures contract is a standardized contract between two parties where one of the parties commits to sell, and the other to buy, a stipulated quantity (and quality, where applicable) of a commodity, currency, security, index or some other specified item at an agreed price on a given date in the future.

The futures contracts are standardized ones, so that

(i) the quantity of the commodity or the other asset which would be transferred or would form the basis of gain/loss on maturity of a contract,
(ii) the quality of the commodity—if a certain commodity is involved—and the place where delivery of the commodity would be made,
(iii) the date and month of delivery,
(iv) the units of price quotation,
(v) the minimum amount by which the price would change and the price limits for a day's operations, and other relevant details are all specified in a futures contract. Thus, in a way, it becomes a standard asset, like any other asset, to be traded.

Futures contracts are traded on commodity exchanges or other futures exchanges. People can buy or sell futures like other commodities. When an investor buys a futures contract (so that he takes a *long position*) on an organized futures exchange, he/she is in fact assuming the right and obligation of taking the delivery of the specified underlying item on a specified date. Similarly, when an investor sells a contract, to take a *short position*, one assumes the right and obligation to make the delivery of the underlying asset. There is no risk of non-performance in the case of trading in futures contracts. This is because a *clearing house*, or a *clearing corporation* is associated with the futures exchange, which plays a pivotal role in the trading of futures. A clearing house takes the opposite position in each trade, so that it becomes the buyer to the seller and the seller to the buyer. When a party takes a short position in a contract, it is obliged to sell the underlying commodity in question at the stipulated price to the clearing house on maturity of the contract. Similarly, an investor who takes a long position on the contract, can seek its performance through the clearing house only.

To illustrate, if a futures contract maturing on December 23 and involving 500 shares of Company X at Rs 375 is bought by investor *A* and sold by another investor *B*, then each of these investors has his rights and obligations to the clearing corporation. Thus, on December 23, *A* shall call upon the clearing corporation for the delivery of 500 shares of X upon a payment of Rs 375 per share. Similarly, *B* is obliged to deliver the shares to the corporation and is entitled to receive an amount of Rs 187,500 (500×375). Note that the traders are not obliged to each other directly.

A significant point to note is that while a clearing house guarantees the performance of the futures contracts, the parties in the contracts are required to keep *margins* with it. The margins are taken to ensure that each party to a contract performs its part. The margins are adjusted on a daily basis to account for the gains or losses, depending upon the price at which the futures contracts are being traded in the market. This is known as *marking to the market* and involves giving a credit to the buyer of the contract, if the price of the contract rises and debiting the seller's account by an equal amount. Similarly, the buyer's balance is reduced when the contract price declines, and the seller's account is accordingly updated. In the example given above, while the futures price is Rs 375 when the contract is entered into, it will change in the course of time much in the same way as the spot price changes. The investor *A* would get the credit if the price rules at more than Rs 375 and a debit if it is lower than that. In effect, the profit or loss on a futures contract is settled daily and not on maturity of the contract, as for a forward contract.

It is not necessary to hold on to a futures contract until maturity and one can easily close out a position. Either of the parties may reverse their position by initiating a reverse trade, so that the original buyer of a contract can sell an identical contract at a later date, cancelling, in effect, the original contract. Thus, the exchange facilitates subsequent selling (buying) of a contract so that a party can offset its position and eliminate the obligation. The fact that the buyer as well as the seller of a futures contract are free to transfer their interest in the contract to another party makes such contracts essentially marketable instruments. Thus, the futures contracts are highly liquid in nature. In fact, most of the futures contracts are cancelled by the parties, by engaging into reverse trades: the buyer cancels a contract by selling another contract, while the seller does so by buying another contract. Only a very small proportion of them are held for actual delivery.

Difference between Forward and Futures Contracts

We may now differentiate between forward and futures contracts. Broadly, a futures contract is different from a forward contract on the following counts:

(i) Standardization A forward contract is a tailor-made contract between the buyer and the seller where the terms are settled in mutual agreement between the parties. On the other hand, a futures contract is standardized in regard to the quality, quantity, place of delivery of the asset etc. Only the price is negotiated.

(ii) Liquidity There is no secondary market for forward contracts, while futures contracts are traded on organized exchanges. Accordingly, futures contracts are usually much more liquid than the forward contracts.

(iii) Conclusion of Contract A forward contract is generally concluded with a delivery of the asset in question whereas the futures contracts are settled sometimes with delivery of the asset and generally with the payment of price differences. One who is long a contract can always eliminate his/her obligation by subsequently selling a contract for the same asset and same delivery date, before the conclusion of contract one holds. In the same manner, the seller of a futures contract can buy a similar contract and offset his/her position before maturity of the first contract. Each one of these actions is called *offsetting* a trade.

(iv) Margins A forward contract has zero value for both the parties involved so that no collateral is required for entering into such a

contract. There are only two parties involved. But in a futures contract, a third party called clearing corporation is also involved with which margin is required to be kept by both the parties.

(v) Profit/Loss Settlement The settlement of a forward contract takes place on the date of maturity so that the profit/loss is booked on maturity only. On the other hand, the futures contracts are *marked to market* daily so that the profits or losses are settled daily.

Evolution of Futures: A Historical Perspective

Futures contracts, specially those which involve agricultural commodities, have been traded for long. In the USA, for instance, such contracts began trading on the Chicago Board of Trade (CBOT) in the 1860s. Subsequently, contracts began to trade on commodities involving precious metals like gold, silver etc. However, significant changes have taken place in the last three decades with the development of financial futures contracts. They represent a very significant financial innovation. Such contracts encompass a variety of underlying assets—securities, stock indices, interest rates and so on. The beginnings of financial futures were made with the introduction of foreign currency futures contracts on the International Monetary Markets (IMM) in 1972. Subsequently, interest rates futures—where a contract is on an asset whose price is dependent solely on the level of interest rates—were introduced on the CBOT in October 1975. Within a short span of time, CBOT made a headway and introduced the Government National Mortgage Association contract (GNMA), and the years 1976 and 1977 saw the launching by IMM, respectively, of the Treasury Bill Futures and Treasury Bonds Futures. Treasury Bonds is one of the most actively traded futures contract in the world and has, in particular, lent great impetus to the introduction of similar futures on many futures exchanges the world over. An important development took place in the world of futures contracts in 1982 when stock index futures were introduced in the USA, after strong initial opposition to such contracts. A futures contract on a stock index has been a revolutionary and novel idea because it represents a contract based not on a readily deliverable physical commodity or currency or other negotiable instrument. It is instead based on the concept of a mathematically measurable index that is determined by the market movement of a predetermined set of equity stocks. Such contracts are now very widely traded the world over.

OPTIONS

Like forward and futures, options represent another derivative instrument and provide a mechanism by which one can acquire a certain commodity or other asset, or take positions in, in order to make profit or cover risk for a price. The options are similar to the futures contracts in the sense that they are also standardized but are different from them in many ways. Options, in fact, represent the rights.

An option is the right, but not the obligation, to buy or sell a specified amount (and quality) of a commodity, currency, index, or financial instrument, or to buy or sell a specified number of underlying futures contracts, at a specified price on or before a given date in future. Like other contracts, there are two parties to an options contract: the buyer (or the holder, or owner) who takes a *long* position, and the seller (or writer), who takes a *short* position. The options contract gives the owner a right to buy/sell a particular commodity or other asset at a predetermined price by a specified date. The price involved is called *exercise* or *strike price* and the date involved is known as *expiration.* It is important to understand that such a contract gives its holder the right, and *not* the obligation to buy/sell. The option writer, on the other hand, undertakes upon himself the obligation to sell/buy the underlying asset if that suits the option holder. The notion of options can be exemplified as follows.

Suppose you go for shopping in a market, and in a certain store you see an article, say a carpet, which you like. However, you do not have the full amount to pay for it. You ask the manager to keep some money as advance so as to allow you to buy the carpet within the next three days, and he agrees to the proposal. Now, you may or may not go to the store to buy the carpet within the stipulated time. For example, if you find an identical carpet at a lower price in another store, you may simply forget about the first one. Here you have an option to buy—you are not obliged to buy. However, the manager is obliged to sell the carpet should you choose to buy. Similarly, suppose that you buy some goods which are covered by a warranty so that you are given the liberty of returning them back within a specified period of time, with a refund of the price paid in case you are dissatisfied with them in any way. Forgetting for a moment that you have bought the goods originally and concentrating only on the right to send them back, you have the option to sell the items back, but you are not obliged to do so. The company is obliged to buy them back if you so desired.

Options are of two types: *call options* and *put options.* A call option gives an owner the right to buy while a put option gives its owner the right to sell. There is a wide variety of underlying assets including agricultural commodities, precious metals, shares, indices and so on, on which options are written. Further, like futures contracts, options are also tradeable on exchanges. The exchange-traded options are standardized contracts and their trading is regulated by the exchanges that ensure the honouring of such contracts. Thus, in case of options as well, a clearing corporation takes the other side in every contract so that the party with the long position has a claim against the clearing corporation and the one with short position is obliged to it. However, while buying or selling of futures contracts does not require any price to be paid, the options are bought and sold on the exchange for a price, called the *premium.* The writer of an option receives the premium as a compensation of the risk that he takes upon himself. The premium belongs to the writer and is *not* adjusted in the price if the holder of the option decides to exercise it. This price is determined on the exchange, like the price of a share, by the forces of demand and supply. Further, like the share prices, the option prices also keep on changing with passage of time as trading in them takes place.

One difference between futures and options trading may be noted. Whereas both parties to a futures contract are required to deposit margins to the exchange, only the party with the short position is called upon to pay margin in case of options trading. The party with the long position does not pay anything beyond the premium.

When an option contract is bought, it is upto the holder to exercise it or not, and the writer has no say. To illustrate, suppose it is January now and an investor is considering to buy March option contract on Reliance Industries Limited (RIL) involving 600 shares with an exercise price of Rs 210. If it is a call option, the investor obtains, on purchase of the option, the right to buy 600 shares of RIL at the rate of Rs 210 per share on the expiration day stipulated in the month of March. Obviously, if on that day, the price of the share in the market is quoted at higher than Rs 210, the investor would like to exercise the call. By buying shares at Rs 210 and selling them at the prevailing higher price, the investor can make a profit. If, on the other hand, the price of the share is quoted at Rs 210 or lower, the investor would not exercise the call as it would amount to buying shares costlier than the market price. In any case, the writer of the call option is obliged to sell the shares at Rs 210 per share, if called upon. Now, in case the option involved happens to be a put option, it would give the investor the right to sell 600 shares of RIL at Rs 210 per share at the expiration date, to the writer of the option. The investor would naturally be inclined to exercise the option if the share price on the stipulated date happens to be lower than Rs 210. By buying the shares in the market at a rate lower than Rs 210 per share, and selling them at Rs 210 per share, the investor would stand to gain. In this option, the writer would be obliged to buy the shares at a price of Rs 210 per share in case the holder of the option opts for that.

It may be noted that it is not necessary to hold an option until maturity. Buying an option, after all, is like buying a ticket for, say, a cricket match. Once you buy a ticket, you may decide to watch the match on the stipulated day (which exemplifies exercising your option), not to go the match venue in which case the ticket goes waste (this is not exercising your option and letting it expire), or you may sell the ticket before or on the match date. Accordingly, the option holder can keep the option till expiry or sell it in the market anytime before it expires. Options markets are highly liquid, generally.

While we have talked about options contracts which are traded on exchanges, there are situations when such contracts may be entered in to privately by parties. For example, institutions sometimes do need to enter into such contracts when they need a product with characteristics not available in exchange-traded products. Such contracts are thus not standardized and have unique characteristics. Such over-the-counter options are generally not liquid and their trading is not regulated.

Options: A Historical Perspective

The options have a long history. The idea of an option existed in ancient Greece and Rome. The Romans wrote options on the cargoes that were transported by their ships. In the 17th century, there was an active options market in Holland. In fact, options were used in a large measure in the ‘tulip bulb mania’ of that century. However, in the absence of a mechanism to guarantee the performance of the contract, the refusal of many put option writers to take delivery of the tulip bulbs and pay the high prices of the bulbs they had originally agreed to, led to bursting of the bulb bubble during the winter of 1637. A number of speculators were wiped out in the process.

Options were traded in the USA and UK during the 19th century and confined mainly to the agricultural commodities. Earlier, they were declared illegal in UK in 1733 and remained so until 1860 when the Act declaring them illegal was repealed. They were again banned in the third decade of this century, albeit temporarily. In the USA, options on equity stocks of the companies were available on the over-the-counter (OTC) market only, until April, 1973. They were not standardized and involved the intra-party risk. In India, options on stocks of companies, though illegal, have been traded for many years on a limited scale in the form of *teji* and *mandi*, and related transactions. As such, this trading has been a very risky proposition to undertake.

In spite of the long time that has elapsed since the inception of options, they were, until not very long ago, looked down upon as mere speculative tools and associated with corrupt practices. Things changed dramatically in the 1970s when options were transformed from relative obscurity to a systematically traded asset which is an integral part of financial portfolios. In fact, the year 1973 witnessed some major developments. Black and Scholes published a seminal paper explaining the basic principles of options pricing and hedging. In the same year, the Chicago Board Options Exchange (CBOE) was created. It was the first registered securities exchange dedicated to options trading. While trading in options existed for long, it experienced a gigantic growth with the creation of this exchange. The listing of options meant orderly and thicker markets for this kind of securities. Options trading is now undertaken widely in many countries besides the USA and UK. In fact, options have become an integral part of the large and developed financial markets.

TRADERS IN FUTURES AND OPTIONS MARKETS

The derivative instruments are used for various purposes. As indicated earlier, they are primarily used for purposes of managing risk by those managing funds. The trading of these instruments also allows the market participants the opportunities of making profits either by taking risk, i.e. *speculation*, or simultaneously taking opposite positions in the spot and futures markets, or in the futures market alone, to take advantage of price differentials, i.e. *arbitrage*.

Accordingly, there are varied types of traders who trade in the futures and options markets. Hedgers, speculators and arbitrageurs constitute three major classes of such traders.

Hedgers

As already observed, hedging (covering against losses) is the prime reason which led to emergence of derivatives. The availability of derivatives allows the undertaking of many activities at a substantially lower risk. Hedgers, therefore, are an important constituent of the traders in derivatives markets.

Hedgers are the traders who wish to eliminate the risk (of price change) to which they are already exposed. They may take a long position on, or short sell, a commodity and would, therefore, stand to lose should the prices move in the adverse direction. It will be instructive to illustrate hedging with some examples. To begin with, suppose a leading trader buys a large quantity of wheat that would take two weeks to reach him. Now, he fears that the wheat prices may fall in the coming two weeks and so wheat may have to be sold at lower prices. The trader can sell futures (or forward) contracts with a matching price, to hedge. Thus, if the wheat prices do fall, the trader would lose money on the inventory of wheat but will profit from the futures contract, which would balance the loss. Similarly, an investor who holds a large quantity of shares of a company can hedge by selling futures on them or by buying put option contracts, in case he fears a fall in the price of that share.

Again, traders dealing in exports and imports are subject to fluctuations in the foreign exchange rates, called the *forex risk*. In the absence of any hedging instruments, they are bound to remain exposed to such risk and suffer in case of adverse changes in the exchange rates. However, the forex risk, an integral component of the foreign trade business, can be hedged with derivatives. For example, today, with the dollar-rupee forward contracts and with the cross-currency options in India, it is possible to engage in foreign trade with a lesser degree of risk. Accordingly, the trading volumes on the dollar-rupee forward contracts are worth as much as $400 million per day.

As another example, consider a fund manager who believes in stock picking. However, at the same time he has to live with the real risk that his analysis of securities may go awry. In such situations, the stock index derivatives may be employed in order to eliminate/reduce the risk.

It may be noted that hedging only makes an outcome more certain, it does not necessarily lead to an improved outcome. Suppose today's dollar-rupee exchange rate is US \$1 = Rs 45.50, while the three-month forward rate is US \$1 = Rs 46.40. Suppose an Indian firm has a commitment to pay \$100,000, three months from now. The firm, being unsure of the way the dollar-rupee exchange rate would move in the three months' time, decides to buy a forward contract and lock-in the exchange rate. It involves no initial payment. With this, the firm knows for sure that it would need Rs 46,40,000 to meet its obligation. Now, at the end of the three months, if the rate becomes \$1 = Rs 47.20, then the firm would stand to gain Rs 80,000. Without the forward contract, the payment needed would have been Rs 47,20,000. Similarly, if the exchange rate were \$1 = Rs 46.10, then the firm would regret having entered into the forward contract, because it would have to pay Rs 46,40,000 for something that could be bought for Rs 46,10,000, without the contract.

Of course, the firm may alternatively consider hedging through buying an options contract also. It would enable the firm to avoid the loss involved in buying US dollars if they become cheaper in terms of Indian rupees, and enjoy the profit if movement in the exchange rate were favourable. Nevertheless, while a forward contract requires no payment, an options contract involves an initial cost: if the call is not exercised, the premium paid for it becomes a net loss while if it is exercised, the profit resulting from the call exercise would be reduced by this cost.

Speculators

If hedgers are the people who wish to avoid the price risk, speculators are those who are willing to take such risk. These are the people who take positions in the market and assume risks to profit from fluctuations in prices. In fact, the speculators consume information, make forecasts about the prices and put their money in these forecasts. In this process, they feed information into prices and thus contribute to market efficiency. By taking positions, they are betting that a price would go up or they are betting that it would go down. Depending on their perceptions, they may take long or short positions on futures and/or options, or may hold *spread* positions (simultaneous long and short positions on the same derivative).

In the absence of the derivatives, speculation activity would become very difficult as it might require huge funds to be invested. For example, if an investor believes that the price of a share is likely to rise substantially, then he would need a very large sum of money to buy the shares, keep them and sell them off when the price rises. With derivatives, however, it is much easier to do so because the derivatives are highly levered instruments. If the speculator's prediction of the direction and amount of price change is correct, huge profits can be realized. For example, suppose that a share is currently quoted at Rs 32 and a speculator is strong on this share. Assume that a call option, with exercise price of Rs 35 and due in one month, on this share is available in the market at 50 paise (per share). Buying this option would require Rs 50 (a call is for 100 shares) only. Now, if the price of the share is either less than, or equal to, Rs 35, the call shall not be exercised and the loss would be Rs 50 or 100% of the investment. If, on the other hand, the price rules at Rs 40, then a gain of $100 \times$ (Rs 40 – Rs 35) = Rs 500 would be made, which works out to be 900% of the investment! With no option or other derivative available, the investor would be required to invest Rs 3200 (for 100 shares) and would make a profit of Rs 800, i.e., only 24% of the amount invested. Not only that, much bigger losses would be incurred if the share price were to settle at less than Rs 32. Obviously, therefore, the derivatives adequately address the needs of the speculators without threatening the market integrity in the process.

The speculators in the derivatives markets may either be *day traders* or *position traders.* The day traders speculate on the price movements during one trading day, open and close positions many times a day and do not carry any position at the end of the day. Obviously, they monitor the prices continuously and generally attempt to make profit from just a few ticks per trade. On the other hand, the position traders also attempt to gain from price fluctuations but they keep their positions for longer durations—may be for a few days, weeks or even months. They use *fundamental analysis* and/or *technical analysis* as also any other information available to them to form their opinions on the likely price movements.

Arbitrageurs

Arbitrageurs thrive on market imperfections. An arbitrageur profits by trading a given commodity, or other item, that sells for different prices in different markets. In a handbook brought out by the

Institute of Chartered Accountants of India, the word 'Arbitrage' has been defined as follows:

> "Simultaneous purchase of securities in one market where the price thereof is low and sale thereof in another market, where the price thereof is comparatively higher. These are done when the same securities are being quoted at different prices in the two markets, with a view to make a profit and carried on with the conceived intention to derive advantage from difference in prices of securities prevailing in the two markets."

Thus, arbitrage involves making risk-less profit by simultaneously entering into transactions in two or more markets. If a certain share is quoted at a lower rate on the Delhi Stock Exchange (DSE) and at a higher rate on The Stock Exchange, Mumbai (BSE), for example, an arbitrageur would profit by buying the share at DSE and simultaneously selling it at BSE. This type of arbitrage is arbitrage over 'space'. With the introduction of derivatives trading, the scope of arbitrageurs' activities extends to arbitrage over 'time'. For instance, if an arbitrageur feels that the futures are being quoted at a high level—considering the cost of carry—he could buy securities underlying an index today and sell the futures, maturing in a month or two hence. Similarly, since futures and options with various expiration dates are traded in the market, there are likely to be several arbitrage opportunities in trading. Thus, if a trader believes that the price differential between the futures contracts on the same underlying asset with differing maturities is more or less than what he/she perceives them to be, then appropriate positions in them may be taken to make profits.

It may be noted that the existence of well-functioning derivatives markets alters the flow of information into the prices. This is because in a purely cash market, speculators feed information into the spot prices. In contrast, the presence of a derivatives market, besides a cash market, ensures that a major part of the transformation of information into price takes place at the derivatives market, due to lower transactions costs involved in such a market, and then it gets transmitted to the spot markets. It is here that the arbitrageurs provide a link between the derivatives market and the cash market by synchronizing the prices in the two. Thus, through their actions, the arbitrageurs provide a critical link between the cash and derivatives markets.

FUNCTIONS PERFORMED BY DERIVATIVES MARKETS

The derivatives markets perform a number of useful economic functions:

1. Price Discovery The futures and options markets serve an all important function of price discovery. The individuals with better information and judgement are inclined to participate in these markets to take advantage of such information. When some new information arrives, perhaps some good news about the economy, for instance, the actions of speculators swiftly feed their information into the derivatives markets causing changes in prices of the derivatives. As indicated earlier, these markets are usually the first ones to react because the transaction cost is much lower in these markets than in the spot markets. Therefore, these markets indicate what is likely to happen and thus assist in better price discovery.

2. Risk Transfer By their very nature, the derivative instruments do not themselves involve risk. Rather, they merely redistribute the risk between the market participants. In this sense, the whole derivatives market may be compared to a gigantic insurance company—providing means to hedge against adversities of unfavourable market movements in return for a premium, and providing means and opportunities to those who are prepared to take risks and make money in the process.

3. Market Completion The existence of derivative instruments adds to the degree of completeness of the market. A complete market implies that the number of independent securities (or instruments) is equal to the number of all possible alternative future states of the economy. To understand the idea, let us recall that the derivative instruments of futures and options are the instruments that provide an investor the ability to hedge against possible odds (or events) in the economy. A market would be said to be complete if instruments may be created which can, solely or jointly, provide a cover against all the possible adverse outcomes. It is held that a complete market can be achieved only when, firstly, there is a consensus among all investors in the economy as to the number of odds, or states, that the economy can land up with, and, secondly, there should exist an 'efficient fund' on which simple options can be traded. Here an *efficient fund* implies a portfolio of basic securities that exist in the market with the property of having a unique return for every possible outcome, while a *simple option* is one whose payoff depends only on one underlying return. Evidently, since the condition requiring identification and listing of all possible states of the economy can never be obtained in practice, and it is not possible to design enforceable financial contracts which can cover an endless range of contingencies, a complete market remains a theoretical concept—an ideal situation which cannot be obtained in practice. The presence of futures and options markets does, however, lead to a greater degree of market completeness.

WORLD DERIVATIVES MARKETS

The past three decades have witnessed a singular rise in the development and growth of derivatives markets the world over. Futures and options trading has registered a phenomenal rise and new products have been evolved. Futures and options exchanges and OTC derivative markets are integral parts of virtually all the economies which have reached an advanced state of economic development. Such markets are likely to become important parts of developing economies as well, when they move into advanced stages of development with the passage of time.

Apart from USA, UK and several European countries, Japan, and Singapore, amongst others, which have well-developed futures and options markets, a large number of other countries have also developed, or are in the process of developing such markets. The countries and markets include Argentina, Brazil, Bulgaria, Chile, China, Columbia, Costa Rica, Greece, Guatemala, Hungary, India, Indonesia, Korea, Malayasia, Mexico, Phillipines, Poland, Portugal, Russia, Slovak Republic, Slovenia, South Africa, Thailand and Turkey.

Significant advances are expected in the field in the time to come.

TEST YOUR UNDERSTANDING

Mark the following statements as True or False.

1. _______ Derivatives are used for purposes of risk management.
2. _______ Derivatives are so called because they derive their values from some underlying variable which may be a share price, a share price index, a currency, etc.

3. _______ Options and futures may be used as a means of acquiring goods or other assets.
4. _______ A forward contract is an agreement to enter into a contract at a pre-specified future date.
5. _______ Forward contracts are not guaranteed to performance.
6. _______ Futures contracts are an improvement over forward contracts in terms of the quality of the underlying assets and the hedging ability.
7. _______ A party with a long position in a futures contract is one which agrees to buy a specified quantity of the underlying asset, while the one with a short position agrees to sell it.
8. _______ The party who is long in a futures contract has the right of its performance on the clearing corporation and not directly on the party who is short.
9. _______ A long or a short position in a futures contract can be closed easily by initiating a reverse trade.
10. _______ Most of the futures contracts result in actual performance by the parties involved.
11. _______ Margins are required to be kept by both the parties to a futures contract to ensure its performance.
12. _______ *Mark to Market* implies adjusting the margins after every transaction.
13. _______ In some futures contracts, no physical delivery is possible. They are, therefore, bound to be cash-settled.
14. _______ A futures contract on a stock index represents a contract based on a concept of mathematically measurable index based on the market movement of a predetermined set of equity stocks and not on a readily deliverable physical commodity or currency or other negotiable instrument.
15. _______ A call option gives its holder the right to buy any quantity of the underlying asset from the other party at a pre-specified price.
16. _______ In a put option, the party with the long position is obliged to sell while the party with the short position is obliged to buy the underlying asset.
17. _______ Honouring of the options contracts is also guaranteed by the clearing corporations.

18. _______ Premium on an option is the price payable by the buyer of the option to its writer.
19. _______ Hedging has been the prime reason for the development of the derivatives.
20. _______ Hedgers are those who wish to eliminate the risk of adverse price changes in respect of their positions in the assets.
21. _______ Hedging only makes an outcome more certain—it does not necessarily lead to an improved outcome.
22. _______ Options cannot be used for hedging purposes, they are only tools for speculation.
23. _______ Speculators take positions in the market and hope to make profits from the price fluctuations.
24. _______ It is the speculators who feed information into prices.
25. _______ While the information is fed directly into the spot prices if there are no derivatives markets, it is transmitted primarily via derivatives markets if they exist.
26. _______ Derivatives are highly levered instruments: they allow substantial positions to be taken in the market, with relatively small investments.
27. _______ Arbitrageurs are the critical link between the spot and the derivatives markets.
28. _______ Futures and options markets serve a very useful economic function of price discovery.
29. _______ The derivatives markets redistribute the risk between the market participants.
30. _______ The existence of a derivatives market leads to a complete market.

EXERCISES

1. What are derivatives? Why are futures and options termed as derivatives?
2. What are forward contracts? What is their utility?
3. "Futures contracts are improvised forward contracts." Do you agree? Explain.

4. Briefly discuss about futures contracts which do not involve delivery of physical commodities and are settled in cash only.
5. What do you understand by options contracts? Do you think an options contract is an asymmetric one in the sense that it gives one party a right and the other an obligation? Discuss.
6. "Options are highly levered instruments." Do you agree? Explain.
7. Discuss each of the following type of traders in a derivatives market: hedgers, speculators and arbitrageurs.
8. Discuss the important economic functions performed by the derivatives markets. Does a derivatives market complete a market?

CHAPTER

2

Forward and Futures Contracts

Having discussed some basic concepts relating to derivatives in the introductory chapter, we now consider them in more detail. This chapter begins with an introduction to forward contracts and then focuses on futures contracts. The coverage, broadly, is as follows: Starting with the features of futures contracts, we see how they are different from forward contracts. Then we look into how financial futures are different from commodity futures, after which we consider the concepts related to the valuation of forward and futures contracts. Finally, we examine the uses of futures markets to its various participants and in particular, their use in hedging.

FORWARD CONTRACTS

A forward contract is a simple derivative that involves an agreement to buy/sell an asset on a certain future date at an agreed price. This is a contract between two parties, one of which takes a *long* position and agrees to buy the underlying asset on a specified future date for a certain specified price. The other party takes a *short* position, agreeing to sell the asset at the same date for the same price. Thus, when one orders a car which is not in stock, from a dealer, one is in fact buying a forward contract for the delivery of a car. The price and description of the car are specified.

The mutually agreed price in a forward contract is known as the *delivery price.* The delivery price is chosen in such a way that the value of the forward contract to both the parties is zero, which means that it does not cost anything to take either a long or a short position. On maturity, the contract is settled so that the holder of the short position delivers the underlying asset to the holder of the long position who in turn pays a cash amount equal to the delivery price.

It may be noted that while the delivery price contracted remains the same, the value of a contract to the parties involved is determined mainly by the market price of the underlying asset. Changes in the market price bring about changes in the contract value. To illustrate, suppose silver is currently selling at Rs 7048 per kg. Based on their perceptions of the movement of silver prices, *A* and *B* enter into a contract where *A* takes a short position and thereby agrees to deliver one kg of silver to *B* on 15th October of the year at a price of Rs 7,200 and *B* agrees to take the delivery and pay the agreed price. Now, after some days, if there is a spurt in the market price of silver, it would make the investor with long position, that is *B*, happy since an increase in the spot market would also cause the price expected in the future to increase. If the price increase does stay at the date of maturity of the contract, the buyer would stand to gain and the seller lose from it. Thus, although the delivery price does not change, the value of the contract to the long increases and to the short decreases with increases in the market value of the underlying asset. Similarly, a fall in the price of the underlying asset, after the contract is entered into, would render the contract more valuable to the short position and less valuable to the long position.

The Forward Price

The forward price of a contract is the delivery price which would render a zero value to the contract. As already stated, the 'zero value' implies that no party is required to pay any amount to the other when the contract is entered into.

Since upon initiation of the contract the delivery price is so chosen that the value of the contract is nil, it is obvious that when a forward contract is entered into, the delivery price and forward price are identical. With the passage of time, the forward price would change, while of course, the delivery price would remain unchanged. Generally, the forward price at any given time varies with the maturity of the contract so that the forward price of a contract to buy/sell in one month would be typically different from that of a contract with a time of three months or six months to maturity.

Table 2.1 gives the buying and selling rates of important currencies in the foreign market as on January 8, 2002. This table reveals that the spot rate (for immediate delivery), that is the buying rate for the US $ is Rs 48.22 while the selling rate is Rs 48.32 (the gap between the two being the margin of profit of the banker or the seller of the currency).

For a forward contract of one-month duration, the buying rate is Rs 48.35, whereas for a three months contract, the buying rate for the US dollar is Rs 48.80 and it is Rs 49.58 for a six-month contract. The other values can be interpreted similarly.

Obviously, if one enters into a forward contract, the delivery price (the foreign exchange rate here) would remain unchanged at the agreed level, but the fortunes of the two parties would swing according to changes in the exchange rate. On a given day, the spot price would be indicative of whether the contract has a positive or negative or, possibly, zero value for the party with the long position and the party with the short position.

Table 2.1

Foreign Exchange Rates

	Buying				*Selling*			
Currency	*Spot*	*One Month*	*Three Months*	*Six Months*	*Spot*	*One Month*	*Three Months*	*Six Months*
US Dollar	48.22	48.35	48.80	49.58	48.32	48.54	48.99	49.77
Pound Sterling	69.49	69.61	70.12	70.99	69.66	69.85	70.25	70.98
Euro	42.90	42.95	43.29	43.87	43.01	43.15	43.45	44.00
Swiss Franc	29.17	29.22	29.49	29.96	29.25	29.38	29.66	30.15
Japanese Yen (100)	36.37	36.45	36.84	37.53	36.46	36.69	37.13	37.90
Canadian Dollar	30.12	30.16	30.44	30.91	30.19	30.32	30.59	31.08
Danish Kroner	5.77	5.78	5.82	5.90	5.78	5.80	5.84	5.91
Swedish Kroner	4.64	4.65	4.69	4.75	4.66	4.67	4.65	4.75
Hong Kong Dollar	6.18	6.20	6.25	6.35	6.20	6.22	6.28	6.38
Singapore Dollar	26.07	26.11	26.36	26.81	26.14	26.27	26.54	27.01
Australian Dollar	25.10	25.28	25.46	25.77	25.17	25.27	25.37	25.63

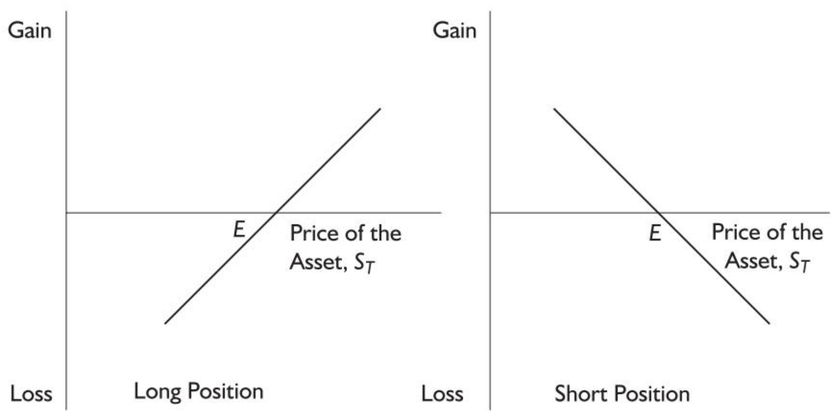
Source: *The Hindu, 'Business Line',* January 9, 2002

The pay-off from a long position in a forward contract on one unit of an asset is equal to the excess of the spot price of the asset on maturity of the contract over the delivery price. Clearly, if the spot price on maturity date is more than the delivery price, the buyer stands to gain and if the spot price is less than it, he stands to lose. For the party with a short position, the pay-off would be exactly opposite to that of the long position. Both the parties break even if the spot price exactly matches with the delivery price. To illustrate, let us consider a forward contract whereby *A* agrees to buy from *B*, 10 metric tonnes of wheat of a certain quality at Rs 650 per quintal in two months' time. Now, if wheat is selling at Rs 634 per quintal when the contract matures, the buyer, *A*, would suffer a loss $(634 - 650) \times 10 \times 10 =$ Rs 1600. Similarly, if the spot price happens to be greater than Rs 650 per quintal, then the seller, *B*, would lose money, whereas both, the buyer and the seller, would not gain or lose anything if the spot price rules at Rs 650 a quintal.

Symbolically, let S_T be the spot price of the asset at the date of maturity and E be the delivery price agreed upon in the contract, we have,

		$S_T > E$	$S_T = E$	$S_T < E$
Pay-off for Long position :	$S_T - E$	Gain	Break-even	Loss
Pay-off for Short position :	$E - S_T$	Loss	Break-even	Gain

The profit/loss profile of the two parties is represented graphically in Figure 2.1.



➢ **Fig. 2.1** *Pay off Profile*

An Evaluation of Forward Contracts

As we have observed, a forward contract enables the removal of future price uncertainty for both the parties involved in it, by fixing the price at which the underlying asset would change hands at the conclusion of the contract. Thus, a forward contract enables the parties involved to concentrate on things other than the price at which the asset would be transferred. No wonder then, forward contracts have existed in various countries for centuries, especially for agricultural products.

While forward contracts are very useful for the parties involved, it may be noted that each such contract is unique, entered on a one-to-one basis between the parties, like a business deal for the sale of a house. Such contracts are not standardized. The uniqueness of such contracts to the parties involved implies the possibility of non-performance. To illustrate, when a contract is entered into to transfer a certain asset at a given time in the future at a particular price, one of the two parties may not feel interested in performing its part of the contract, should the price of the asset move adversely by a significant margin. Thus, those proposing to enter into forward contracts may have to satisfy themselves about the credit-worthiness of their counter parties, every time they do so. Also, the forward contracts offer no liquidity as they do not allow the parties to transfer their interests to others, if they so wish.

To overcome these problems associated with forward contracts, futures contracts were evolved. The futures contracts represent an improvisation and provide for trading like forward contracts, but without its attendant problems.

FUTURES CONTRACTS

Forward contracts, particularly for agricultural products, have existed in various countries for centuries. Such contracts remove future price uncertainty for both parties involved. However, each such contract is unique, on a one-to-one basis with no standardization. A problem with a forward contract may be the uncertainty of its performance. Subsequent upon entering into a forward contract, a party to it may fail to fulfill contractual obligations. As stated earlier, futures contracts were evolved to take care of these problems.

A futures contract is a promise to buy/sell a certain quantity of a standardized good/asset on a certain future date at an agreed price. Accordingly, futures contracts are promises: the person who initially sells the contract promises to deliver a specified quantity of a standardized commodity to a designated delivery point during a certain month, called the *delivery month*. The other party to the contract promises to pay a pre-determined price for the goods upon delivery. Thus, a futures contract is very much like a forward contract and represents an agreement between two parties to buy/sell an asset at a certain time in the future for a certain price. Of the two parties, one agrees to buy, i.e. take a long position, while the other agrees to sell, taking a short position. But, while forward contracts are between two parties who directly deal with and have accountability to each other for the particular contract, the futures contracts are (i) standardized contracts, (ii) between two parties who do not necessarily know each other, and (iii) guaranteed for performance by an intermediary, known as the clearing corporation or clearing house.

Since the contracts are guaranteed for performance, the parties involved in such a contract need not worry about the credit-worthiness of each other, like in case of forward contracts. It thus allows for face-less trading. Further, since the contracts are standardized, and are tradeable like shares, debentures etc. on a futures exchange, they have a secondary market and offer a high degree of liquidity. Thus, futures markets are characterized by security, standardized terms and conditions, liquidity and competitive pricing.

There are two points to note here. One is that the purpose of futures contracts is not to provide a means for transfer of goods. In other words, the property rights to assets—real and financial—cannot be transferred through futures contracts. Such contracts enable people to reduce some risks that they assume in their business. A second point is that most of the futures contracts get eliminated before the delivery month (date of maturity) and only an insignificant proportion of them result in deliveries. Most of the traders cancel their positions in the market by taking reverse positions. To illustrate, a person who took a long position in a futures contract involving, say, 100 quintals of wheat might not want to take delivery of the wheat and the farmer who hedged by selling the contract might like to sell his wheat in a local market rather than deliver it at the designated delivery point. In either case, the contract can be satisfied by making an offsetting trade. The person with a long position would sell a contract and thereby cancel his position. Similarly, the other party, the farmer here, with a short position, would buy such a contract. Both the parties would be out of this market.

Futures Contract Specifications

The futures contracts are standardized contracts developed by futures exchanges. In developing a futures contract, an exchange should specify the details about the nature of agreement between the buyer and the seller. It should specify the asset, the contract size, the time of delivery, the place of delivery, quotation of prices, alternative asset(s), if any, which may be acceptable for delivery in lieu of the particular asset, etc. It is significant that in case alternatives are provided for in the contract, the party with the short position, i.e., the one which sells it, is entitled to choose between the alternatives available.

Details about the futures contracts including the quantity and quality of the commodity are obviously relevant in case of commodities futures, while for financial futures the quality of the asset is not relevant. There can be no "quality" variation in a contract involving American dollars and Indian rupees, for example.

As an illustration, the details of a CBOT Wheat Futures Contract Specifications are as given in Box 2.1. It is evident from this sample contract that besides the quantity and quality of the asset (i.e. wheat) involved in one contract, several other details are provided. It is provided as to how the price would be quoted and what the tick size—the minimum price change, would be. Also provided are the limits within which the price would be allowed to vary on a trading day. Other details include the contract month, start of the contract year, last trading day, last delivery day, trading hours and ticker symbol to identify the asset.

An important point on which a futures contract on commodities differs from a forward contract is that the exact delivery date is not specified on it. A futures contract is referred to by its delivery month and the exchange specifies the period during the month when delivery must be made. In respect of commodities, the delivery period is generally the whole month and the holder of the short

Box 2.1 ***CBOT Wheat Futures Contract Specifications***

Trading Unit	5000 Bushels
Deliverable Grades	No. 1 Northern Spring wheat at par and No. 2 Soft Red, No. 2 Hard Red Winter, No. 2 Dark Northern Spring and substitutions at differentials established by the exchange.
Price Quotation	Cents and quarter-cents per bushel
Tick Size	One-quarter cent per bushel ($12.50 per contract)
Daily Price Limit	20 cents per bushel ($1000 per contract) above or below the previous day's settlement price (expandable to 30 cents per bushel). No limit in the spot month (limits are lifted two business days before the spot month begins.)
Contract Months	March, May, July, September, and December
Contract Year	Starts in July and ends in May
Last Trading Day	Seventh business day preceding the last business day of the delivery month
Last Delivery Day	Last business day of the delivery month
Trading Hours	9.30 A.M. to 1.15 P.M. (Chicago time), Monday through Friday. On the last trading day of an expiring contract, trading in that contract closes at noon.
Ticker Symbol	W

Source: *Contract Specifications* 1991 (Chicago Board of Trade) p. 34

position has the right to choose the time during the delivery period at which the delivery would be made. The buyer as well as the seller (or the writer) of futures contracts are free to transfer their interest in the contract to another party so that such contracts are essentially marketable instruments. Also, either of the parties may reverse his/her position by initiating a reverse trade. Thus, the original writer of a contract can long an identical contract at a later date, cancelling, in effect, the original contract. As indicated earlier, in actual trading of commodity futures, only a few contracts, may be less than five percent, are held to the maturity date. If a buyer does hold the contract on the maturity date, it is settled by having the title or ownership transferred from the seller to the buyer.

Types of Futures Contracts: Commodity and Financial Futures

Basically, there are two types of futures contracts: *commodity futures* and *financial futures.* The sample contract given in Box 2.1 is an example of commodity futures. The commodity futures contracts involve a wide range of agricultural and other commodities, including precious metals. The list of commodities on which futures contracts are traded in the major American futures exchanges like Chicago Board of Trade, Kansas City Board of Trade, Chicago Mercantile Exchange, New York Cotton Exchange, New York Commodity Exchange, New York Mercantile Exchange, Mid-America Commodity Exchange etc., includes wheat, corn, oats, soybeans, soybean oil, soybean meal, cotton, orange juice, crude oil, heating oil, unleaded gasoline, natural gas, platinum, silver, gold, hogs, pork bellies, lumber, feeder cattle, cattle and so on.

On the other hand, the financial futures involve financial assets/tools as against commodities. Here too, contracts are written over a wide range of the underlying assets. The first financial future came into existence in the U.S.A. with the introduction of currency futures by the International Monetary Market (IMM), a division of the Chicago Mercantile Exchange. IMM introduced contracts on Treasury securities in 1976. The year 1982 saw introduction of the Stock index futures by the Kansas City Board of Trade in the U.S.A. There is a long list of the financial futures traded in the U.S.A., Japan, U.K. etc. These include 10-year Treasury Notes, 5-year Treasury Notes, 2-year Treasury Notes, US Treasury Bonds, 30-day Interest Rate, Municipal Bond Index, Major Market Index, US Treasury Bills, S&P 500, Nikkie 225 Average, Euro Dollars, British Pound, Canadian Dollars, Japanese Yen, Swiss Franc, Australian Dollar, Value Line Stock Index, Mini Value Line Stock Index, NYSE Composite, Russell 2000, Russell 3000, FT 30, All Share, FT-SE 100, etc., stock index futures on Sensex, the 30-share index of The Stock Exchange, Mumbai, and S&P CNX Nifty, the 50-share index of the National Stock Exchange of India, futures on individual stocks in India, ...and the list seems unending.

A sample contract specification for financial futures, in respect of the Japanese Government Bond Futures, traded on the Tokyo Stock Exchange, is given in Box 2.2.

Box 2.2 ***Contract Specification for Japanese Government (10-Year) Bond Futures***

Contract	Standardized 6%, 10-year Japanese Government Bond
Contract Months	March, June, September, December Cycle. (five contract months traded at all times)
Trading Units	Japanese Government Bonds ¥100 million face value
Minimum Fluctuation	1/100 point per 100 points (¥10,000 per contract)
Daily Price Limit	2 points upward or downward. (¥2 million per contract)
Last day of Trading	The 9th business day prior to each delivery date. The trading day in a new contract month begins on the business day immediately following the last trading day.
Delivery Date	20th of each contract month
Deliverable Grade	Exchange listed Japanese Government Bonds having maturity of 7 years or more but less than 11 years
Margin Requirements for Customers	Greater of 3% of nominal transaction value or ¥6 million
Margin Requirements for Customers	2% of nominal transaction value
Trading Hours	9 a.m. to 11 a.m. 12.30 p.m. to 3.00 p.m.
Trading System	Pure auction through the Computer-assisted Order Routing and Execution System for FUTURES (CORES-F)

Source: *Fact Book 1995,* Tokyo Stock Exchange

Difference between Commodity and Financial Futures

The contract characteristics, mechanics of trading and other details of the financial futures are the same as that of the commodity futures.

However, there are some differences between commodity and financial futures as discussed here.

1. Cash Settlement Some financial futures do have underlying real assets. In this sense, they are *derivative securities* since their value is determined by the price movements of the assets which they represent. In some cases, however, the assets which they represent do not exist. Thus, a futures contract on SENSEX represents only a hypothetical portfolio of the constituent stocks, and it can not be settled by a physical delivery of the shares. Thus, stock index futures contracts must be settled for cash on the date of delivery.

2. Contract Life The financial futures generally are available with longer lives than the futures on agricultural or other commodities. Whereas agricultural contracts are mostly for 90 days or less, and in general, not more than one year, the US Treasury Bond futures are traded with settlement dates even more than two years away.

3. Maturity Dates While maturity months for commodities futures contracts vary depending upon the nature of the underlying commodity, the maturity dates for financial futures are standardized.

TRADING IN FUTURES CONTRACTS

The futures contracts are traded on recognised exchanges which are similar to stock exchanges. Trading is done in the same way as other securities like shares. Usually, contracts with different delivery months are traded at any given time. Once an investor decides to buy a certain contract, he calls his broker and instructs to buy him the desired contract. The broker would send the message to his representative on the exchange if there is an *open out cry* system, and would look for such a contract at the screen if it is screen-based trading. Once the deal is struck, the information of confirmation of the conclusion of the order shall reach the investor via the broker (for more details see Chapter 7).

The exchange determines the size of the contract (that is, the amount of the asset to be delivered for one contract), how the price is to be quoted and, maybe, limits on the amount by which the futures price can move in any one day. Also, in case of a commodity, the exchange also specifies the quality of the product and the delivery location. The prices for the commodity contracts, just like other securities, are determined by the forces of demand and supply. If more investors want to go long than short, the price goes up, and conversely, if there are more sellers, then the price goes down.

Where traded, futures prices are regularly reported in the financial press. In this context, we may understand the concept of *open interest*, information on which is reported along with. The open interest means the number of outstanding contracts at any point in time. It may be noted that, as may appear, the open interest does not increase with every contract traded. In fact it may increase, remain the same or decrease depending on the existing positions of the parties involved. If *one* of the parties to the contract holds no earlier position as in the contract under consideration, while the other holds a position opposite to the one held in this contract, then the open interest would not change. Thus, if *A* and *B* already hold long positions in the contract (as a result of their previous trades) and in the new contract *A* takes long and *B* takes short position, then the new contract would lead to a cancellation of one contract for *B*. In this case, the net open interest would not change. Similarly, if both the parties to a contract hold positions opposite to the ones taken in the contract, then the open interest would fall by one contract. Thus, if *A* already holds a short position and *B* holds a long position, then the new contract would effectively cancel the position for each of them by one contract, leading to a reduction in the number of contracts outstanding by one. To sum up, whenever one of the parties to a transaction in a contract takes an offsetting (reverse) position, there shall be no increase in the open interest, and when both the parties take offsetting positions, the open interest would fall by unity for each transaction of one contract. However, when none of the parties in the contract are taking an offsetting position, then the open interest increases.

Clearing House and Its Role

A clearing house plays a pivotal role in the trading of futures contracts. It acts as an intermediary for each contract. It is natural to ask "what happens if someone decides not to pay for the commodity as promised in the contract or if someone is unable to deliver the commodity?" Obviously, if it were possible to back out to the contract without fulfilling one's part, the futures exchanges would die very soon. People would lose confidence in the system and it would provide no attraction to hedgers or speculators. Elimination of this uncertainty is essentially the job of a clearing house.

Once a futures price is agreed upon between the buyer and the seller and the trade is completed, the clearing house of the exchange becomes the opposite party to each one of the parties. Thus, when an investor goes long a futures contract, he/she effectively buys it from the clearing house and, similarly, when one goes short a futures contract, one is in fact liable to the clearing house only. In effect then, the clearing house ensures the integrity of each futures contract by interposing itself between each buyer and seller. Thus, whereas in forward contracts, each party faces the risk that the opposite party may default, the two parties in a futures contract have no worry because of the guarantee of the clearing house.

It may be noted that while the clearing house takes the opposite position to each side of the trade, it does not by itself buy or sell contracts. Its role begins only when two parties to a contract agree to enter into a contract. The clearing house is always neutral: maintaining both long and short, an identical number of contracts.

A clearing house is associated with a futures exchange and is concerned with matching, processing, registering, confirming, settling, and reconciling besides guaranteeing the trades on the futures exchange. An adjunct of the exchange and an intermediary in all the futures transactions, a clearing house has a number of members. The brokers, who are not members, have to channel their business through a member. Since the main function of a clearing house is to eliminate, as far as possible, the risk that someone at some stage would fail to honour their part of the commitment, with the possibility that such a happening could wipe out many of the participants from the exchange, it is no surprise that the members of a clearing house are usually the most financially secure firms of an exchange. In some cases, the clearing house might have the backing of the government as well.

Margins

A key role of the futures exchange is to organize trading such that contract defaults are minimized or even eliminated. The clearing corporation uses the fees it collects on transactions to provide the necessary funds for this purpose. Besides, buyers and sellers are required to deposit a *margin* on the contract. Thus, when a contract is entered into, both the buyer and the seller are required to deposit an initial margin, which is typically 5 to 10 per cent of the value of the contract. The exact amount is determined by the exchange and the clearing house, primarily in keeping with the expected fluctuations which are estimated from the past data.

To understand how margins work, let us consider an investor who contacts his broker on the first trading day of September to buy a wheat futures contract drawn on a certain exchange. Suppose that the contract size is 100 quintals and the current futures price is Rs 600 per quintal. The broker would require the investor to deposit funds in what is called a *margin account.* Suppose the broker has decided to call the buyer to deposit an initial margin of Rs 6,000 when the contract is entered into. After the initial margin is deposited, a change in the price of the futures contract would change the percentage relationship between the margin and the contract value. At the end of each trading day, the margin account is adjusted to reflect the investors' gain or loss. The gains and losses are netted against the initial margin. This is called *marking to market.*

Now, assume that by the end of September 2, the end of the day when the futures contract is entered into, the futures price has declined from Rs 600 to Rs 598. The investor loses $100 \times 2 =$ Rs 200. This is because the contract for 100 quintals of wheat that the investor has agreed to buy at Rs 600 per quintal can now be sold for Rs 598 only. Thus, the balance in margin account will be reduced by Rs 200 to Rs 5,800. In a similar manner, the margin account would increase to Rs 6,200 if the futures price had instead been Rs 602 at the end of the day. A trade is first marked to market at the end of the day on which it takes place. After this, it is marked to market at the end of each trading day. If the delivery day is reached and delivery is made by the party with the short position, the price received would generally be the futures price at the time when the contract was last marked to market.

In marking to market day after day, it is just possible that the margin may become too low, or possibly even wipe out or the balance may be negative. To prevent this kind of situation, an investor is required to ensure a *maintenance margin*, which is typically three-fourths of the initial margin. In the process of marking to the market, if the balance in the margin account falls below the maintenance margin, the investor receives a *margin call* and is required to deposit additional funds to bring the balance to the level of initial margin in a very short period of time. The extra funds deposited are called *variation margin.* If the investor does not provide the variation margin, the broker closes out the position. With the liquidation of the contract, any remaining margin is given to the investor. On the other hand, if the balance in the margin account exceeds the initial margin, the excess may be withdrawn by the investor.

The process of marking to market is, for the wheat futures contract example, illustrated in Table 2.2 by taking some hypothetical futures prices. It is assumed that the initial margin is Rs 6,000, the maintenance margin is Rs 4,500, and the contract is closed out on September 27.

It may be observed from the table that the wheat futures price, when the contract is entered into, on September 2 is Rs 600 while on the same day, it closes at Rs 598.20, thus causing a loss of Rs 180 [100 × (598.20 – 600.00)], and the balance is reduced by this amount to become Rs 6000 – Rs 180 = Rs 5820. Next day again, the price declines to Rs 593.60, causing a further loss of Rs 460. Thus, cumulative loss becomes Rs 180 + Rs 460 = Rs 640, and the balance reduces to Rs 5360. The second column gives the closing prices for the various trading days, except the first entry which is the price at which the futures contract is bought, while the third column gives the gain/loss over the previous day's price. The next column depicts the cumulative gain/loss while the margin account balance is given in the fifth column.

Notice that on September 6, the balance falls to Rs 4480, which is below the maintenance margin of Rs 4500. Thus, a margin call of Rs 6000 – Rs 4480 = Rs 1520 is made and it is assumed that the amount is deposited by the investor by the next day. Again, a call for Rs 1630 is made on September 17 when the balance falls to Rs 4370, and the amount is assumed to be deposited by the next day. On September 18, when the balance in the margin account crosses the initial mark of Rs 6000, the investor is entitled to withdraw the excess of Rs 130. Similarly, the balance is found to be in excess of the initial margin amount in subsequent days as well. Here, the calculations are based on the assumption that this amount is not withdrawn.

The effect of marking to market is that a futures contract is settled daily instead of being settled at the date of the maturity. Writing of gain/loss to the margin account of the investor has the effect of bringing the value of the contract back to zero. Essentially then, a

Table 2.2

Operation of Margins on a Wheat Futures Contract

Trading Day September	*Futures Price*	*Daily Gain (Loss)*	*Cumulative Gain (Loss)*	*Margin Account Balance*	*Margin Call*
2	600.00				
	598.20	(180)	(180)	5820	
3	593.60	(460)	(640)	5360	
4	594.00	40	(600)	5400	
5	589.50	(450)	(1050)	4950	
6	584.80	(470)	(1520)	4480	1520
9	582.20	(260)	(1780)	5740	
10	583.70	150	(1630)	5890	
11	577.30	(640)	(2270)	5250	
12	577.10	(20)	(2290)	5230	
13	572.40	(470)	(2760)	4760	
16	570.10	(230)	(2990)	4530	
17	568.50	(160)	(3150)	4370	1630
18	569.80	130	(3020)	6130	
19	573.80	400	(2620)	6530	
20	573.60	(20)	(2600)	6550	
23	577.30	370	(2230)	6920	
24	576.80	(50)	(2280)	6870	
25	578.80	200	(2080)	7070	
26	578.00	(80)	(2160)	6990	
27	584.20	620	(1540)	7610	

futures contract is closed out and rewritten at a new price each trading day.

Who fixes the Margin Level? The margin is aimed at being a bond for performance and not as a down payment for the contract. The minimum levels for initial and maintenance margins are determined by the exchange and the clearing house. The individual brokers are free to require greater, but not lower, margins than determined by the futures exchange. The margin levels are affected by a number of factors like,

- 'Distance' from the clearing house,
- Price volatility of the underlying security,
- Daily price moves permitted for the contract,
- Time needed to recover position losses from the customers,
- Objectives of the trader.

If the trader happens to be a bona fide hedger, then a lower margin may be required than called for from a speculator. Similarly, if a trader engages in a *day trade*, that is if the trader takes a long or short position in a day and makes it known to the broker that he/she is going to close out the position at some other time during the day by taking the reverse position, then a smaller margin would be required. Similarly, if an investor takes a long and short position simultaneously in two contracts with different delivery months, known technically as a *spread transaction*, then also comparatively lower margins are needed.

Clearing Margins In the same way as an investor is required to maintain a margin account with his/her broker, a clearing house member is required to maintain a margin account with the clearing house. The margin accounts of the members are adjusted daily against the profit/loss during the day in the same way as those of investors. However, there is no maintenance margin in case of clearing house members. Thus, on the basis of the transactions made during the day and the price movements, a clearing house member may have to bring in funds to add to its margin account, or it may find that it can remove the funds (in excess of the initial margin) from the margin account.

In may be noted that for the purposes of calculating the margins needed, the clearing house may calculate the number of contracts outstanding on a *gross* or a *net* basis. In the *gross* basis, all the long positions of the clients of a member are added to all the short positions of the clients. However, in the *net* basis, the long positions are netted out against the short positions and the margins for net positions are determined.

Limits

An important aspect of the futures markets is that of limits. For most futures contracts, there are limits (both minimum and maximum), on the daily movements of their prices. Every futures contract has a minimum limit on trade-to-trade price changes, which is called a *tick*. For instance, the tick size for the gold futures contract trading in some American exchange may be 10 cents/ounce or $10/contract. Similarly, there will usually be maximum limits on daily price change. For example, a futures contract may provide a daily movement limit of Rs 100. If the price moves up by an amount equal to the daily price limit, the contract is said to be *limit up*, while if it moves down by that amount, it is said to be *limit down.* Normally, trading on a contract stops once the contract is limit up or limit down. However, exchange may change the limits when they feel appropriate. The price limits for the contract whose delivery date is the nearest is likely to be different from those for the contracts requiring delivery in the distant future.

The idea of such price limits is to prevent large price movements occurring because of speculative excesses and to allow the market to digest any information which is likely to affect the futures prices in a significant way. For example, the news of a loss to the wheat crop as a result of very heavy monsoon rains is likely to cause the price of wheat to rise substantially. This is prevented from being fully and instantly reflected in the futures price by the existence of price limits. Possibly, the presence of such limits may prevent a trader from closing out a position.

Opinions are different and divergent on the imposition of price limits—some people believe that without such limits, the futures price changes may sometimes be irrational while others believe that no price change could ever be judged as irrational and that limits only act as artificial barriers to trading.

DIVERGENCE OF FUTURES AND SPOT PRICES: THE BASIS

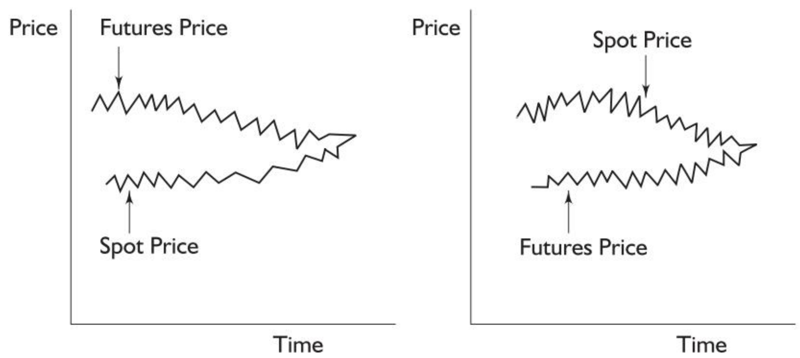
Commodities are generally traded in the cash or spot market at the market price, P_0. The futures price, P_t represents the price of the commodity at some future point in time. The difference between the futures price and the current price is known as the *basis.* Thus,

$$\text{Basis} = P_t - P_0$$

In a "normal market", the futures price would be greater than the spot price and, therefore, the basis will be positive, while in an "inverted market", the reverse holds. In an inverted market, the basis is negative since the spot price exceeds the futures price in such a market.

In case of agricultural commodities, the basis may be expected to be positive (ignoring the market pricing inefficiencies, of course). The futures price is expected to be higher than the spot price because of the carrying costs associated with a particular commodity—storage costs, insurance, cost of funds invested in them, and other costs incurred to keep the commodity in inventory until its delivery date. Generally, the longer the time to maturity, the greater the carrying costs. As the delivery month approaches, the basis declines until the spot and futures prices are approximately the same. This phenomenon is known as *convergence.*

It is also possible for commodity futures contracts to have negative basis. For example, a particular commodity may be in short supply now and, therefore, its spot price may be high. If the supply is likely to improve in the course of time, due to good monsoons, for example, then the futures price may indeed be lower. In case of other commodities as well, the basis may be found to be negative or positive. In either case, however, the convergence to the spot price occurs, as shown in the Fig. 2.2. It is easy to understand why the futures price equals, or is very close to the spot price, when the delivery period is reached. If the two are unequal, then arbitrage opportunities exist for traders. For instance, if the futures price is higher than the spot price, an investor would do well to (a) short sell a futures contract, (b) buy the asset, and (c) make the delivery to reap a profit equal to the excess of the futures price over the spot price. As traders exploit this opportunity, the price of futures would drop. Similarly, if the futures price is lower than the spot price, an investor who is interested in buying an asset would be inclined to buy a futures contract and take the delivery.



➢ **Fig. 2.2** *Convergence of Futures and Spot Prices*

Expected Basis The basis is primarily attributable to the carrying costs of a commodity. If there were no carrying costs involved and if there were no uncertainty, then the futures today would command a price equal to the expected spot price in the future (i.e., the date of maturity). In conditions of certainty, then, the expected basis would be equal to zero in a market where there are no carrying costs and other inefficiencies. When uncertainty is introduced, however, the relationship between the futures prices and the expected spot prices at a future date is not unambiguous. In case of uncertainty, there are three hypotheses to explain the expected basis. They are:

1. Normal backwardation
2. Contango
3. Expectation principle

Normal Backwardation According to this hypothesis, the expected basis is negative as the futures price tends to be a downward estimate of its spot price in the cash market at the contract's maturity date. This hypothesis was propounded by J.M. Keynes who argued that the futures market is dominated by short hedgers who attempt to avoid the risk associated with a decrease in the price of a commodity. They are seen to depend on the speculators who are willing to assume this risk by taking a long position in the contract. Therefore, they are expected to write contracts below the expected spot price in order to get compensated for the risk they take. The theory is thus dependent on the assumption that speculators usually buy, i.e., *net long*, the contracts while the hedgers usually write, i.e., *net short*, the contracts.

Contango This hypothesis assumes the other possibility—the hedgers generally buy the contracts, while the speculators generally sell the contracts. It contends the speculators, because of their knowledge and expertise about the futures market, and the inefficiencies of the market, are largely willing to assume the price risk in anticipation of earning profits. In view of the anticipated profits, they bid up the prices of the commodity contracts, which results in a positive basis. They can make profit only if they net short and the futures price declines. With the price of a futures contract above the spot price initially and then declining over time, this phenomenon is termed as contango.

Expectation Principle This theory postulates that the expected basis would be equal to zero. This is based on the argument that futures prices are an unbiased estimate of expected future spot prices, as would be expected in an efficient market. Thus, there is no room for any excess returns for either the hedgers or the speculators.

MARKET PARTICIPANTS IN A FUTURES MARKET: HEDGERS, SPECULATORS AND ARBITRAGEURS

To be successful, a futures market basically needs to have two types of participants: hedgers and speculators. The markets simply cannot exist without hedgers and the speculators cannot then perform any economic function.

Hedgers In the context of futures contracts, a hedger is one who is engaged in a business activity where an unacceptable price risk exists. For example, a farmer might be worried about the price the wheat grown by him would fetch, when the crop is ready. His fortunes depend on the price he can obtain for his produce. If the price is indeed high, the farmer would earn a fair amount of profit. Should the price, however, be low because of, say abundant supplies, he might not be able to make a reasonable profit, or might even run into losses. To reduce this risk, the farmer may choose to hedge in the futures market. He can do so by selling futures contracts. Thus, suppose it is November now and the April wheat is being sold for Rs 820 per quintal. Assume that the farmer finds this price is attractive because it provides for a reasonable level of profit and eliminates price risk associated with growing wheat. The farmer can hedge the price risk by agreeing to sell his produce at Rs 820 per quintal to someone who agrees to take a long position. Thus, the farmer is assured of this price for his crop and not worry if the price were to fall subsequently.

In agricultural commodities, the hedger usually goes short in the futures market because the farmer wants to deliver his produce. This is called *short hedge*. However, hedging may also involve taking long position. To illustrate, if a jewellery firm takes an export order for some jewellery to be supplied after 4 months, it may like to guard itself against the possible adverse movement in the price of gold by taking long position in the futures market. This is termed *long hedge*.

Hedging is the very reason for creation of the derivatives markets. The mechanism of hedging using futures is discussed in detail in the following section.

Speculators While the hedgers avoid the price risk, the speculators are the class of participants in the futures markets who are willing to bear the risk. Obviously, for the hedgers to eliminate the unacceptable price risk, they must find those who are prepared to take such risk. Of course, both long and short hedgers may be present in the market so that entering into a transaction may be to their mutual benefit. But since at any moment, they usually are not present in equal numbers, the speculators step in and provide a vital economic function. Speculators are such people who are financially capable of bearing such risk. In fact, the speculative demand for futures contracts is much greater in volume and frequency than the hedging demand. A speculator does not have an economic activity that requires the use of futures but rather finds investment opportunities in the futures markets and takes positions in an attempt to make profit from price movements.

A speculator would take long position in a futures contract if he feels that prices are likely to rise and a short position if he feels otherwise. Since price increases are relatively easier to visualise, speculators generally take long positions. However, if the prices are believed to go down, they assume short positions as well. Notice here that a speculator taking a short position in a wheat contract is not a producer of wheat and, therefore, does not intend to eventually supply it on the date of maturity of the contract. Instead, he would take a long position in such a contract and, therefore, cancel the original position and making profit/loss as the difference between the prices he agreed for in the two positions. Evidently, speculators' role in the futures markets is much like that of an insurance company's. The speculators provide liquidity (implying continuous presence of buyers and sellers) that helps to make the futures markets an efficient hedging mechanism. Further, by putting their money on the prices, the speculators aid in the process of price discovery, thus performing an important economic function.

Speculators may be *position traders* so that they maintain futures positions day-after-day (may be for weeks), or *day traders*, who close all their positions before trading closes each day. The day traders do not carry over their transactions overnight.

Scalpers Scalpers represent another type of traders who play a crucial role in the economic functioning of the futures markets. They are the individuals who engage in continuous buying and selling of contracts on their own behalf. They work on low margins but their continuous trading enables them to make good profits on their operations. Of course, when the markets show greater volatility, they can make handsome profits.The presence of scalpers ensures the futures prices to be both continuous and accurate, thus imparting liquidity to the markets in a good measure.

Arbitrageurs Another group of participants in futures markets is that of the arbitrageurs. The arbitrageurs do not take view on prices, like speculators do. They thrive on inefficiencies of the market and so their actions help keep the market efficient and functioning well. The arbitrageurs come into action once they find that the prices in the spot market and the futures market, or in the futures market in respect of different maturities are deviating from the "normal". For example, if an arbitrageur finds that prices of futures contracts with a certain maturity date is higher than what should it be in accordance with the price in the spot market, he would step in to short futures contracts and buy in the spot market. With more and more people taking similar positions, the futures prices would tend to fall relative to spot price. As the gap between the two prices narrows, the arbitrageur would earn profit.

HEDGING USING FUTURES CONTRACTS

Hedging is the process of reducing exposure to risk. Thus, a hedge is any act that reduces the price risk of a certain position in the cash market. It may be recalled that the futures contracts were initially developed for the sole purpose of providing the producers and users of various commodities with some tool that was able to hedge against price risk. Futures contracts continue to be an important means of hedging as they enable the market participants to alter the risks they face from unexpected adverse price changes.

Futures act as a hedge when a position is taken in them which is opposite to that of the existing or anticipated cash position. Thus, hedgers sell futures when they have taken a long position on the cash asset and they buy the futures in case they have taken a short position on the cash asset. In a *short hedge*, the hedger sells a futures contract, apprehending that prices would fall. In the event of a fall in the prices, losses would be sustained in the spot position. For a short hedger, who is currently long on the cash good or has an obligation to sell in the future time at an unknown price, a loss in the cash market would result when the prices do fall, but a gain would occur due to the short position in futures. Of course, the prices may rise also. In that case, a gain in the spot market will result but, simultaneously, a loss would be sustained in the futures position. On the other hand, in a *long hedge*, a hedger buys futures contracts when he/she is either currently short the cash good or is obliged to buy the good at the spot price prevailing at a future date. The long hedger faces the risk that prices may rise. If a price rise does take place, the long hedger would incur a loss in the cash good but would realize gains on the long futures position.

It may thus be observed that any gains in the futures market offset losses in the cash market and any losses in the futures market are offset by gains in the cash market so that the futures hedging does not necessarily make the financial position better. In fact, what it does is that it reduces the variability of returns to the hedger which may be rather high in case of a non-hedger.

For a number of reasons, hedging through futures contracts does not work perfectly in real life. For example, the asset whose price is to be hedged may not exactly match with the asset underlying the futures contracts, so that the hedge is actually a *cross hedge.* The situation is exemplified by a hedger who owns a portfolio different from the 30 component shares in the Sensex and uses the Sensex futures contract as the hedging medium. Similarly, a flour mill anticipates the purchase of wheat in the near future. To hedge itself against price rise, it goes long on wheat futures. This hedge would be a cross hedge if the quality of wheat desired by the mill is different from the quality of wheat underlying the futures contract.

Other reasons for imperfect hedging when using futures contracts include the possibility that the hedger may not be certain about the date when an asset would be bought or sold, or that the date of expiry of the futures contract may not match with the date when the asset is to be bought or sold. These problems give rise to the 'basis risk'.

Basis Risk

For a hedger, the difference between the futures price and that of the cash asset that he/she is long or short on is relevant. However, this is not what the speculators/arbitrageurs are concerned with. They are interested in the basis defined by the difference between the futures price and the price of the deliverable asset underlying the futures contract. For instance, if you are hedging with Sensex index futures, you would be considering the difference between the prices of the portfolio of securities on which long or short positions have been taken by you and the futures price. On the other hand, a speculator/

arbitrageur would be interested in the prices of the securities underlying the index and the price of a futures contract on this index.

Now, consider an investor who is currently long or short on one unit of a cash asset, with a spot price of say, S_0. The investor runs the risk that the price of the asset would be S^*_1, (which is a *random variable*, meaning that it may take one of the several possible values) at a subsequent point of time, say time 1. In other words, the risk faced by this un-hedged investor is $S^*_1 - S_0$. After the investor hedges by using a futures contract on one unit of an underlying asset that the investor believes shall move in line with the cash asset being hedged, the risk equals the change in the price of the futures *less* the change in the price of the cash asset or $(F^*_1 - F_0) - (S^*_1 - S_0)$, where F_0 is the present futures price and F^*_1 is the futures price at time 1. A minus sign between the two terms in parentheses is due to the fact that the hedger takes a position in the futures that is opposite to the one in the cash asset. We may rearrange the terms in the above expression to get $(F^*_1 - S^*_1) - (F_0 - S_0)$, which is, then, (basis 1 *minus basis* 0). While today's basis, basis 0, is known, the basis at time 1 is unknown, and is a random variable. Thus, it may be observed that while an un-hedged investor faces the price risk (that is, the risk that the price may change), a hedged investor faces the basis risk—the risk that basis may change.

Had the basis remained unchanged over time, or if it were perfectly predictable at the end of the hedging duration, then the investor would have a perfect hedge. However, since basis does change randomly, perfect hedging may not be expected. Of course, to minimize risk, the hedger hopes that the price changes of the cash asset and the futures price will be highly correlated. The higher the degree of correlation between the two, the smaller is the basis risk and, in the event of a perfect correlation, the basis risk is, theoretically, eliminated. As the asset underlying the futures contract becomes more and more like the cash asset, the degree of correlation increases.

Hedge Ratio

Using the relationship between the changes in the futures prices and prices of cash asset, we may now proceed to determine the appropriate number of futures contracts to buy or sell when hedging. In this context, the *hedge ratio* is defined as the number of futures contracts to buy (or sell) per unit of the spot good position. Normally, one would believe that the size of the position taken in the futures contracts should be the same as the size of exposure in the cash asset, (implying that for a Rs 10 lac position in the cash market, the position taken in the futures market should also be Rs 10 lac) so that the hedge ratio is implicitly taken to be 1.0. However, the optimal hedge ratio, as we shall see, depends on the extent and nature of relative price movements of the futures prices and the cash good prices.

The optimal hedge ratio, h^*, for a risk-minimising hedger can be obtained by regressing changes in spot prices (Δ_S) on changes in futures prices (Δ_F). For this, we may run the following regression model:

$$\Delta_S = \alpha + \beta\Delta_F$$

The slope co-efficient, β, of the regression line so obtained would yield the estimated optimal hedge ratio.

Before we discuss the operation of regression model, let us consider how Δ_S and Δ_F values are obtained. Consider the following example.

Example 2.1

The spot and futures prices in respect of a certain commodity are given below:

Month[a]	*Spot Price*	*Nearby Futures Price*[b]	*Distant Futures Price*
Jan	603	617.2 Mar	624.6 Jun
Feb	609	619.5 Mar	627.8 Jun
Mar	601	603.2 Mar	614.7 Jun
Apr	587	599.0 Jun	606.3 Sep
May	598	608.4 Jun	612.7 Sep
Jun	596	597.1 Jun	604.9 Sep
Jul	612	621.7 Sep	627.3 Dec
Aug	616	623.3 Sep	629.6 Dec
Sep	623	621.8 Sep	623.7 Dec
Oct	614	622.4 Dec	628.4 Mar
Nov	620	627.8 Dec	631.1 Mar
Dec	615	623.7 Dec	627.2 Mar
Jan	621	629.2 Mar	632.8 Jun
Feb	618	627.2 Mar	631.2 Jun
Mar	627	628.1 Mar	632.4 Jun
Apr	624	629.2 Jun	633.7 Sep
May	630	639.3 Jun	642.1 Sep

Notes:

(a) An italicized month denotes a delivery month for a futures contract.

(b) The 'nearby' and 'distant' futures prices are provided. For example, in the first month, that is January, the price of a March futures is 617.2 while the price of the June futures is 624.6. This information is needed for making calculations about changes in the futures prices, as explained later.

Calculate changes in spot prices (Δ_S) and changes in futures prices (Δ_F), using these data.

The given data are reproduced in Table 2.3.

Table 2.3

Calculation of Changes in Spot and Futures Prices

Month	*Spot Price*	*Nearby Futures Price*	*Distant Futures Price*	Δ_S	Δ_F
Jan.	603	617.2 Mar.	624.6 June		
Feb.	609	619.5 Mar.	627.8 June	6	2.3
Mar.	601	603.2 Mar.	614.7 June	– 8	– 16.3
Apr.	587	599.0 June	606.3 Sept.	– 14	– 15.7
May	598	608.4 June	612.7 Sept.	11	9.4
June	596	597.1 June	604.9 Sept.	– 2	– 11.3
July	612	621.7 Sept.	627.3 Dec.	16	16.8
Aug.	616	623.3 Sept.	629.6 Dec.	4	1.6
Sept.	623	621.8 Sept.	623.7 Dec.	7	– 1.5
Oct.	614	622.4 Dec.	628.4 Mar.	– 9	– 1.3
Nov.	620	627.8 Dec.	631.1 Mar.	6	5.4
Dec.	615	623.7 Dec.	627.2 Mar.	– 5	– 4.1
Jan.	621	629.2 Mar.	632.8 June	6	2.0
Feb.	618	627.2 Mar.	631.2 June	– 3	– 2.0
Mar.	627	628.1 Mar.	632.4 June	9	0.9
Apr.	624	629.2 June	633.7 Sept.	– 3	– 3.2
May	630	639.3 June	642.1 Sept.	6	10.1

The changes in the spot prices, ΔS, are given in the fifth column of the table. The values are obtained by finding differences between successive spot prices, 609 – 603 = 6, 601 – 609 = – 8, etc. Similarly, the differences between futures prices, ΔF, are calculated and given in the last column. For a month following the one in which delivery is made in a futures contract, the price difference between the 'nearby' futures price and the 'distant' futures price corresponding to the delivery month should be considered. For example, for the month of

April, the price of the nearby, June futures, is 599.0. To find the change in futures price we cannot take the difference between this value and the previous value, i.e., 603.2 because that is a value for the March futures. The correct difference would be between June futures price in April (i.e., 599) and the June futures price in March (i.e., 614.7). Accordingly, other futures price changes can be calculated as given in the last column of the table.

Regression Analysis

If we let Y represent the variable ΔS and X represent the variable ΔF, we can restate the regression equation as

$$Y = \alpha + \beta X.$$

The values of α and β can be obtained as follows:

$$\beta = \frac{n\Sigma XY - \Sigma X\, \Sigma Y}{n\Sigma X^2 - (\Sigma X)^2}$$

and $$\alpha = \bar{Y} - \beta \bar{X}$$

The beta co-efficient, β, can also be computed as follows:

$$\beta = r \times \frac{\sigma_Y}{\sigma_X}$$

In this expression, r refers to the co-efficient of correlation between the changes in spot prices (ΔS) and changes in futures prices (ΔF), σ_Y refers to the standard deviation of the changes in spot prices and σ_X is the standard deviation of the changes in the futures prices. These inputs may be calculated as shown below:

$$\sigma_X = \sqrt{\frac{\Sigma (X - \bar{X})^2}{n}} \text{ or } \sqrt{\frac{\Sigma X^2}{n} - (\bar{X})^2}\text{, where } \bar{X} = \frac{\Sigma X}{n}$$

$$\sigma_Y = \sqrt{\frac{\Sigma (Y - \bar{Y})^2}{n}} \text{ or } \sqrt{\frac{\Sigma Y^2}{n} - (\bar{Y})^2}\text{, where } \bar{Y} = \frac{\Sigma Y}{n}$$

$$r = \frac{\text{Covariance}}{\text{Standard deviation of } X \times \text{Standard deviation of } Y}$$

Alternately,

$$r = \frac{\Sigma (X - \bar{X})(Y - \bar{Y})}{n\sigma_X \sigma_Y}$$

$$= \frac{n\Sigma XY - \Sigma X\, \Sigma Y}{\sqrt{n\Sigma X^2 - (\Sigma X)^2}\ \sqrt{n\Sigma Y^2 - (\Sigma Y)^2}}$$

The β being equal to $r \times \sigma_Y/\sigma_X$, it can be said that the optimal hedge ratio is the product of the coefficient of correlation between ΔF and ΔS and the ratio of the standard deviation of ΔS to the standard deviation of ΔF. From the formulation, it may be observed that the optimal hedge ratio is 1.0 when $\Delta F = \Delta S$ and $r = 1$, that is, when futures price changes replicate the spot price changes. It follows from this that the size of the position to be taken in futures contracts needs to be matched with the size of exposure in the cash asset only when the futures prices and the spot prices move in tandem with each other. Further, when $r = 1.0$ and $\Delta F = 2\,\Delta S$, the optimal hedge ratio would be 0.5, which is expected since the change in the futures price is always double that of the spot price. Similarly, if $r = 1.0$ and $2\,\Delta F = \Delta S$, then the optimal hedge ratio would be 2 so that two futures contracts are needed to hedge for each one unit position in the cash good since in this case, the futures price always changes by one-half as much as the spot price.

We now illustrate the calculation of β.

Example 2.2

Using the ΔS and ΔF values given in Example 2.1, obtain the regression equation $Y = \alpha + \beta X$. Also, verify that the value of the slope coefficient β is the same as obtained by the expression $r \times \sigma_Y/\sigma_X$.

The $X (= \Delta F)$ and $Y (= \Delta S)$ values obtained earlier are reproduced in Table 2.4. The calculation of the inputs required for determining the beta is also shown in the table.

We have,

$$\beta = \frac{n\Sigma XY - \Sigma X\, \Sigma Y}{n\Sigma X^2 - (\Sigma X)^2}$$

$$= \frac{16 \times 915.6 - (-6.9)(27)}{16 \times 1189.29 - (-6.9)^2}$$

$$= 0.782$$

$$\alpha = \bar{Y} - \beta \bar{X}$$

$$= 1.6875 - 0.782 \times (-\,0.43125)$$

$$= 2.025$$

Table 2.4

Determination of Optimal Hedge Ratio

X	Y	X^2	Y^2	XY
2.3	6	5.29	36	13.8
– 16.3	– 8	265.69	64	130.4
– 15.7	– 14	246.49	196	219.8
9.4	11	88.36	121	103.4
– 11.3	– 2	127.69	4	22.6
16.7	16	282.24	256	268.8
1.6	4	2.56	16	6.4
– 1.5	7	2.25	49	– 10.5
– 1.3	– 9	1.69	81	11.7
5.4	6	29.16	36	32.4
– 4.1	– 5	16.81	25	20.5
2.0	6	4.00	36	12.0
– 2.0	– 3	4.00	9	6.0
0.9	9	0.81	81	8.1
– 3.2	– 3	10.24	9	9.6
10.1	6	102.01	36	60.6
Total – 6.9	27	1189.29	1055	915.6

(Here $\bar{Y} = \Sigma Y/n = 27/16 = 1.6875$, and $\bar{X} = \Sigma X/n$
$= -6.9/16 = -0.43125$)

Thus, $Y = 2.025 + 0.782X$

Also, we have

$$r = \frac{n\Sigma XY - \Sigma X\,\Sigma Y}{\sqrt{n\Sigma X^2 - (\Sigma X)^2}\,\sqrt{n\Sigma Y^2 - (\Sigma Y)^2}}$$

$$= \frac{16 \times 915.6 - (-6.9)(27)}{\sqrt{16 \times 1189.29 - (-6.9)^2}\,\sqrt{16 \times 1055 - (27)^2}}$$

$$= 0.847$$

$$\sigma_X = \sqrt{\frac{\Sigma X^2}{n} - (\bar{X})^2}$$

$$= \sqrt{\frac{1189.29}{16} - (-0.43125)^2}$$

$$= 8.61$$

$$\sigma_Y = \sqrt{\frac{\Sigma Y^2}{n} - (\bar{Y})^2}$$

$$= \sqrt{\frac{1055}{16} - (27)^2}$$

$$= 7.94$$

Accordingly,

$$\beta = r\frac{\sigma_Y}{\sigma_X}$$

$$= \frac{0.847 \times 7.94}{8.16}$$

$$= 0.782$$

In terms of the original data,

$$\Delta S = 2.025 + 0.782\ \Delta F$$

Since the slope coefficient, β, is the definition of h^* for a risk-minimizing hedge, it may be observed from these results that 0.782 futures contracts should be sold to hedge one unit of the spot position. Thus, if the spot and futures prices given in the above example are per quintal rates, with each futures contract involving 100 quintals, then 9.384 (= 0.782 × 1200/100) futures contracts should be sold for hedging.

Now, suppose that the futures price subsequently changes in exactly the same way as predicted by this regression model so that we can obtain the change in the futures price expected corresponding to a given change in the spot price. For instance, suppose that price change in the spot market is – 7.2, then from this model, the change expected in the futures price will be a decline of 9.21 per quintal (– 7.2/0.782 = – 9.21).

Let us assume that the current spot price is Rs 604 per quintal and the futures price is Rs 630 (per quintal). Fearing that the price may decline, the investor sells 9.384 futures at Rs 630. Further, suppose that after a certain period, the spot price declines by Rs 7.2 to become 595.8 (= 603 – 7.2) and the futures price declines as predicted, by 9.21 and becomes 630 – 9.21 = 620.79. Now, if 9.384 futures are bought at this price, the position in this short hedge shall be as follows:

Spot Market

Total quantity of wheat = 1200 quintals
Decline in the spot price over the period = Rs 7.2 per quintal
Thus, loss = 1200 (595.8 – 603) = 1200 × (– 7.2) = Rs 8640

Futures Market

No. of futures contracts sold and bought = 9.384
Selling price = Rs 630 (per quintal)
Buying price = Rs 620.79 (per quintal)
Therefore, Profit = 9.384 × 100 × (630 – 620.79) = Rs 8642

Thus, the profit in the futures market exactly matches the loss incurred in the spot market (except for a negligible difference on account of rounding off).

It is clear that if the futures price changes exactly as predicted, then hedging would be perfect. But, if the futures price does not change as expected, as would normally be, then the hedging will not be perfect and a profit or loss would eventually result.

A few observations are in order at this point:

1. Before hedging, one must be confident that a reliable relationship exists between price changes of the spot asset to be hedged and the price changes of the futures contract. The strength of this relationship is measured by the coefficient of determination, R^2 (or r^2), which is numerically equal to the square of the coefficient of correlation between two variables. Since the coefficient of correlation, r, between two variables ranges between 0 and 1 (0 and – 1 in case the correlation is negative), it follows that R^2 can also vary between 0 and 1, or 0 and 100%. It is a measure of the percentage of the variability of the *dependent variable* ΔS which is 'explained' by the variability of the *independent variable* ΔF. The higher the value of R^2, the greater would the effectiveness of the hedge be. In case of a choice between two possible futures contracts for hedging a given spot position, it may be better to choose the one with a higher R^2 (it goes without saying that r must be positive). Further, if R^2 is found to be rather low for a contract, say less than 50%, it may be prudent not to engage in hedging with the same.

2. In the example given above, monthly data are considered to build the relationship between spot and futures prices. A natural question to ask is whether monthly data should always be used. As an

answer to this, it may be stated that, broadly, the choice of data to be used depends upon the hedging horizon, particularly when the period is small. If hedging was to be done for a day, then daily price change data should be used, and if the horizon of hedging was, say, 2, 3, 4 or 5 days, then historical data on spot and futures price with, respectively, 2, 3, 4 and 5 days apart should be used. However, for longer hedging periods, it does not make much difference whether weekly, bi-weekly or monthly values are taken. It is not advisable to take values for periods which are longer than a month apart. One reason for this is that for determining the slope, a smaller number of values would be available with the result that the accuracy of the slope may become questionable. It can be easily visualized that 24 monthly values will give a better estimate of the slope than 8 quarterly values for the same period. A second reason for not taking large-interval values is that their use would require employing values which are distant in the past. Using these, we may get a distorted estimate of the current relationship between spot and futures prices. Although consideration of small intervals, daily price changes, or price changes that are two days apart, provide a large data base, they are not necessarily better than the weekly price changes because of the presence of noisy influences in them. Also, therefore, hedging for small time intervals, one day or few days, would involve a greater basis risk and should, therefore, be done very cautiously.

Rolling Forward of a Hedge

Sometimes, the horizon of hedging may extend beyond the delivery dates of all the futures contracts that may be used. In such an event, a hedger must roll the hedge forward. This implies closing out one futures contract and taking the same position in a futures contract with a later delivery date. The process is continued until the hedging span is reached. Obviously, this strategy has a number of basis risks (or sources of uncertainty). Apart from this, each time when the hedge is rolled forward, there is uncertainty about the difference between the futures prices for the contract being closed and for the contract being entered into.

VALUATION OF FORWARD AND FUTURES PRICES

We now proceed to discuss as to how the prices of forward and futures contracts are related to the prices of underlying assets. In the first place, we shall consider the pricing of the forward contracts. It can be shown that the futures prices are very close to the forward prices for the contracts of same maturity. Thus, we shall take the futures prices to be the same as the forward prices for all practical purposes.

It is pertinent to note in connection with the valuation process that a distinction is made in respect to the assets which are held as investments by most of the investors and those which are held exclusively for consumption. For instance, gold is a 'financial product' held by investors as investment while the agricultural commodities are meant primarily for consumption purposes rather than for investment purposes.

The financial forward and futures contracts are priced using the *Cost of Carry Model.* With varying degrees of success, the model can also be used to value some non-financial contracts. Gold provides such an example. This is because gold is non-perishable, can be stored easily and is used for investment purposes. It is, what is known as a 'carry type' physical commodity. Sometimes, other commodities, like silver, also lend themselves to be treated so and be priced accordingly. However, difficulties arise in using the cost of carry approach to value such contracts. Also, the model cannot be used to value contracts involving agricultural commodities as they are not held for investment purposes.

We shall first consider the valuation of the financial futures contracts, which will be followed by a brief discussion about the valuation of other 'carry' and 'non-carry' commodities.

The pricing is done in such a way that no arbitrage opportunities arise. It may be recalled that arbitrage refers to a trade which leads to a risk-free profit with no cash outlay. It is not expected to be present in the markets operating well. But, market imperfections, such as transactions costs, etc., do allow arbitrage opportunities and, therefore, the actual prices may deviate from their theoretical values.

Assumptions for Pricing of Financial Contracts

The pricing of financial contracts is based on certain assumptions:

1. The markets are perfect.
2. There are no transaction costs.
3. All the assets are infinitely divisible.
4. Bid-ask spreads do not exist so that it is assumed that only one price prevails.

5. There are no restrictions on short selling. Also, short sellers get to use full proceeds of the sales.

Carry Pricing Model

The carry pricing model stipulates that the forward or futures price, defined as the value of one unit of the asset underlying the contract, is equal to the sum of the spot price and the carrying costs incurred by buying and holding on to the deliverable asset, *less* the carry return, if any. Thus,

Forward (or Futures)

$$\text{Price} = \text{Spot Price} + \text{Carry Costs} - \text{Carry Return}$$

Here, *Spot Price* is the current price of one unit of the deliverable asset in the market. *Carry Costs* refer to the holding costs, including the interest charges on borrowing the cash to buy (or the opportunity cost of using one's own funds) the asset. In case of physical commodities, the carrying costs also include costs such as insurance, obsolescence, storage, etc. *Carry Return* refers to the income, such as dividends on shares, which may accrue to the investor.

Valuation Concepts

The valuation in all cases that we will take up later requires knowledge of the concepts of continuous compounding and short selling. These concepts are explained below.

Continuous Compounding The calculation of forward prices and option prices is based on the concept of continuous compounding. The concept of compounding is widely used in everyday life in the context of deposits in banks, loans, etc. The most generally used idea is that of annual compounding. We know that the compounded value, A, of a sum P, carrying an interest of r per annum, after n years is given by

$$A = P(1 + r)^n$$

For example, a sum of Rs 1000 compounded at 10% per annum for 2 years becomes

$$A = 1000 \times (1 + 0.1)^2 = \text{Rs } 1210$$

Note that with an interest rate of 10%, r is taken as $10/100 = 0.10$ so that the first calculation of interest is done at the end of the first year, while the next at the end of the second year.

Accordingly,

$$\text{Interest for Year 1} = \frac{1000 \times 10 \times 1}{100} = \text{Rs } 100$$

Principal for second year = Rs 1000 + Rs 100 = Rs 1100

$$\text{Interest for Year 2} = \frac{1000 \times 10 \times 1}{100} = \text{Rs } 110$$

Amount at the end of the Year 2 = Rs 1100 + Rs 110 = Rs 1210

Now, if the compounding was done twice a year, the amount at the end of two years can be calculated as follows:

Beginning of Period	*Principal*	*Interest*†	*Amount at the End*
I Half-year	1000	1000 × 0.05 = 50	1050
II Half-year	1050	1050 × 0.05 = 52.50	1102.50
III Half-year	1102.50	1102.5 × 0.05 = 55.125	1157.6254
IV Half-year	1157.625	1157.625 × 0.05 = 57.881	1215.51

It is observed that with all the inputs being the same, the amount is a little higher when the frequency of compounding is increased from one to two in each year. With a still greater compounding frequency, the amount at the end of the two year period would increase. For instance, for different compoundings: quarterly, monthly, weekly, and daily, the amounts at the end of the two years for the above example are as given below:

Compounding	*Amount*
Quarterly	1218.40
Monthly	1220.39
Weekly	1221.17
Daily	1221.37

In general terms,

$$A = P\left(1 + \frac{r}{m}\right)^{mn}$$

where r is the per annum rate of interest, m is the number of compoundings per annum and n is the number of years. For quarterly compounding, for example, $m = 4$, while for daily compounding, $m = 365$.

† Since interest is 10% per annum, it is taken as 5% per half-year.

To carry the idea further, if the number of compoundings per annum increases more and more, the time period between successive compoundings would steadily fall. In the extreme case, the compounding may be thought to be continuous. In such an event, it can be shown mathematically that the amount may be calculated as follows:

$$A = Pe^{nr}$$

where all symbols carry the same meaning as before, and e is a mathematical constant whose value is 2.7183 (just like another constant π which is equal to 22/7 and with which we are all familiar).

Since the compounding is continuous, the amount is likely to be the largest. To know the exact amount, we make the following calculation:

$$A = 1000 \times 2.7183^{2 \times 0.1} = 1000 \times 1.22140 = \text{Rs } 1221.40$$

For obtaining value of e^x, we may refer to Table A1. In this table, for various values of x (which is equal to the product of n and r), the values of e^x are readily available. An alternative is to use a calculator/computer for the purpose.

Just as compounding is needed to be done, in many cases discounting may be required to be undertaken. Discounting is opposite to the compounding process and is needed when some money to be received in future is to be expressed in terms of the present time—the time value of money, in other words. After all, a rupee received today is worth more than a rupee to be received after, say, three years and, therefore, the present value of a rupee receivable after three years would be less than one rupee. The present value may be found easily by toying a little with the compound interest formula.

Since $A = P(1 + r)^n$, we have $P = A/(1 + r)^n$. This may equivalently be expressed as, $P = A(1 + r)^{-n}$. If A is taken to be one rupee, we get $P = (1 + r)^{-n}$. Here P gives the present value of one rupee receivable after n time periods and r is the rate of interest involved (referred sometimes as the *discount rate* since discounting is being done). The value of $(1 + r)^{-n}$ is referred to as the *present value factor* (PV factor). If the continuous compounding is involved, the PV Factor will be e^{-rn}.

It is possible to establish equivalence between interest rates when the compounding frequencies are different. It means that, for example, if a certain rate of interest with annual compounding is given, we can determine the rate of interest which will yield the same amount if continuous compounding was undertaken. Thus, if r_1 be the rate of interest when m compoundings are done and r_2 be the equivalent rate when continuous compounding is done, then we must have

$$A\left(1+\frac{r_1}{m}\right)^{mn} = Ae^{r_2 n}$$

Cancelling A on both sides of the equation, we get

$$\left(1+\frac{r_1}{m}\right)^{mn} = e^{r_2 n}$$

This meant that

$$r_2 = m \ln\left(1+\frac{r_1}{m}\right)$$

Similarly,

$$r_1 = m\,(e^{r_2/m} - 1)$$

Here ln is the natural logarithm. In fact, if $y = \ln x$, then $x = e^y$.

Example 2.3

An interest rate is quoted as 12% per annum with quarterly compounding. This means $r_1 = 12\% = 0.12$ and $m = 4$. The equivalent rate with continuous compounding would be

$$r_2 = 4 \times \ln\,(1 + 0.12/4)$$
$$= 11.82\%$$

Example 2.4

A lender gives a loan on which he quotes the interest rate as 15% per annum with continuous compounding. To calculate the equivalent rate if compounding was done quarterly, we can solve for r_1, where with $m = 4$ and $r_2 = 0.15$:

$$r_1 = 4 \times (e^{0.15/4} - 1)$$
$$= 15.28\%$$

Short Selling Short selling is another concept used in relation to some strategies involving futures (and options) arbitrage strategies. The *short selling* implies selling the securities which are not owned by the seller and buying them back at a later date. This is done with the hope that the price of a security would go down. A decline in the price of the security would benefit the short seller because he/she replenishes the security bought at a lower rate, while if the price increases, the short seller stands to lose.

The mechanics of short selling can be understood with a simple example. Suppose that an investor contacts a broker to short 500 Reliance shares, the broker immediately borrows 500 Reliance shares from another client or from his own stock, if he maintains one and sells them in the market in the usual way, and deposits the sale proceeds to the account of the investor. If there are shares which can be borrowed, the investor can continue to maintain the short position for as long as desired. After sometime, the investor will choose to instruct his broker to close out the position so that by utilizing the proceeds in the investors' account, the broker buys and replaces the shares in the account of the client from whom the shares were borrowed. If, at any time while the contract is open, the broker finds it is not possible to borrow the shares, the investor may be called by the broker to close out the position. The investor is said to be *short squeezed* and he is obliged to close out whether he is ready or not to do so.

Brokers usually require significant initial margins from clients with short positions. The margin is generally 25 per cent of the market value of shares shorted. Sometimes, the proceeds of the initial sale are kept as initial margin. As is the case with the futures contracts, higher margins may be required by the broker in case of significant unfavourable movements in the prices of shares. In some cases, brokers pay interest on margin accounts and they accept margin in the form of marketable securities as well. It is sometimes laid down that the shares may be sold short only on an up-tick so that the last movement on the price was an increase. An investor who sells the shares short must pay to his/her broker any income (e.g., dividend) that would normally be received on securities shorted, who would, in turn, transfer this to the account of the client from whom the securities were borrowed.

Pricing of Forward Contracts

In the first place, we will develop rules for determining prices of the forward contracts and then use these to obtain the prices of futures contracts. In particular, we consider the three cases listed below:

1. For securities providing no income.
2. For securities providing a given amount of income.
3. For securities providing a known yield.

Case 1: Securities Providing No Income This is the easiest forward contract for valuation, and is exemplified by a share which is not expected to pay any dividend, or by discount bonds. In order that there be no arbitrage opportunities, the forward price F should be:

$$F = S_0 \, e^{rt}$$

Here, S_0 is the spot price of the asset underlying the contract, r is the riskfree rate of interest per annum with continuous compounding, and t is the time to maturity.

Now, assume that $F > S_0 \, e^{rt}$. In this case, an investor may buy the asset by borrowing an amount equal to S_0 for a period of t at the riskfree rate, and take a short position in forward contract. At the time of maturity, the asset will be delivered for a price of F and the amount borrowed will be repaid by paying an amount equal to $S_0 \, e^{rt}$, and the deal would result in a net profit of $F - S_0 \, e^{rt}$. Similarly, if $F < S_0 \, e^{rt}$, then the investor would do well to short the asset, invest the proceeds for the time period t at an interest rate of r per annum, and long a forward contract. When the contract matures, the asset would be purchased for a price of F and the short position in the asset would be closed out. This would result in a profit of $S_0 \, e^{rt} - F$.

Example 2.5

> Consider a forward contract on a non-dividend paying share which is available at Rs 70, to mature in 3-months' time. If the riskfree rate of interest be 8% per annum compounded continuously, the contract should be priced at $70e^{(0.25)(0.08)}$ or Rs 70 × 1.0202 = Rs 71.41.

If the forward contract was priced at a higher value than this, say at Rs 73, an arbitrageur should short a contract, borrow an amount of Rs 70 for three months at the riskfree rate, and buy the share for Rs 70. At maturity, sell the share for Rs 73 (forward contract price), repay the loan amount of Rs 71.40 and make a profit of Rs 73 – Rs 71.40 = Rs 1.60. In a similar way, if the forward contract was quoted at Rs 71, then the investor should buy a contract, short a share and invest the amount realized for three months, to get Rs 71.40 back after this period. Then the share would be bought for Rs 71 and replaced. This would result in a net gain of Re 0.40.

Case 2: Securities Providing a Known Cash Income We may now consider a forward contract on a security which provides a certain cash income to the investor. Preference shares are an example of this.

In such a case, we first determine the present value of the income receivable. For instance, if the income Y is receivable in two months' time from now and r is the discount rate per annum (compounded continuously), then the present value I, of income Y would be $I = Ye^{(-2/12)r}$. Now, if there is to be no arbitrage, then the price of the forward contract should be $F = (S_0 - I)e^{rt}$. In the same manner as discussed earlier, first suppose that $F > (S_0 - I)e^{rt}$. Here an arbitrageur can short a forward contract, borrow money and buy the asset. When the income is received, it is used to partly repay the loan. At maturity, the asset is sold for F and the outstanding loan of $(S_0 - I)e^{rt}$ is repaid. This result in a net profit of $F - (S_0 - I)e^{rt}$.

On the other hand, $F < (S_0 - I)e^{rt}$, then an arbitrageur can short the asset, invest the proceeds, and take a long position in a forward contract. This operation will yield a net gain of $(S_0 - I)e^{rt} - F$ at maturity.

Example 2.6

Let us consider a 6-month forward contract on 100 shares with a price of Rs 38 each. The riskfree rate of interest (continuously compounded) is 10% per annum. The share in question is expected to yield a dividend of Rs 1.50 in 4 months from now. We may determine the value of the forward contract as follows:

Dividend receivable after 4 months	$= 100 \times 1.50 =$ Rs 150
Present value of the dividend, I	$= 150e^{-(4/12)(0.10)}$
	$= 150 \times 0.9672$ or Rs 145.08
Value of forward contract	$= (3800 - 145.08)e^{(0.5)(0.10)}$
	$= 3654.92 \times 1.05127$
	$=$ Rs 3842.31

Case 3: Securities Providing a Known Yield While in Case 2, we considered pricing of forward contracts for securities that provide a known amount of income, we now look at the case of securities which provide a certain yield. Stock indices may be regarded as such securities. The shares included in the portfolio comprising the index are expected to return dividends in the course of time which may be expressed as a percentage of their prices, termed as yield, and thus be related to the index. Theoretically, it is assumed to be paid continuously at a rate of y per annum.

In such a case, the forward price may be calculated as follows:

$$F = S_0 \, e^{(r - y)t}$$

Example 2.7

Assume that the stocks underlying an index provide a dividend yield of 4% per annum, the current value of the index is 520 and that the continuously compounded riskfree rate of interest is 10% per annum. To find the value of a 3-month forward contract, we proceed as follows:

Here $S_0 = 520$, $r = 0.10$, $y = 0.04$, and $t = 3/12$ or 0.25. Accordingly, the forward price, F, can be computed as

$$F = 520e^{(0.10 - 0.04)\,(0.25)} = 520 \times 1.0151 = \text{Rs } 527.85$$

Pricing of Futures Contracts

We have stated earlier that comparable forward and futures prices tend to be practically the same. In fact, it may be shown that in a perfect market where the interest rates remain unchanged, the futures prices would equal the forward prices, with the marking to the market having no impact on the prices. However, when interest rates are variable, the two may be different. Broadly speaking, if movements in the futures prices are positively correlated to the interest rates, then the futures prices are likely to be higher than the forward prices. As futures' prices increase, long positions on futures are profitable. If the interest rates also rise simultaneously (a positive correlation), then the marking to market cash inflows can be reinvested at higher rates. Similarly, if interest rates fall when futures prices fall (still a positive correlation) then losses that long position holders incur can be offset by borrowing at lower interest rates. Consequently, the futures prices tend to be bid higher in relation to the forward prices. The reverse happens when the futures prices and interest rates are negatively correlated. That is to say, when interest rates tend to decline with an increase in the futures prices, then the cash flows resulting from marking to the market would be reinvested at lower interest rates, while increased interest rates associated with falling futures prices would imply that losses to long position on futures have to be offset by borrowing at higher rates of interest. This has the effect of bidding lower futures prices than those of forward contracts.

However, these results tend to hold in case of perfect markets. In the imperfect real world markets, this does not work so well—the presence of transactions costs, indivisibilities and taxes tend to weaken these propositions. Accordingly, the futures prices may be reasonably taken to be the same as the forward prices derived from the cost of carry model. Even in the real markets it is observed that the futures and forward prices run very close to each other and the process of daily settlement has only an insignificant impact on prices.

We shall now describe the pricing of the futures contracts. In this chapter, pricing of futures on commodities will be considered. The question of pricing of futures on stock indices and on individual stocks will be considered in the next chapter.

Futures on Commodities For purposes of pricing the futures on commodities, a distinction is made between commodities which are of 'carry type' i.e., used for investment purposes, and those which are of non-carry type and are meant primarily for consumption.

Carry Type Commodities Gold and silver are the classic examples of carry type commodities which are held by a significant number of investors for investment alone. If the storage cost is zero, they are analogous to securities providing no return. As such, the price of a futures contract would be: $F = S_0\, e^{rt}$, with symbols having their usual meanings.

The storage costs incurred, if any, may be regarded as negative income. If S is the present value of all the storage costs that may be incurred during the life of a futures contract, the price of the contract would be: $F = (S_0 + S)e^{rt}$.

If, however, the storage costs are regarded as proportional to the price of the commodity involved, they would be the same as providing a negative yield. If s represents the storage costs per annum as a proportion of the spot price, we have $F = S_0\, e^{(r + s)t}$.

Example 2.8

Let us consider a 6-month gold futures contract of 100 gm. Assume that the spot price is Rs 480 per gram and that it costs Rs 3 per gram for the 6-monthly period to store gold and that the cost is incurred at the end of the period. If the riskfree rate of interest is 12% per annum compounded continuously, the futures price may be obtained as follows.

With $r = 0.12$, $S_0 = 480 \times 100 =$ Rs 48,000, $t = 6/12$ or 0.5 and $S = 3 \times 100\, e^{-(0.12 \times 0.5)} =$ Rs 282.53, the futures price, F, is given by

$$F = (48{,}000 + 282.53)e^{0.12 \times 0.5} = \text{Rs } 51{,}268.15.$$

Non-carry Commodities For commodities that are not held primarily for investment purposes, the cost of carry model cannot be applied as above for determining the futures prices. In respect of such commodities, this model serves to determine the *upper bound* only. In other words, for the agricultural and other non-carry commodities, we may say that the futures price will not exceed the sum of the spot price and the carrying costs *less* carry return, if any. When considering carry commodities the arbitrage arguments work, but for non-carry commodities, such arguments cannot be used. Investors who keep such a commodity in inventory do so because of its consumption value and not because of value as investment. Thus, they are reluctant to sell the commodity and buy futures contracts since futures contracts cannot be consumed. Similarly, pure arbitrageurs will not always be able to find supplies of cash goods to borrow and sell short. Producers need to maintain supplies of these goods in order to use them in their production processes—thus, for instance, cereal manufacturers need to keep wheat and corn in inventory. It is quite possible, therefore, that the spot prices of such commodities are higher than the futures prices, and it is possible that no one might be able to arbitrage by selling the commodity in the spot market and buying futures contracts.

Thus, the valuation of the non-carry commodity futures requires introducing another concept—called *convenience return*, or *convenience yield*, which is the return (expressed in monetary terms or in percentage terms) that an investor (the holder) realizes for carrying inventory of the commodity over his/her immediate short-term needs. The financial assets have no convenience return while agricultural commodities frequently have a high return. Note that the convenience return for a commodity is likely to be different for different investors, and may vary over time. As such, the convenience return cannot be measured and expressed easily and objectively. Nevertheless, if the monetary value of storage costs associated with carrying the commodity is known and has a present value s, and the convenience yield, c, is known, then

$$F = (S_0 + s)e^{(r - c)t}$$

And, if the storage costs per unit are a constant proportion, p, of the spot price, then

$$F = S_0 e^{(r + p - c)t}$$

UTILITY OF FUTURES MARKETS

Futures markets provide several benefits to the participants and others. These markets make transactions across time easier because they allow production, consumption and inventory decisions be made more optimally. Futures markets allow traders to make low cost agreements to exchange money for goods at future times. By allowing hedging against unfavourable price changes, they make it possible for shifting risk from hedgers (those who do not want to take risk) to speculators (those who want to take risk). Moreover, futures prices are informative in that they permit producers and consumers to have an efficient idea of what the future spot price is likely to be or what future demand and supply of the commodity would likely be by gauging the current futures price.

TEST YOUR UNDERSTANDING

Mark the following statements as True or False.

1. ________ A forward contract is an agreement to buy a certain asset at a certain future date, for a price to be determined in the future.
2. ________ A forward contract is not a derivative security like futures.
3. ________ A long position indicates a buyer in a derivatives contract while a short position implies a seller in the contract.
4. ________ Delivery price in a forward contract is determined by the market forces of demand and supply.
5. ________ A prime determinant of the delivery price is the market value of the underlying asset.
6. ________ The initial value of a forward contract is zero so that neither of the parties has to pay the other for entering into such a contract.
7. ________ Subsequent upon entering into a forward contract, if the price of the underlying asset drops, then the contract would have positive value for the holder of the short position and negative value for the one with the long position.
8. ________ The forward price of a contract is the delivery price which would render a nil value to the contract.
9. ________ At the time of initiation of a forward contract, the forward and delivery prices are equal.

10. ________ With other inputs being the same for two forward contracts, the one with a longer time to maturity has a greater forward price.
11. ________ Forward contracts and futures contracts are both standardized in nature.
12. ________ All futures contracts are guaranteed for performance.
13. ________ A clearing corporation acts as an intermediary in futures contracts.
14. ________ A party with a long position in a futures contract can directly ask the party with the short position to deliver the underlying asset.
15. ________ A futures contract is designed by the parties involved, on a mutually agreed basis.
16. ________ A futures contract contains all details about the nature of agreement including the asset and its quality to be delivered, the contract size, the time of delivery, the price of delivery alternative assets, if any, which may be delivered in lieu of the asset, etc.
17. ________ In case alternatives to the quality of the asset are provided in a futures contract, it is the prerogative of the party with the long position to decide about the particular alternative.
18. ________ Futures contracts are not marketable instruments.
19. ________ A futures contract on a commodity is referred to only by its delivery month and no exact delivery date is specified on it.
20. ________ For the execution of commodities futures contracts, the holder of the long position has the right to choose the time during the delivery period at which the delivery would be made.
21. ________ The exchange specifies the tick size and the limits on the amount by which the futures price can move on any one day.
22. ________ Futures contracts are usually much more liquid than forward contracts.
23. ________ Collaterals are not required to be kept in futures contracts but margins are needed in case of forward contracts.

24. ________ In case of forward contracts, profits or losses are booked only on maturity while for futures contracts they are settled on a daily basis.
25. ________ Both the parties to a futures contract are required to keep margins which are marked to the market on a daily basis.
26. ________ The maintenance margin may be lower than, equal to, or greater than the initial margin.
27. ________ If the price of a futures contract increases, the margin account of the holder of the short position is credited for the gain.
28. ________ In the course of marking to the market, if the balance in the margin account of an investor falls below the maintenance margin, then a call is made to the investor for depositing such an amount that will restore the balance to the initial margin level.
29. ________ An investor is entitled to withdraw any amount in excess of the initial margin standing to his/her credit.
30. ________ *Variation margin* refers to the extra funds deposited by an investor upon getting a margin call in the event of the balance in the margin account falling below the level of the maintenance margin.
31. ________ The maximum margin limit for investors is set by the exchange while it is left to brokers to decide as to what exact margins are required by them from individual investors.
32. ________ A clearing house may determine the margin required to be kept by a member on the basis of the number of contracts outstanding, on a gross or a net basis.
33. ________ To a certain extent, the imposition of price limits serves as a barrier to trading.
34. ________ The difference between the futures price and the current price of a commodity is called the basis.
35. ________ The basis, defined as the excess of futures price over spot price, is expected to be positive for agricultural commodities.
36. ________ *Convergence* refers to the shortening of the gap between futures price and spot price with passage of time.

37. ________ In case of commodity futures contracts, the basis is attributable primarily to the carrying costs of a commodity.
38. ________ The normal backwardation hypothesis postulates that the expected basis is negative as the futures price tends to be a downward estimate of its spot price in the cash market at the contract's maturity date.
39. ________ According to the contango hypothesis, the speculators net short and are generally willing to assume the price risk in anticipation of earning high profits thereby bidding for higher contract prices resulting in a positive basis.
40. ________ The expectation theory states that the basis is likely to be positive or negative according to whether the futures prices are expected to be higher or lower.
41. ________ It is possible for a financial futures contract to have no underlying real asset.
42. ________ A futures contract on a stock index, like NIFTY, is not a derivative security because there is no asset underlying it.
43. ________ A futures contract on SENSEX can be settled in cash only.
44. ________ The financial futures contracts generally have a longer life than the futures on agricultural commodities.
45. ________ Futures contracts are a very effective hedging device.
46. ________ Futures act as a hedge when the same position is taken in them as taken/expected to be taken in the cash market.
47. ________ When the asset underlying the futures contract is different from the asset whose price is to be hedged, it is called a *cross hedge*.
48. ________ Perfect hedging is possible only if the basis remains unchanged over time or if it is perfectly predictable at the end of the hedging duration.
49. ________ The higher the degree of correlation between the price of the asset and the futures price, greater is the degree of basis risk.
50. ________ Hedge ratio is defined as the number of futures contracts to buy (or sell) per unit of the spot good position.
51. ________ For perfect hedging, the size of position taken in the futures contracts should be the same as the size of exposure in the cash asset.

52. ________ The optimal hedge ratio depends on the extent and nature of relative price movements of the futures prices and the cash good prices.
53. ________ The variance (of the value of the portfolio) minimizing hedge ratio is the optimal one.
54. ________ The optimal hedge ratio is equal to the product of the coefficient of correlation between changes in futures prices and changes in spot prices, and the ratio of standard deviation of changes in futures prices to the standard deviation of changes in spot prices.
55. ________ The slope of the regression line of changes in the spot prices on changes in the futures prices yields the optimal hedge ratio.
56. ________ A hedger has to roll the hedge forward in case the horizon of hedging extends beyond the delivery dates of all the futures available at the time of hedging.
57. ________ The co-efficient of correlation between changes in spot prices and changes in futures prices gives the optimal hedge ratio.
58. ________ If X and Y represent the changes in futures price and changes in spot price respectively, the two parameters of the regression equation are obtained as here:

$$\beta = r(\sigma_Y/\sigma_X) \text{ and } \alpha = \overline{X} - \beta\overline{Y}$$

59. ________ The financial forward and futures contracts are priced on the basis of the cost of carry model.
60. ________ The basic cost of carry pricing model stipulates that the forward or futures price, defined as the value of one unit of the asset underlying the contract, is equal to the sum of the spot price and the carrying costs incurred by buying and holding on to the deliverable asset, *less* the carry return, if any.
61. ________ The computation of forward prices is based on the concept of continuous compounding.
62. ________ For a given rate of interest per annum, higher the periodicity of compounding, greater will the final amount be.
63. ________ The theoretical valuation of financial contracts is done by assuming, mainly, that there are no transaction costs and taxes, perfect markets exist, and the assets are not divisible.

64. ________ *Short selling* is selling of securities not owned by an investor and buying them back at a later date.
65. ________ An investor who sells the shares short must pay to his broker any income that would normally be received on securities shorted, to be transferred to the account of client from whom securities were borrowed.
66. ________ For a security providing a known cash income, the price of a forward contract, $F = (S_0 + I)e^{rt}$, I being the present value of the amount of income.
67. ________ While futures prices are nearly the same as the forward prices (of comparable contracts), it can be shown that the two coincide when the market is perfect and interest rates remain unchanged.
68. ________ If movements in futures prices are positively correlated with the interest rates, then the forward prices are likely to be higher than the futures prices.
69. ________ The valuation of non-carry commodity futures needs information about convenience return.
70. ________ For a given commodity, convenience return is likely to be different for different investors.

EXERCISES

1. "Forward contracts are zero-sum games." Explain. Also give the difference between the delivery price and the forward price.
2. Discuss various characteristic features of futures contracts. What is the role of clearing corporations in trading of such contracts?
3. Bring out the differences between forward and futures contracts.
4. Explain the need and operation of margins in relation to the futures contracts, explaining the concept of marking to the market in this context.
5. Define "basis". When do you expect basis to be (i) positive? (ii) negative?
6. Discuss the normal backwardation hypothesis, contango and the expectation principle in relation to the expected basis.

7. How are financial futures different from commodity futures? Give some examples of financial futures.
8. Discuss the pricing of forward contracts including the assumptions you might make.
9. Establish the equivalence between the interest rates when compounding is (i) discrete, and (ii) continuous.
10. How is the pricing of commodity futures different from pricing of financial futures?
11. Discuss the meaning of the "cost to carry" and "convenience yield", and establish the relationship between the futures price, the spot price, the cost of carry and the convenience yield.
12. What can you say about the relationship between the prices of forward and futures contracts?
13. What is basis risk? How is it related to hedging?
14. What do you understand by optimal hedge ratio? How can it be determined?
15. A bond offers an interest rate of 15 percent per annum, compounded half-yearly. Obtain the equivalent rate with (i) an annual compounding, and (ii) continuous compounding.
16. A company offers an interest rate of 20 percent per annum on its debentures and offers to redeem them after 4 years along with an interest of Rs 107.36 for every Rs 100 deposited. Calculate the continuously compounded risk-free rate of interest.
17. The fixed deposit scheme of a company promises to double the amount in 5 years. What is the rate of return per annum when compounding is (i) annual, (ii) continuous?
18. An investor receives a sum of Rs 1200 in one year's time for an investment of Rs 1000 now. Calculate the percentage annual return with
    (a) annual compounding
    (b) half-yearly compounding
    (c) monthly compounding
    (d) continuous compounding
19. Using the following data, prepare the margin account of the investor. Assume that if a margin call is made at any time, the investor would deposit the amount called for.

    Position : Short

Contract size	:	500 units
Unit price	:	Rs 22
No. of contracts	:	8
Initial margin	:	12 percent
Maintenance margin	:	3/4ths of initial margin
Date of contract	:	June 3
Closing prices	:	

Date	:	Jun 4	Jun 5	Jun 6	Jun 7	Jun 10	Jun 11	Jun 12
Price (Rs)	:	22.30	23.10	22.90	23.00	23.15	22.85	22.95

20. On a non-dividend paying share, a 4-month forward contract is entered into, when it is selling at Rs 72. If the risk-free rate of interest with continuous compounding is 12 per cent per annum, what would the forward price be?

21. Calculate the forward price on a 6-month contract on a share, expected to pay no dividend during the period, which is available at Rs 75, given that the risk-free rate of interest be 8% per annum compounded continuously.

22. A forward contract on a share that is selling at Rs 92, is entered into at a price of Rs 96.50. The contract has a maturity of 3-months. Determine the continuously compounded risk-free rate of interest implied in this contract.

23. Calculate the price of a forward contract using the following data:

Price of the share	:	Rs 75
Time to expiration	:	9 months
Dividend expected	:	Rs 2.20 per share
Time to dividend	:	4 months
Continuously compounded risk-free rate of return	:	12% per annum

24. The regression of changes in the spot values on the changes in the futures values yields the equation $Y = 3.760 + 1.25X$. Obtain the optimal hedge ratio from this information.

25. Let changes in the spot values are represented by Y and changes in the futures values by X. From a given set of calculations, it is found that

Mean of X	= 1.5425
Mean of Y	= 0.2345
Standard deviation of X	= 0.680

Standard deviation of Y	$= 0.825$
Coefficient of	
Correlation between X and Y	$= 0.85$

Obtain the regression equation from these data and determine the optimal hedge ratio.

CHAPTER 3

Futures on Stock Indices and Individual Stocks

In Chapter 2, we have discussed the nature and characteristic features of futures contracts. As indicated earlier, the beginning of futures contracts was made with agricultural commodities. Later, the markets for futures contracts widened extensively to cover a large variety of industrial commodities and precious metals. Subsequently, the introduction of financial futures transformed the futures markets, the world over. Today, they represent the fastest growing segment of the market. Of the financial futures contracts, the key contracts are stock index futures and futures on individual stocks. In this chapter, we consider these, in turn.

STOCK INDEX FUTURES

Stock index futures were introduced in the U.S.A. in 1982 with the Commodity Futures Trading Commission (CFTC) approving the Kansas Board of Trade (KCBT) proposal. Interestingly, the approval came only $4\frac{1}{2}$ years after application. This resulted in the beginning of trading in the Kansas City Value Line Index futures. After this, stock index futures contracts started on other indices at a number of exchanges—both inside and outside the U.S.A. In India, the beginning of the financial futures was made with the introduction of stock index futures by the National Stock Exchange of India Limited (NSE) and The Stock Exchange, Mumbai, in June 2000.

A distinct and peculiar characteristic of the stock index futures contracts is the nature of the underlying asset—the stock index that traders promise to buy and deliver. One can easily visualise that the commodities like wheat, cotton, rice, or metals like gold and silver may be held and delivered, but it is not clear how someone can "buy" or "sell" a stock index like the Sensex! A stock index is just a mathematical formula used for measuring stock price changes. It is interesting to see how it can be traded as well.

The futures market in India has opened up with the introduction of stock index futures. To understand these, as a first step, let us get an idea of the index numbers, see how equity index numbers are constructed and then have a brief account of the major indices available on the Indian capital market scene.

Index Construction

For a proper understanding about the futures on indices, it is necessary to have an idea about the stock indicies. An index number is a statistical tool by which relative changes in some variable or a group of variables are measured and expressed, usually, in the percentage form. To illustrate, if a share closes at a price of Rs 50 on one day and at Rs 52 the next day, then it has registered an increase of 4 percent (Rs 2 on Rs 50) in a day. We can express this information like this: if the closing price of the share on the first day is 100, then the next day's price would be quoted at 104. Here day 1 is the *base period* and day 2 is the *current period*. For day 2, the price index is stated to be 104. The index for the base period is usually taken to be 100. To continue with the example, if the price of the share quotes at Rs 47 on the third day, the index for the day would be 94 since price of day 3 in relation to the price of the day 1 is $(47/50) \times 100 = 94$.

The idea of price index can be extended to a group of shares as well. But when multiple shares are involved, their prices are usually considered along with their respective numbers outstanding (which serve as the *weights* of those shares so that each scrip will influence the index in proportion to its respective market importance). For this a certain *base period*, normally a year (or may be a certain day of a year), is chosen in the first instance and the average market value of the shares of those companies for this base period is obtained. Similarly, the current market value for each scrip is obtained by multiplying the price of the share by the number of shares outstanding. The index on a given day is calculated as the percentage of the aggregate market value of the same set of companies, as are included in the base period calculation.

An index number obtained in such a manner has the flexibility to adjust for the price changes caused by several corporate actions like bonus issues, rights issues etc. For example, when a company issues bonus shares, the new weighing factor would be the number of equity shares outstanding after the bonus issue has been made. This new weighing factor would be used while computing the index from the date when the change becomes effective. Similarly, when a company makes a rights issue, its weighing factor will be increased by the number of additional shares issued. A proportionate change is then effected in the base year average. This is done as follows:

$$\text{New Base Year Average} = \text{Old Base Year Average} \times \frac{\text{New Market Value}}{\text{Old Market Value}}$$

To illustrate, suppose a company makes a rights issue which increases the market value of the shares of that company by, say Rs 50 crores. The existing Base Year Average, suppose, is Rs 2680 crores and the aggregate market value of all the shares included in the index before the rights issue is made is, say, Rs 5264 crores. The New Base Year Average would then be obtained as follows:

$$\text{New Base Year Average} = \frac{2680 \times (5264 + 50)}{5264}$$
$$= \text{Rs } 2705.45 \text{ crores}$$

This revised base year average of Rs 2705.46 would be used for calculating the index number until a next revision is necessitated.

The weighing factors need to be revised also when new shares are issued by a company upon conversion of debentures or loans into equity by financial institutions or consequent upon mergers. Base Year Average also needs to be suitably adjusted when convertible bonds/debentures, preference shares etc. are issued as rights to the equity shareholders. Such an adjustment is done on the basis of the ex-right price of the equity shares.

The methodology discussed here is used for most of the popularly used indices including Standard and Poor's, Dow Jones Index, NYSE Composite Index, FT-SE100 Index, TOPIX, Hang-Sang Index. In India as well, the calculation of indices follows similarly.

Major Indices in the Indian Capital Market

An account of the major indices in the capital market in India is given here.

(i) BSE Sensitive Index Number of Equity Prices, BSE-30: SENSEX

This is the most widely used and accepted equity price index in the country. With the base year to be 1978-79, it comprises of 30 scrips from the specified and non-specified categories of listed companies on The Stock Exchange, Mumbai. Popularly known as *sensex*, the index has been serving in a large measure, the purpose of quantifying the price movements as also the sensitivity of the market in an effective manner. The compilation of the index values is based on the weighted aggregative method. The sensex is calculated every minute and displayed continuously during trading hours.

(ii) BSE National Index of Equity Prices

After the introduction of sensex in January 1986, another index was launched in January 1989 in the form of BSE National Index of Equity Prices with the base year as 1983-84, comprising of 100 scrips from the specified and non-specified categories of listed companies on the country's five major Stock Exchanges at Mumbai, Kolkata, Delhi, Ahmedabad and Chennai. In addition to being a relatively broad-based index, this index enabled the assessment of stock price movements on a national level. However, since October 1996, the prices of The Stock Exchange, Mumbai, only are taken in to account for calculation of the index, which is now designated as the BSE Index.

(iii) BSE-200 and the Dollex

With the number of companies listed on The Stock Exchange, Mumbai having registered phenomenal growth from 992 in the year 1980 to about 3200 by the end of March 1994 and their combined market capitalization having grown from Rs 5421 crores to Rs 368,070 crores during the period, need was felt to have a more broad-based index which could reflect price changes in a sufficient manner. Accordingly, a new index series was introduced in May 1994 with the title **BSE-200**. Also introduced was the dollar-linked version of the BSE 200 the **Dollex**, where the formula for calculating BSE 200 is adjusted for movement of rupee-dollar conversion rates.

For construction of this index, equity shares of 200 companies, selected on the basis of their market capitalization and other factors from the specified and non-specified categories of listed companies on The Stock Exchange, Mumbai, are included. The index is constructed taking the year 1989-90 as the base. The index is constructed on the weighted aggregative basis, with the number of equity shares outstanding as weights. On a given day, the index is calculated as the percentage of the aggregate market value of the equity shares of all the companies (in the sample) on that day to the average market value of those companies during the base period.

It was conceived as the "new broad-based index series reflecting the present market trends in a more effective manner and providing a better representation of the increased equity stocks, market capitalization as also the newly emerged industry groups". It was also intended that *an index based futures contract can be built around this index in due course of time.*

(**Source:** *Launching of the BSE-200 and The Dollex* by Dr. C. Rangarajan)

(iv) BSE 500

The BSE 500 Index is a broad-based index comprising of 500 scrips chosen from among top 750 companies listed on The Stock Exchange, Mumbai, in terms of market capitalization. The index is very broad-based covering all the 23 major industries and 102 sub-sectors of the economy. The index has the base date fixed at February 01, 1999 and has the base value set at 1000.

(v) NSE-50: S&P CNX NIFTY

The NSE-50 index was launched by the National Stock Exchange of India Limited, taking as base the closing prices of November 3, 1995 when one year of operations of its Capital Market segment were completed. It was subsequently renamed S&P CNX Nifty—with S&P indicating endorsement of the index by Standard and Poor's and *CNX* standing for CRISIL NSE Index. According to the NSE, the index was introduced with the objectives of

(i) reflecting market movement more accurately,

(ii) providing fund managers with a tool for measuring portfolio returns *via-a-vis* market returns, and

(iii) providing *a basis for introducing index-based derivatives.*

The index is based on the prices of the shares of 50 companies (chosen from among the companies traded on the NSE), each with a market capitalization of at least Rs 500 crores and having high degree of liquidity. The methodology used for the computation of this index is market capitalization weighted as followed by the S&P-500. The base value of the index has been set at 1000.

The index allows for the corporate actions like stock splits, rights issues etc. without affecting its value. For this, the base capitalization value is adjusted to maintain the index at a level prior to such corporate action announcement. The adjustment to base capitalization value is as follows:

New Base Capitalization = Old Base Capitalization

$$\left[\text{Changed Issue Size} \times \text{Issue Price} \times \frac{\text{Initial Index Value}}{\text{Previous Closing Index}}\right]$$

Alongwith, another index called **S&P CNX Defty** is calculated, which is the dollar equivalent of S&P CNX Nifty. Both the indices are calculated and displayed in real time.

On the hedging effectiveness of the index, a publication of the NSE states that "Exhaustive calculations have been carried out to determine the hedging effectiveness of the 50-security index against numerous randomly chosen equally-weighted portfolios of different sizes varying from 1 to 100 of smallcap, midcap and largecap companies as well as many industry indices/sub-indices provided by CMIE. It was observed that R^2 for various portfolios and indices using monthly returns data on the NSE-50 *vis-a-vis* other indices was significantly higher, indicating that the NSE-50 had higher hedging effectiveness."

(vi) NSE Midcap Index: CNX NIFTY Junior

While S&P CNX Nifty index includes highly liquid companies with a market capitalization of more than Rs 5 billion, the S&P Nifty Junior includes companies which are highly liquid, have a market capitalization of at least Rs 2 billion and which are other than those included in the S&P CNX Nifty index set. It was introduced on January 1, 1997, with a base date as November 4, 1996 and base value as 1000. The securities included in this index, like in case of S&P CNX Nifty, are those having high liquidity in terms of both: trading frequency and low impact cost. The S&P CNX Nifty Junior index is intended to be a representative bench-mark to measure the performance of stocks in the medium capitalization range.

In addition to the above discussed index numbers, there are a host of other indices. But they are used only locally or are not seen to reflect changes in the economy to the extent the stated indices do.

Sample Stock Index Futures Contracts

A typical stock index futures contract specifies the underlying index, the contract size or the amount and value of the asset (the index), the daily price movement limits, the tick size and the margins to be maintained. Also, it contains the month in which the contract is going to expire.

Some sample contracts on stock indices are given in the following pages. Box 3.1 contains contract specification in respect of the TOPIX Futures Market, traded on the Tokyo Stock Exchange.

As another example, the specifications of an S&P 500 Composite futures contract are as given in Box 3.2.

It may be noted that every index based futures contract has a "multiplier", which for instance, is 1000 for TOPIX and 500 for S&P500 Composite. This is used for determining the value of a futures contract. For example, the value of a futures contract on TOPIX, when TOPIX index value is 320, would be equal to $320 \times 10000 =$ ¥3.2 million. Similarly, if S&P500 index is 392, the value of a futures contract ton this would be equal to $392 \times 500 =$ \$196,000.

Like in the case of commodities futures, minimum and maximum movements in prices of futures contracts are provided by the exchange. Whenever a change in a TOPIX futures contract takes place, it has to be one full point of TOPIX or ¥10,000, at the minimum. Similarly, depending on the value of the previous day's closing index, the maximum moves in the futures' values are provided for, as given in the schedule containing the contract specifications for Topix futures.

Box 3.1 ***Contract Specification for TOPIX Futures***

Contract	TOPIX (Tokyo Stock Price Index)	
Contract Months	March, June, September, December cycle. (five contract months traded at all times)	
Basic Trading Unit	¥10,000 times TOPIX (decimal fractions of TOPIX discarded)	
Minimum Fluctuation	1 full point of TOPIX	
Value of Minimum Move	¥10,000	
Daily Price Limit	Previous day's closing index	
	less than 2000 up/down	100 points
	2000 – less than 3000	150
	3000 – less than 4000	200
	4000 or more	250
Last Day of Trading	The business day prior to the second Friday of the month. Trading in a new contract month begins on the business day immediately following the last day of trading.	
Settlement Date	3rd business day following the second Friday of the month	
Margin Requirements for Customers	Greater of 15% of transaction value or ¥6 million	
Margin Requirements for Members	10% or more of the first day's closing price of each contract month	
Trading Hours	9 a.m. to 11 a.m. and 12.30 p.m. to 3.10 p.m.	
Trading System	Pure auction through the Computer-assisted Order Routing and Execution System for Futures (CORES-F)	

Source: *Fact Book 1995*, Tokyo Stock Exchange

Box 3.2 ***Contract Specifications for S&P500 Composite Index***

Contract	S&P500 Composite
Exchange	Chicago Mercantile Exchange
Multiplier	500
Delivery Months	March, June, September, December
Tick Size	0.05 = $25
Last Trading Day	Thursday prior to third Friday of Delivery Month

Indian Markets At present, futures contracts are available for trading on two most widely used indices: *Sensex* of The Stock Exchange, Mumbai and *S&P CNX Nifty* of the National Stock Exchange of India. The contract specifications for these are given in Box 3.3 and Box 3.4 respectively.

Box 3.3 ***Contract Specifications for Futures on Sensex***

Item	*Specification*
Security Description	BSX
Underlying Unit	Sensex of The Stock Exchange, Mumbai
Multiplier	50
Price Steps	0.1, Rupee Value is 5 (0.1 × Rs 50)
Price Bands	Not applicable
Trading Cycle	A maximum of three months trading cycle—the near month (one), the next month (two) and the far month (three). New contract is introduced on the next trading day following the expiry of near-month contract.
Last Trading Day	Last Thursday of the expiry month, or the preceding trading day if the last Thursday is a trading holiday.
Settlement	In cash on T+1 basis
Final Settlement Price	Closing value of Sensex of the cash market of the last trading day.
Daily Settlement Price	Closing price of futures contract
Settlement Day	Last trading day

Source: *The Stock Exchange, Mumbai*

Box 3.4 ***Contract Specifications for Futures on S&P CNX Nifty***

Item	*Specification*
Security Description	N FUDITX NIFTY
Underlying Unit	S&P CNX Nifty Index
Contract Size	200 or multiples thereof
Price Steps	Re 0.05
Price Bands	Not applicable
Trading Cycle	A maximum of three month trading cycle—the near month (one), the next month (two) and the far month (three). New contract is introduced on the next trading day following the expiry of near-month contract
Last Trading/Expiration day	The last Thursday of the expiry month, or the preceding trading day if the last Thursday is a trading holiday
Settlement	In cash on T+1 basis
Final Settlement Price	Index closing price of the last trading day.[1]
Daily Settlement Price	Closing price of futures contract
Settlement Day	Last trading day
Trading Hours	9.55 a.m. to 3.30 p.m.
Margins	Upfront initial margin on daily basis

1. On the last day, the futures closing price for each Nifty futures contract is computed by taking the weighted average price for the last half-an-hour's trades.

Source: *NSE Fact Book 2000*

It is evident that the underlying in these contracts are, respectively, Sensex and S&P CNX Nifty indices. The multiplier in case of Sensex contracts is 50 while the S&P CNX Nifty can be bought in multiples of 200 units. To illustrate, if the Sensex is 3500, the notional value of a futures contract would be Rs 175,000 (3500 × Rs 50). Similarly, if the S&P CNX Nifty value is 1040, then one contract would be valued at 1040 × 200 = Rs 208,000. Further, while the minimum price fluctuation in the value of a futures contract is Rs 5 in case of futures on Sensex, with price steps of Re 0.05, the value of each contract on S&P CNX Nifty can fluctuate by multiples of Rs 10 (= 200 × 0.05).

Further, it may be noted that for each of these contracts, the lifetime of every series is three months. At any point in time, three series are open for trading including those expiring in the near month, next month and far month. Accordingly, we have one-month futures, two-month futures and three-month futures available for trading. In each case, the contract matures on the last Thursday of the designated month. On the immediately succeeding trading day, after the maturity day, a new series is introduced. To illustrate, in March 2002, three series, viz. March, April and May, would be available for trading on any day up to 28th March, which is the last Thursday of the month. On Friday, the 29th March, another series with June expiry (3-month contract) would be introduced for trading. As a consequence, the April contracts that were earlier two-month contracts, would become one-month contracts. Similarly, the May contracts would change from three-month to two-month contracts. Thus, unexpired contracts change every time an expired series is replaced by a new three-month series.

It may be mentioned that SEBI has mandated that the minimum value of a contract should be Rs 2 lac. Accordingly, the respective minimum lot sizes (multipliers of the two contracts) have been established. Further, since an index cannot be delivered, an index futures contract is always cash-settled. This implies that there is no physical delivery of the underlying securities and only the difference between the contract value and the closing index value (on the day of contract expiry) is settled.

VALUATION OF STOCK INDEX FUTURES

A stock index traces the changes in the value of a hypothetical portfolio of stocks. The value of a futures contract on a stock index may be obtained by using the cost of carry model. For such contracts, the spot price is the "spot index value", the carry cost represents the interest on the value of stock underlying the index, while the "carry return" is the value of the dividends receivable between the day of valuation and the delivery date. Accordingly, indices are thought of as securities that pay dividends, and the futures contracts valued accordingly. As discussed in Chapter 2, the valuation of stock index futures may be done as follows:

Case 1 *When the securities included in the index are not expected to pay any dividends during the life of the contract*: Here we have,

$$F = S_0 e^{rt}$$

where F is the value of futures contract, S_0 is the spot value of index, r is the continuously compounded risk-free rate of return, and t is the time to maturity (in years).

Example 3.1

Calculate the value of a futures contract using the following data:

Spot value of index = 3090

Time to expiration = 76 days

Contract multiplier = 100

Risk-free rate of return = 8% p.a.

From the given information, we have

Spot value, $S_0 = 3090$

Time to expiration = 76/365 year

Continuously compounded rate of return = ln (1.08)
= 0.077

Accordingly,

$$F = S_0 e^{rt}$$
$$= 3090\ e^{(76/365)\ (0.077)}$$
$$= 3090 \times 1.01615$$
$$= 3139.92$$

Thus, the value of a contract = 3139.92 × 100 = Rs 3,13,992.

Case 2 *When dividend is expected to be paid by one or more of the securities included in the index during the life of the contract*: In the event of dividends expected to be paid on some securities, the dividend amount is discounted to present value terms and then the rule of pricing securities with known income is applied. Thus,

$$F = (S_0 - I)e^{rt}$$

where I is the discounted value of the dividend and other symbols are same as defined earlier.

The amount of dividend receivable, however, needs a careful consideration, as shown in the example that follows.

Example 3.2

Assume that a market-capitalization weighted index contains only three stocks A, B and C as shown below. The current value of the index is 1056.

Company	*Share Price (Rs)*	*Market Capitalization (Rs crores)*
A	120	12
B	50	30
C	80	24

Calculate the price of a futures contract with expiration in 60 days on this index if it is known that 25 days from today, Company A would pay a dividend of Rs 8 per share. Take the risk-free rate of interest to be 15% per annum. Assume the lot size to be 200 units.

We first convert the given rate of interest equal to 15% p.a. into continuously compounded rate of return as follows:

Continuously compounded risk-free rate of return, $r = \ln(1 + 0.15)$

$$= 0.1398$$

From the given information, it may be seen that Company A constitutes 12/66 of the index, which implies that its value in the index is $(1056 \times 12)/66 = 192$. With a price of Rs 120 per share, $192/120 = 1.60$ shares of A are held for every unit of the index. Accordingly, dividend receivable on 1.60 shares $= 1.60 \times 8 =$ Rs 12.80. The present value of dividend $D =$ Rs 12.80 may be obtained as under:

Present value of dividend, $I = 12.80e^{-(25/365)(0.1398)}$

$$= 12.80 \times 0.9905$$

$$= 12.68$$

Accordingly,

$$F = (S_0 - I)e^{rt}$$

$$= (1056 - 12.68)e^{(0.1398)(60/365)}$$

$$= 1043.32 \times 1.0232$$

$$= 1067.53$$

With a lot size of 200, the value of the contract would be Rs 1067.53 × 200 = Rs 2,13,506.

Case 3 *When dividend on the securities included in the index is assumed to be paid continuously during the life of the contract*: If the dividends may be assumed to be paid continuously, with the dividend yield rate being Y, then the futures price, F, would be given by

$$F = S_0 e^{(r - y)t}$$

Example 3.3

Consider a three-month futures contract on NSE-50. Assume that the spot value of the index is 1090, the continuously compounded risk-free rate of return is 12 per cent per annum, and the continuously compounded yield on shares underlying the NSE-50 index is 4 per cent per annum. Find the value of a futures contract, assuming the multiplier to be 200.

Here, $S_0 = 1090$, $r = 0.12$, $y = 0.04$ and $t = 3/12$ or 0.25.

Accordingly,

$$F = 1090e^{(0.12 - 0.04)(0.25)}$$

$$= 1112.02$$

With a multiplier of 200, the value of futures contract is 200 × 1112.02 = Rs 2,22,404.

A Note on the Spot Value of Index (S_0)

Strictly speaking, S_0 equals the spot index value only if all the shares underlying the index are traded currently. In fact, the reported value of the index is based on the last trade of each component stock and some of these might not have been traded for some time. Thus, the spot index suffers from a lag caused by a non-synchronized trading of its constituent shares and is, hence, stale to an extent.

Divergence of Futures and Spot Index Values: The Basis

As indicated in the previous chapter, the difference between the futures price and the spot price is called the *basis*. With the basis defined this way, it is expected to be positive in case of index futures markets. Thus, in normal times, when the markets are not volatile or headed in a particular direction, the value of futures contracts would quote higher than the spot value of the index. However, it is not always so and the futures value of an index may be quoted lower than the current value. Such a situation illustrates an inverted market. In the normal markets, the futures contracts are sold by investors who buy the index on spot (by buying the underlying shares of the index in the same proportion as their respective weightage in the index) and sell them on a forward basis (in the form of futures contracts) by adding the interest amount (the cost of funds). In an inverted market on the other hand, when the index futures are traded at a discount in relation to the spot, it has the implication that some market players strongly believe that the market would fall, in the future. In such cases they are seen to make a negative call on the market. Thus, selling of index futures at lower than spot value is an extremely bearish sentiment of the trader about the market in the near term, at least.

The Indian index futures market has witnessed basis in both forms, positive and negative. Broadly, since their start and until late February 2001, the index futures were quoting higher than spot values, while for some months following, the futures quoted at discount. For example, on May 21, 2001, the BSE Sensex closed at 3640.10 while the May futures closed at 3589.0. Similarly, the S&P CNX Nifty index on this day closed at 1169.45 and the May-expiration futures at 1146.20. Later on, the futures prices indicated positive cost of carry. For instance, the September 2001 futures on Sensex closed at 2997.8 on 13th September against Sensex closing at 2897.50 on the same day. However, in early December 2001, the futures were again witnessed trading at lower than the spot index values.

Open Interest Like other futures contracts, trading in stock index futures may result in new outstanding positions or offsetting the existing ones. Every transaction in a futures contract by an investor can be viewed as one-half of one contract. Thus, the long and short positions together constitute one contract. Every new long and short position increases the number of outstanding contracts, known as *open interest*, by one. On the other hand, if a position by a trader is opposite to the one held earlier, the open interest would not change, while if a trade results in both the parties taking positions opposite to their respective positions, then the open interest would decline by one. To illustrate, if *A* and *B*, having no earlier positions, take respectively, long and short positions in a contract, the open interest would increase by one; if now *A* takes a short position and *C* takes a long position, the open interest (number of contracts outstanding) would not change and instead, if *A* takes a short position and *B* takes a long position, the open interest would reduce by one, since positions of both the traders are cancelled.

The business dailies report the information on the open interest in various contracts. A high open interest represents an equal number of long and short positions in a contract and is indicative of its liquidity. To illustrate, information about futures contracts on stock indices traded in India is quoted as given in Box 3.5.

Uses of Stock Index Futures

Stock index futures can be used profitably by all market participants including speculators, arbitrageurs and hedgers.

Speculation In a bid to make money, speculators use index futures to take long or short positions. Such positions are taken on the premise that the index would go up or down. If the multiple is 100 (which is used to convert the index into monetary value), then each point of index movement would translate into Rs 100. If a person is bullish and believes that the market would go up in the time to come, he may buy futures and if he is bearish about the market, he may sell futures contracts. He would make money if the market does move as anticipated.

Box 3.5 ***Derivatives Trading Quotations***

DERIVATIVES TRADING

FUTURES

Contracts, (Pr.Cl.) Prices H,L,Cl. [Traded Qty., Value in Rs. Lks, No. of Contracts] open int. Exp. Date

SENSEX FUTURES

Sensex (3288.60) 3412.00, 3284.00, 3327.10 [850, 28, 12, 15] .... 3800 .. 31/01/2002
Sensex (3307.40) 3310.00, 3310.00, 3345.10 [50, 66, 1] .... 800 .. 28/02/2002

Nifty Futures

Nifty (-) 1066.60, 1077.65, 1059.15 [947800, 10128.62, 4739] .... 844800 .. 31/01/2002
Nifty (-) 1065.00, 1077.70, 1060.00 [65200, 69200, 696.22, 326] .... 128400 .. 28/02/2002
Nifty (-) 1068.45, 1075.00, 1062.00 [8400, 89.72, 42] .... 10000 .. 28/03/2002

Source: *The Economic Times*, January 16, 2002

Of course it is not necessary for one to buy futures if the index is likely to rise. Instead of futures, the securities included in the index may be bought and later sold to reap profits. However, it is a costly proposition in terms of the amount of funds required and the transaction costs involved. Not only this, it is very inconvenient because of the necessity of buying and selling a large number of securities simultaneously and in a fixed proportion. Also, an investor might think of acquiring one or more speculative stocks to gain from expected market movements, but this runs the risk of company-specific good/bad news giving him a loss, even in case of movement of the index on predicted lines. It is much more convenient to operate through futures markets as they are much more liquid and therefore, involve much lesser cost and the funds required are just about 10 to 20 percent of those needed in cash market. Thus, significant profits (and losses) can result when speculation is done using futures contracts.

To illustrate, suppose it is the beginning of the month of August. A speculator believes that the stock market will soon improve on the back of sustained economic recovery, but is not quite sure which stocks in particular will rise. He decides, therefore, to take position in a one-month futures contract, say BSXAUG (the futures contract on Sensex of The Stock Exchange, Mumbai, expiring in August), that is currently available at 4480. To take an exposure of Rs 30 lac, he needs to buy 7 contracts of 100 lot size with August maturity.

He decides to take long position in 7 contracts and pays the required margin, say 10% which equals Rs 3,13,600. Now, after two weeks, suppose the contract is trading at 4710. He decides to unwind his position and sell off the contracts. In the process, he makes a profit of $(4710 - 4480) \times 7 \times 100 =$ Rs 1,61,000 *less* the transactions costs of taking two positions in futures. But, again, the transactions costs for entering into futures markets are much lower than in case of securities. It is clear that substantial gains are possible (without risk of default) if underlying index moves in the predicted direction.

Arbitrage Arbitrageurs play a key role in the financial markets. Unlike speculators, they do not take view on prices but they step in as soon as they discover that there is a mismatch between prices. The arbitrageurs thrive on market imperfections and through their actions, they keep the market efficient and well-functioning. It may be mentioned that simultaneous buying and selling the same thing in two markets, like buying and selling of shares of a company in two exchanges to take advantage of price differential in them, is called *arbitrage over space*. On the other hand, attempting to make profits through buying/selling in the spot and futures markets is termed as *arbitrage over time*. In arbitrage over time, an arbitrageur can earn returns by lending money or securities in the market. There is no counter-party risk and the trading technique involves buying/selling in cash and futures markets.

Funds Lending For an arbitrageur willing to employ funds, the methodology involves first buying shares in the cash market and selling index futures. The quantity of shares to be bought is decided on the basis of their weightage in the index and the order is put through the system simultaneously using the program trading method. At the same time, a sell position is taken in the futures market. The position is closed with opposite transactions in cash and futures markets. Similarly, an arbitrageur can earn returns by lending securities in the market. The methodology involves first selling the shares in the cash market and buying index futures, deploying the cash received in some risk-less investment, and finally, buying the same shares and shorting the futures position at the expiration. The quantity of shares to be sold is decided on the basis of their weightage in the index. At the same time, a sell position is taken in the futures market. Here too, the position is closed with opposite transactions in cash and futures markets and the shares are received back.

To illustrate, suppose that on January 2, a futures contract with 29th January expiration is selling at 5145 and the BSE sensex is currently at 5000. Investor *A* wants to lend Rs 5 million to the market and earn this return (of 145/5000 for 28 days). He buys Rs 5 million of BSE sensex on the spot market. He uses program trading and buys 30 stocks underlying the sensex in their appropriate weight (i.e. according to their market capitalization) in one shot. Since all orders are market orders, he suffers an *impact cost* of about 0.2%. The orders are executed for 5010. He receives the delivery of shares. Simultaneously, he sells Rs 5 million worth of futures at 5145, where, because of high liquidity, the impact cost is virtually nil.

On the date of maturity, January 29, he puts market orders to sell his portfolio. Suppose the index is at 5100 and because of impact costs, the sell order goes through at average of 5090. The futures contract also expires at 5100 (because the spot and futures converge and difference becomes zero on last day of the contract). Suppose investor A also pays transaction costs equal to 0.5%.

Impact cost: The concept of impact cost may be understood with the help of an example. Suppose the order book at the trading counter is like this:

Buy Orders		*Sell Orders*	
Buy Price	*No. of Shares*	*Sell Price*	*No. of Shares*
Rs 96	1000	Rs 97	500
Rs 95	2000	Rs 98	1300
Rs 94	1400	Rs 99	1500

The best 'buy' and 'sell' prices here are Rs 96 and Rs 97. Thus, average of these prices = (96 + 97)/2 = Rs 96.5. It is called the *ideal price.* Now suppose that one wishes to buy 2000 shares. From the order book, it is clear that he has to pay $500 \times 97 + 1300 \times 98 + 200 \times 99$ = Rs 195,700 for 2000 shares, thus averaging 195,700/2000 = Rs 97.85 per share. The excess of price paid over ideal price is Rs 97.85 – 96.50 = Rs 1.35, expressed as a percentage of the ideal price works out to be (1.35/96.50) $\times$ 100 = 1.4%. This is impact cost.

The investor gains 2% [(5100 – 5000)/5000] on his buy position in the spot Sensex. He also gains 0.88% [(5145 – 5100)/5145] on the sell position in the futures market. His total gain is 2.88%. He suffers 0.40% impact cost and also pays 0.5% as transaction cost. Accordingly, his total gain works out to be 1.98%. Dividends are ignored here because adjustment for expected dividends is in-built in the difference between spot and futures values. The return for 28 days is handsome here.

However, there are a couple of points to note. First, since there is a time-lag between delivery of shares in the market and receipt of payment for the same from stock exchange, there is an element of opportunity costs involved. Shorter settlement periods are helpful in such a case. Also, if the return works out to be less than risk-free rate of return, then it is not worth lending. Secondly, there may be difficulties in buying/selling if any of the shares included in the index hit circuit filters.

Securities Lending An arbitrageur can earn returns by lending his securities in the market. The methodology involves first selling shares in cash market and buying index futures, deploying the cash received in some risk-free investment, and finally, buying the same shares and settling the futures position at the expiration. The quantity of shares to be sold is decided on the basis of their weightage in the index and order is put through the system using *program trading.* The 'sell' orders suffer some impact cost while futures may be bought for virtually no impact cost. The sold shares are delivered in the market and the money received is invested in risk-free avenues. On the expiration day of futures contracts, the spot and futures prices converge and the difference is zero. Here also, the position is closed with opposite transactions in cash and futures markets and the shares are received back.

To illustrate, suppose an investor with a large portfolio wishes to lend to the market securities worth Rs 5 million and make some money. Currently, the index is at 5000 and the near-month futures are selling at 5030. The investor sells Rs 5 million worth of index on the spot market. Using program trading, he sells the securities underlying the index in the appropriate proportion (i.e. according to their weightage in the index) in one go. Since all orders are market orders, he suffers impact costs of about 0.2%. The orders are executed for 4990. He simultaneously buys Rs 5 million worth of futures at 5030. Because of high liquidity, the impact cost is negligible.

The investor receives the cash for the shares sold and deploys it in risk-free investment yielding a return of, say 2.1% for one month. Now, suppose that at the expiry of the futures contracts, the index is ruling at 5200. The investor puts the buy orders for the securities he had sold. With an impact cost of 0.2%, the order is executed at 5210.4. The futures contracts are settled at 5200 (there being virtually no impact cost, and due to the convergence of futures and spot at the expiration). The investor suffers a loss of 4.42% [(4990 – 5210.4) × 100/4990] on the spot market, gains 3.38% [(5200 – 5030) × 100/5030] and thereby suffers a net loss of 4.42 – 3.38 = 1.54%. Set against the return of 2.1% from the risk-free investment, the net gain to the investor may be seen to be 2.1 – 1.54 = 0.56%. Of course, the gain shall be reduced by an amount of the transactions costs, if any, incurred by the investor.

Strategic Arbitrage An arbitrageur need not hold his positions till the date of maturity. Because of volatility in the markets, the basis (the difference between futures and spot markets) does not remain uniform and keeps on changing. The arbitrageur may keep track of the basis and unwind his position as soon as an appropriate opportunity is seen and take advantage of changes in the basis in short intervals.

We know that an arbitrageur makes profit by taking opposite positions in the spot and futures markets. Now, when the basis becomes larger than the theoretical basis (obtained in terms of the cost of carry model), so that the futures become relatively costlier and/or the spot is relatively cheaper, he sells index futures and buys underlying stocks or spot index. When the basis becomes smaller than theoretical basis, so that the gap between the spot and futures is narrow, making futures relatively cheaper, he may unwind the position in both the markets, making a neat profit. This can possibly be repeated several times a day. This is labelled 'strategic' because this can be achieved without using any funds. However, high transactions costs usually keep the retail investors away from this kind of profit-making by early unwinding.

Hedging Hedging is the prime reason for development of futures contracts. Stock index futures can be effectively used for hedging purposes. They can be used while taking a long or short position on a stock and for portfolio hedging against unfavourable price movements. This subject is discussed in detail below.

HEDGING USING STOCK INDEX FUTURES CONTRACTS

Stock index futures contracts can be used to manage investment exposure and control the risk related to movements in equity market in a well-diversified portfolio of stocks through the use of hedging strategies. However, to understand what is possible to hedge and what is not, we need to understand the concepts of equity risk including some ideas of portfolio theory and Capital Asset Pricing Model (CAPM), and the market versus non-market risk.

We begin with the idea that the stock prices fluctuate because of two sets of factors: Systematic and non-systematic. Systematic factors are those that influence the market as a whole and include such things as interest rates, taxation policies, political conditions, fiscal and monetary policies etc. Non-systematic or company-specific factors are those that are peculiar to a particular company and may relate to technological developments, labour relations, takeover situations etc. When an investor takes a long position in a stock, he believes that it is under-valued and hopes to gain when its price increases. Any appreciation in its value will yield him profits. But his assessment need not be correct. Thus, while taking the long position, he carries the risk of his basic thinking about the stock being wrong. There is another risk he carries, namely the market might move in the unfavourable direction and therefore, the particular stock he bought declines in value. While in the first case he is bound to suffer losses, should his judgement about the stock prove incorrect, he is also prone to suffer losses when the whole market moves in the downward direction for whatever reasons, although his analysis of stock was correct. Similarly, when an investor takes a short position in a stock, in the belief that the stock is overvalued, any decline in the stock price would earn him profits. Here again, the investor runs the twin risks: his analysis and conclusion about the stock being in error and the risk arising from the movement of the entire market in an adverse direction, despite a correct stock pick. To conclude, when an investor takes a long (or short) position in a stock, he also carries a long (or short) position to some extent in the index as well.

The degree of movement in the price of a share of stock with respect to movements in the market, that is, a stock price index, is measured in terms of beta, β. The beta reflects the sensitivity of the movement of a scrip relative to the movement of the index. For its calculations, the returns on security are regressed over the returns on an index and the regression co-efficient β is obtained. Accordingly,

$$\beta = \frac{\text{Covariance (Stock, Index)}}{\text{Variance (Index)}}$$

The covariance and variance are obtained from the returns data of the security and the index. If X and Y be the returns on index and return on stock respectively, we have

$$\text{Covariance} = \frac{\Sigma(X - \overline{X})(Y - \overline{Y})}{n}$$

$$\text{Variance}(X) = \frac{\Sigma(X - \overline{X})^2}{n}$$

in which $\overline{X}$ is the mean value of X series and $\overline{Y}$ is the mean value of the Y series.

Alternatively,

$$\beta = \frac{\Sigma XY - n\overline{X}\,\overline{Y}}{\Sigma X^2 - n\overline{X}^2}$$

The returns on the security and the returns on the market portfolio are calculated as follows. For the security, the return is usually calculated as $(P_t - P_{t-1})/P_{t-1}$, where P_t is the current day's closing price while P_{t-1} is the closing price of the previous day. The return on market portfolio is taken as the return on share price index. The return on index is calculated in the same way as return on the security. This is equal to $(I_t - I_{t-1})/I_{t-1}$. Each of these may be expressed as percentages as well.

The calculation of beta is shown in the following example.

Example 3.4

For a given share, the prices are observed for 13 days and are recorded below along with the index values on those days.

You are required to regress the returns on the share on the returns on the index. What does the beta, the regression coefficient, indicate?

Day	*Share Price Index*	*Price of Share*	*Day*	*Share Price Index*	*Price of Share*
1	1376.15	818.35	8	1447.55	792.30
2	1388.75	811.75	9	1439.70	778.30
3	1408.85	819.85	10	1427.65	740.95
4	1418.00	836.05	11	1398.25	718.35
5	1442.85	815.65	12	1401.40	737.50
6	1445.15	804.30	13	1419.70	735.55
7	1438.65	801.30			

The returns on the index and the security are given in the first two columns of the Table 3.1, headed X and Y respectively. The values of X and Y are calculated as follows:

$$(1388.75 - 1376.15)/1376.15 = 0.009156 \text{ or } 0.9156 \text{ percent}$$

$$(1408.85 - 1388.75)/1388.75 = 0.014473 \text{ or } 1.4473 \text{ percent etc.}$$

$$(811.75 - 818.35)/818.35 = -\,0.008065 \text{ or } -\,0.8065 \text{ percent}$$

$$(819.85 - 811.75)/811.75 = 0.009978 \text{ or } 0.9978 \text{ percent etc.}$$

Note that the values of X and Y are given in percentages.

The mean values of X and Y series are:

$$\overline{X} = \frac{3.1857}{12} = 0.2655$$

$$\overline{Y} = \frac{-10.3751}{12} = -\,0.8646$$

Table 3.1 *Calculation of Share Beta*

Day	*Index*	*Share Price*	*Index Returns X*	*Share Returns Y*	*XY*	*X^2*
1	1376.15	818.35				
2	1388.75	811.75	0.9156	– 0.8065	– 0.738430	0.838319
3	1408.85	819.85	1.4473	0.9978	1.444224	2.094807
4	1418.00	836.05	0.6495	1.9760	1.283326	0.421806
5	1442.85	815.65	1.7525	– 2.4400	– 4.276102	3.071145
6	1445.15	804.30	0.1594	– 1.3915	– 0.221819	0.025411
7	1438.65	801.30	– 0.4498	– 0.3730	0.167766	0.202302
8	1447.55	792.30	0.6186	– 1.1232	– 0.694836	0.382710
9	1439.70	778.30	– 0.5423	– 1.7670	0.958240	0.294085
10	1427.65	740.95	– 0.8370	– 4.7989	4.016600	0.700535
11	1398.25	718.35	– 2.0593	–- 3.0501	6.281236	4.240833
12	1401.40	737.50	0.2253	2.6658	0.600563	0.050752
13	1419.70	735.55	1.3058	– 0.2644	– 0.345272	1.705210
		Total	3.1857	– 10.3751	8.475496	14.027915

$$\beta = \frac{\Sigma XY - n\bar{X}\bar{Y}}{\Sigma X^2 - n\bar{X}^2}$$

$$\beta = \frac{8.475496 - 12 \times 0.2655 \times (-0.8646)^2}{14.027915 - 12 \times 0.2655^2}$$

$$= 0.8519$$

Interpretation of Beta of a Security By definition, the bench-mark, the index beta, is equal to 1.0. If a stock has $\beta > 1$, it is riskier than the market. To be precise, if $\beta = 1.25$ for a given stock then it implies that if the market increases by 10 percent, its value will increase by 12.5 percent, while if the market falls by 10 percent, the value of the stock would fall by 12.5 percent. On the other hand, if a stock has $\beta = 0.92$, then a 1 percent rise in the stock price index would lead to 0.92 percent rise in the stock value and a one percent fall in the index value would imply a 0.92 percent fall in the stock value. The regression coefficient 0.8519 calculated in the example above can be similarly interpreted. Further, a stock with $\beta = 1$ obviously moves "with the market". High beta shares are, naturally, preferable in the bullish markets while low beta shares are "safe" securities—advantageous in times of bearish market conditions.

The beta values for the stocks included in the Sensex for the period June, 2000 to May 2001 are shown in Box 3.6.

Box 3.6 ***Beta Values for the Sensex Securities***

S. No.	*Security*	*Beta*	*S. No.*	*Security*	*Beta*
1.	ACC	1.13	16.	INFOSYS TECH	1.78
2.	BAJAJ AUTO	0.32	17.	ITC LTD	0.54
3.	BHEL	1.08	18.	LARSEN & TOU	1.07
4.	BSES LTD	0.79	19.	MAH & MAH	1.02
5.	CASTROL IND	0.52	20.	MAHANGR TELE	0.95
6.	CIPLA LTD	0.73	21.	NESTLE LTD	0.34
7.	COLGATE	0.32	22.	NIIT LTD	1.59
8.	DR. REDDY'S LAB	0.65	23.	RANBAXY LAB	0.80
9.	GALAXO (I) LTD	0.55	24.	REL PETROL	0.94
10.	GRASIM IND	0.88	25.	RELIANCE	0.88
11.	GUJ AMB CEMENT	0.60	26.	SATYAM COMP	2.39
12.	HIND LEVERL	0.61	27.	STATE BANK	0.85
13.	HIND PETROL	0.63	28.	TATA ENGG	1.06
14.	HINDALCO	0.31	29.	TATA STEEL	1.15
15.	ICICI LTD	0.97	30.	ZEE TELEFILM	2.18

Source: *The Stock Exchange, Mumbai*

In terms of the discussion in the preceding paragraphs, we may restate the ideas in a more formal way as follows. The total risk of a stock, which is usually measured by the variance (or standard deviation) of the distribution of its returns, can be divided into two components: systematic risk and non-systematic risk. The systematic risk is also called the *market risk,* and it results from the systematic factors while the non-systematic risk or specific risk stems from factors peculiar to a company or industry. The two components of risk may be described as follows.

Consider the market model:

$$k_j = \alpha_j + \beta_j \, k_m + e_j$$

It states that the returns on security j are a linear function of the returns on the market portfolio (which may be, for example, SENSEX, NSE-50 etc.). The e_j is the 'error term' and is the deviation of a return from its predicted value. We may restate the above equation as follows:

$$e_j = k_j - [\hat{\alpha} + \hat{\beta} k_m]$$

The term in the brackets gives the estimated or predicted value by using the estimated regression coefficients $\hat{\alpha}$ and $\hat{\beta}$, and a given value of the market return. The error term is caused by the firm *j*'s non-systematic risk. Further, β (beta) here is a measure of the sensitivity to market movements so that the greater the beta of a security, the more sensitive would it be any market moves. The CAPM lays that the investors expect to earn greater returns as beta increases, as it is stipulated that

$$\text{(Expected)} k_j = k_f + [\text{(Expected)}\ k_m - k_f]\ \beta_j$$

In words, it means that the expected return on an investment in a security equals the risk-free rate (k_f) *plus* beta times the excess of expected return on market portfolio over the risk-free rate.

Now, to see that total risk is composed of systematic and non-systematic risk, we take the variances of both sides of the market model equation given earlier, to get

$$\text{var}\ (k_j) = \text{var}\ (\alpha_j + \beta_j k_m + e_j)$$

or, $$\text{var}\ (k_j) = \beta_j^2\ \text{var}\ (k_m) + \text{var}\ (e_j) + 2\beta_j\ \text{cov}\ (k_m, e_j)$$

(because α and β are constants while k_j, k_m and e_j are random variables)

If the covariance of market returns and error terms is zero, then we have

$$\text{var}\ (k_j) = \beta_j^2\ \text{var}\ (k_m) \qquad + \qquad \text{var}\ (e_j)$$

Total Risk = Systematic or Market Risk *plus* Non-systematic or Non-market Risk

Given the beta of a security, the variance of its returns, and the variance of the market returns, we can split the total risk into systematic and unsystematic components.

Need of Hedging and the Hedging Process

Before proceeding further, let us understand why at all hedging may be needed. Hedging can as much be the need of an investor holding one or more stocks, as of a mutual fund. Consider a portfolio manager who has a portfolio of Rs 100 crores held primarily in equity shares. Suppose that he anticipates a decline in the market in the near future. To avoid writing a low portfolio value, he might decide to sell the securities of the portfolio and again invest when the prices fall, thereby protecting his gains. However, it would be very expensive in terms of the commissions, taxes and other costs involved in such a big deal. The alternative is provided by the stock index futures contracts—taking an offsetting position in them. Thus, long position in the stock market would be accompanied by short position in the futures markets. Calculations need to be done to determine the number of contracts to counteract the likely changes in the portfolio value.

Before we consider how stock index futures can be used for hedging purposes, it should be noted that the use of index futures controls only the market risk component of the total risk and not the non-market, or unsystematic, risk. Thus, a cent percent protection should not be expected from such hedging. Another thing to be kept in mind is that hedging is not intended to make profit but rather only as a protection against adverse price movements. Any 'overhedging' (by taking a position bigger than is warranted) implies that the investor is engaging in speculation.

Example 3.5

Suppose that the variance of daily returns of a security with $\beta = 1.2$, is 8.2. Further, the standard deviation of daily returns of an index is 1.7. Calculate the magnitude of risk reduction which a complete hedging will achieve and the risk faced by the investor with hedging.

Here, Total risk, var $(k_j) = 8.2$

Market risk, β_j^2 var $(k_j) = (1.2)^2\ (1.7)^2 = 4.1616$

Thus, risk reduction by hedging = 4.1616, and risk faced by investor, non-market risk = 8.2 – 4.1616 = 4.0384.

We first consider hedging through stock index futures as a long position risk management tool. It is followed by use of stock index futures in relation to portfolio management. In this context, we consider how such futures can be used for adjusting the beta of a portfolio, and then a complete hedge of the portfolio.

Long Position Risk Management

An investor takes a long position in a stock in the expectation that it is undervalued and likely to appreciate. In taking this position, he carries not only the risk of his estimate of the stock being wrong but also he faces the risk of the market moving against his thinking. He can hedge against this latter risk by taking a short position in stock index futures contracts. If the index does fall, he loses the value of the stock held but he gains on the position taken in futures. To determine the value of futures contracts to take position in, the beta of the stock in question is required. Thus, if the stock beta is 1.3, then for hedging a long position of Rs 20 lac worth of shares, one has to take a short position in futures to the extent of Rs 20 lac $\times$ 1.3 = Rs 26 lac. Similarly, a short position in futures for Rs 16 lac is needed for covering a Rs 20 lac long position in a stock with beta equal to 0.8.

To illustrate the risk management in case of long position on stock, assume that an investor buys 2000 shares of a company at a price of Rs 500 per share on September 14, on analysis of company future prospects. On this day, the stock price index, say Sensex, is ruling at 4480. Three weeks after he buys shares, on October 4, the company declares half-yearly results which cause the share price to rise to a level of Rs 534. But almost at the same time he fears that due to a decision of the OPEC members, the oil prices are likely to increase sharply, causing hardships to the world economies. The stock markets are likely to be adversely affected by their action.

To hedge against the likely fall in the index, he needs to take a short position in index futures. The portfolio value on October being 534 $\times$ 2000 = Rs 10,68,000 for which protection is required. The investor learns that the analysis of the last three months' data reveals that this stock price, when regressed over Sensex, has beta equal to 1.2. Accordingly, the short position required for covering Rs 10,68,000 portfolio is worth Rs 10,68,000 $\times$ 1.2 = Rs 12,81,600. Assuming the October futures is trading at 4520, he would short 1281600/4520 = 283.5 or 300 (assuming the market lot is 100) contracts. At the maturity of the October futures if the index closes at, say 4130 and the price of the share in question be, say Rs 478, then the position may be analysed as follows:

Loss in the value of portfolio (534 – 478) $\times$ 2000 = Rs 112,000

Gain in futures contracts: (4520 – 4130) $\times$ 300 = Rs 117,000

Thus, the investor make a marginal gain of Rs 5000 on the deal. It will be reduced, of course, by the amount of transactions costs incurred by him.

It may be noted that the hedge is available to the investor only until the maturity of the futures contracts and not afterwards. In case he still fears a further decline in the market prices, he needs to take a fresh position. In the first instance, if the investor had a feeling that changes might take place lasting the next two months, he would do well to take position in 2-month futures.

Short Position Risk Management

Investors take short positions in individual stocks when they think that the stocks are overvalued and that decline in them will give them profits. However, while taking a short position in a stock, an investor also carries the risk of his basic thinking about the stock being incorrect and the risk of the market moving against his prediction. This risk of market increase can be sorted out by simply buying some amount of index futures. In this way, he hedges his index movement risk and minimises his total risk.

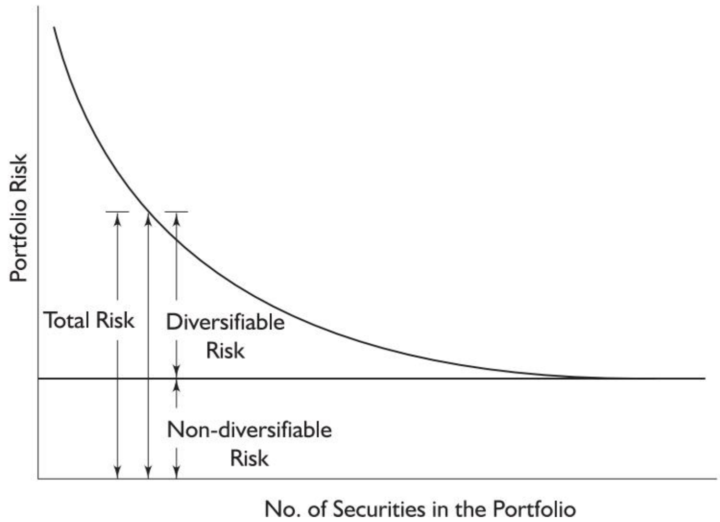
To illustrate, suppose that an investor is short 1000 shares at Rs 690 and the beta of the stock is 0.9, then the investor should hedge by taking a long position in the near-month stock index futures for $690 \times 1000 \times 0.9 =$ Rs 621,000. If the one-month index contracts are trading at 3620, then the investor would sell $621000/3620 = 171.5$ or 200 contracts (if the market lot is 100 contracts). By the expiry of this contract, suppose the market recovers and the index becomes 4280 and the price of the underlying share becomes Rs 761. In this case, the investor's position can be analysed as follows:

Loss on position in share: $(761 - 690) \times 1000 =$ Rs 71,000

Gain on futures contracts: $(4280 - 3620) \times 200 =$ Rs 66,000

Thus, the investor is immunised against market movements by taking position in index futures.

Portfolio Risk and Portfolio Beta Like for an individual security, the total risk of a portfolio of securities can also be decomposed as systematic risk and non-systematic risk. The total risk is a function of the number of securities in a portfolio. Non-systematic risk is diversifiable in nature so that it can be reduced in a portfolio by increasing the breadth (that is to say, by increasing the number of securities) of the portfolio. In fact, a principal result of the capital market theory is the fact that the investors are not rewarded for bearing unsystematic risk. The market assumes that the investor has reduced the risk through diversification as much as possible, for a given level of expected return. On the other hand, the systematic risk is not diversifiable by adding securities to the portfolio. As depicted in Figure 3.1, the total risk declines with an increase in the number of securities in the portfolio until it reaches a limit, beyond which it does not decline.



➢ **Fig. 3.1** *Portfolio Risk*

We shall see shortly that *the systematic risk can be reduced in a portfolio by hedging with index products.*

It has been said earlier that beta of a security measures its sensitivity to market movements. Specifically, it means, for example, that a security with a beta of 1.5 will, on an average, move 1.5 times, or 1.5 percent for each 1 percent move in the market. Similarly, a beta of 1 would indicate a stock that fluctuates in line with the underlying market, while a beta factor of 0.75 would indicate a stock which fluctuates 0.75 percent for every 1 percent market move. (The beta factors of various equities are obtainable from leading data bases.)

Using beta factors of equities consisting a portfolio, it is possible to work out a weighted arithmetic mean beta factor for the portfolio itself. In symbols,

$$\beta_p = w_1\beta_1 + w_2\beta_2 + \cdots + w_n\beta_n$$

wherein $w_1, w_2, \cdots w_n$ is the fraction of total investment placed in the respective securities, and $\beta_1, \beta_2, \cdots \beta_n$ are their corresponding beta factors.

Example 3.6

A portfolio manager owns three securities, as detailed below:

Security	*No. of Shares*	*Price per Share (Rs)*	*Beta*
1	15,000	40	1.2
2	25,000	20	1.8
3	15,000	60	0.8

The beta value for this portfolio can be obtained as shown in Table 3.2.

Table 3.2

Calculation of Portfolio Beta

Security	*Value (in lacs of Rs)*	*Weight* (w_i)	β_i	$\beta_i w_i$
1	6	6/20 = 0.30	1.2	0.36
2	5	5/20 = 0.25	1.8	0.45
3	9	9/20 = 0.45	0.8	0.36
Total	20			1.17

The value for each security is the product of the number of shares and the price per share. The weightage of each security is obtained by dividing its value by the total value of the portfolio. The summation of the products of the beta values and the weightage of the securities works out to be 1.17, which is the beta value of the given portfolio.

Obviously, if the portfolio beta is greater than 1, as in this case, then in a rising market, the portfolio would rise faster than the market and, so, expectedly outperform the market. On the other hand, a portfolio with a low beta will not lose as much value as the market average and the losses will be considerably lower than for a portfolio with a high beta. It is thus possible to tune the beta of a portfolio either when a greater perfect hedge is sought or an improvement in performance is considered when a strong market view is perceived. Naturally, risky portfolios fluctuate more than the market average and thus need a greater hedge, while low-beta portfolios, being conservative, need a smaller hedge.

Adjusting the Beta of a Portfolio Using Stock Index Futures

As mentioned above, portfolio managers would adjust their portfolio betas in keeping with the changes in the risk and return offered by the stock market. Thus, when they believe that the stock market offers a relatively high expected return, for a given level of risk, they would increase the beta values of their portfolio, and, on the other hand, when they turn more bearish or feel that the market risk has increased, they would tend to lower their portfolio betas.

The changes in the portfolio beta can be effected by selling or buying part of the portfolio and substituting them by risk-less securities. Also, instead of buying/selling and substituting the securities which may involve significant transactions cost, the manager can bring about the desired changes by buying or selling index futures contracts instead.

Reconsider the example above. The manager has a portfolio of Rs 20 lacs, with a beta value of 1.17. Suppose now that the spot index is at 1120 and the futures price is 1125. Further, the futures contract has a multiple of 50. We may now see as to how to use stock index futures to, say, (a) decrease the portfolio beta to 0.9, and (b) increase the portfolio beta to 1.5.

(a) To decrease the portfolio beta from 1.17 to 0.9, the portfolio manager may sell off a portion of equities and use the proceeds to buy risk-less securities. If we let the existing portfolio as asset 1 and the risk-less security as asset 2, we have,

$$\begin{aligned}\beta_p &= w_1\beta_1 + w_2\beta_2 \\ &= w_1\beta_1 + (1 - w_1)\beta_2\end{aligned}$$

(since the new portfolio consists of only two assets)

We have, $\beta_p = 0.9$ (the desired portfolio beta), $\beta_1 = 1.17$ (the beta value of the existing portfolio or asset 1), and $\beta_2 = 0$ (this being a risk-less asset). Substituting the known values, we get

$$0.9 = w_1 \times 1.17 + (1 - w_1)0$$

or, $$w_1 = 0.76923$$

This implies that a portfolio consisting of Rs 15.3846 lacs, 0.76923 times Rs 20 lacs, invested in three securities as given above and Rs 20 (lacs) – Rs 15.3846 (lacs) = Rs 4.6154 lacs in risk-less securities (Treasury Bills) would have a beta of 0.9.

Alternatively, the manager can sell stock index futures contracts. We have seen earlier that the number of futures contracts to trade in order to have a risk-minimizing hedge can be obtained as under:

Number of Futures Contracts to Trade =

$$h \times \left(\frac{\text{No. of Units of Spot Position Requiring Hedging}}{\text{No. of Units Underlying One Futures Contract}} \right)$$

Here, we may use beta of the portfolio to serve as h^*, and take the ratio of the monetary value (Rupee value) of the spot position to be hedged, and the monetary value of the spot index. For our example,

$$h^* = 1.17$$

Rupee value of the Spot Position to be Hedged = Rs 4.6154 lacs

Rupee value of one Futures Contract = Index Value × Multiplier
= 1120 × 50 = Rs 56,000
= Rs 0.56 lacs

Number of Futures Contracts required to change Portfolio Beta from 1.17 to 0.9 = 1.17 × 4.6154/0.56 = 9.643

Alternatively, the calculation can be done as under:

Number of Futures Contracts required to be Sold =

$$\frac{P(\beta_p - \beta'_p)}{F}$$

where P refers to the value of the given portfolio

β_p is the value of the beta of the portfolio

β'_p is the desired value of beta

F is the value of a futures contract

We have P = Rs 20 lacs, $\beta_p = 1.17$ $\beta'_p = 0.9$, and $F = 1120 \times 50 =$ Rs 0.56 lacs. With these values, we get

Number of Futures Contracts required to be Sold =

$$\frac{20 \times (1.17 - 0.9)}{0.56} = 9.643$$

Thus, instead of selling Rs 4.6154 lacs of the risky equity portfolio, the manager can reduce the beta to 0.9 by selling 9.643 (or 10) stock index futures. The manager may, therefore, continue to own the Rs 20 lacs equity stock portfolio by selling the required number of futures to hedge Rs 5.40 lacs of that portfolio.

(b) Now, to increase the portfolio beta from 1.17 to 1.50, we proceed as follows:

We have, $\beta_p = w_1\beta_1 + (1 - w_1)\beta_2$

or $1.5 = w_1 \times 1.17 + (1 - w_1)0$

or $w_1 = 1.28205$

This implies shorting the risk-less asset Treasury Bills with a market value of 0.28205×20 = Rs 5.641 lacs, so that the total investment in the portfolio of three securities be Rs 25.641 lacs and Rs 5.641 lacs is borrowed.

The aim of increasing beta to 1.5 can be achieved alternately by buying stock index futures contracts equivalent to Rs 5.641 lacs. The required number of contracts can be determined as follows:

Number of Futures Contracts required to change Portfolio Beta from 1.17 to 1.50 = $1.17 \times 5.641/0.56 = 11.786$.

The same answer can be obtained using the alternative approach given earlier. Accordingly, with P = Rs 20 lacks, $\beta_p = 1.17$, $\beta'_p = 1.50$, and $F = 1120 \times 50$ = Rs 0.56 lacs, the required number of contracts would be equal to

$$\frac{20 \times (1.50 - 1.17)}{0.56} = 11.786$$

Note that in the numerator, the difference between the actual and desired portfolio beta values is needed, which was taken to be $\beta_p - \beta'_p$ in the first case and $\beta'_p - \beta_p$ in the second case. In fact, we should subtract the smaller value from the larger value in a given situation.

In any case, the hedger should buy 11.786 or 12 contracts in this situation.

Adjusting the Portfolio β to Zero: A Complete Hedge

We have seen how futures contracts can be used for tuning the beta of a given portfolio in keeping with expectations about market movements. However, if the market is expected to decline, then while a reduction in the beta is beneficial, it does not completely protect the investor. A full protection calls for adjusting the beta value equal to zero. Obviously, if beta value is set equal to zero, then a given portfolio is immune to market changes. Thus, a complete hedge may be achieved by shorting futures contracts as follows:

No. of Futures Contracts to Sell

$$= \frac{\text{Value of spot position requiring hedging}}{\text{Value of a futures contract}} \times \text{Portfolio beta}$$

The above given formula is employed if cent percent of the portfolio is to be hedged. If higher or lower than 100% portfolio value is required to be hedged then the above expression is multiplied by the such percentage value. Thus, in the above case, if it is desired to hedge 80 percent of the portfolio, the number of contracts to short would be 80% of the number determined.

To illustrate complete hedging, suppose that an investor has a portfolio of Rs 34 lakhs, comprising of five securities. The portfolio has beta equal to 0.94. The investor is thinking of hedging using November SENSEX futures. He finds that presently, on September 5, the SENSEX is trading at 4930 and the November expiry futures are trading at 4972. Accordingly, the value of a futures contract (assuming the multiple is 100) is Rs 100 × 4972 = Rs 497,200. Now, the investor has to short (3400,000/497,200) × 0.94 = 6.43 or 7 contracts. Thus, his sell value is Rs 34,80,400.

We now consider the consequences of different market scenarios at the final delivery of the contract.

(a) The market declines If the market declines as anticipated by the investor, he would stand to lose on the stock portfolio but would gain in the futures market. Suppose the SENSEX falls from 4930 to 4512. This is a decline of 8.48 percent in the index. The portfolio value would have, therefore, declined by 8.48 × 0.94 or 7.9712% or Rs 271,000 (approximately). In the futures market, he would gain. He would close the 7 contracts sold by buying as many contracts at 4512 (since at maturity, the price of the futures contract matches with the index). Thus, the gain to the investor in this market would be 460 × Rs 100 × 7 contracts = Rs 322,000. The net position is a gain of 322,000 – 271,000 = Rs 51,000.

(b) The market rises Now, assume that the market does not move the way the investor thought and instead, rises, with SENSEX scaling to 5480. This increase of 550 points, or 11.16 percent results in a gain in the portfolio value by 11.16 × 0.94 = 10.49 percent or 3400,000 × 10.49% = Rs 356,660. However, the investor incurs a loss in the futures market, amounting to 7 × 100 × (5480 – 4972) = Rs 355,600. The combined position in the cash and futures markets means a net gain of 356,660 – 355,600 = Rs 1060.

(c) The market is unchanged In the third possible scenario, suppose the SENSEX remains unchanged at 4930. This would cause the value of the portfolio remain at Rs 3400,000. However, in the futures market he would make a gain of (4972 – 4930) × 100 × 7 =Rs 29,400. Thus, the investor gains Rs 29,400 in the process.

Note, however, that in each of the three situations discussed above, we have not considered the costs like commissions etc. But, the costs of taking positions are relatively very low in comparison to the cash markets.

Example 3.7

On January 1, 2002, an investor has portfolio consisting of eight securities as shown below:

Security	*Price*	*No. of Shares*	*β*
A	29.40	400	0.59
B	318.70	800	1.32
C	660.20	150	0.87
D	5.20	300	0.35
E	281.90	400	1.16
F	275.40	750	1.24
G	514.60	300	1.05
H	170.50	900	0.76

The cost of capital for the investor is given to be 20% per annum. The investor fears a fall in the prices of the shares in the near future. Accordingly, he approaches you for advice.

You are required to:

(a) state the options available to the investor to protect his portfolio.
(b) calculate the beta of his portfolio.
(c) calculate the theoretical value of the futures contracts according the investor for contracts expiring in (1) February, (2) March.

(d) calculate the number of units of S&P CNX Nifty that he would have to sell if he desires to hedge until March (1) his total portfolio, (2) 90% of his portfolio and (3) 120% of his portfolio.
(e) determine the number of futures contracts the investor should trade if he desires to reduce the beta of his portfolio to 0.9.

You can make use of the following information/assumptions:

(i) The current S&P CNX Nifty value is 986.
(ii) S&P CNX Nifty futures can be traded in units of 200 only.
(iii) The February Futures are currently quoted at 1010 and the March Futures are being quoted at 1019.

(a) There are two options for the investor to protect his portfolio:
   (1) to sell the shares now and repurchase them later when they are cheaper.
   (2) to sell the NIFTY futures contracts and keep the portfolio intact.

Option 1 is likely to be costlier since the selling of shares and repurchasing them would require incurring of transaction costs including brokerage charges, stamp duty and payment of service or other taxes, if any. Not only this, he is likely to lose some more amount because of illiquidity in the market. While selling his shares, he might have to quote a price slightly lower than the best bid in an attempt to sell his entire holding. Similarly, while buying shares, he might have to quote a somewhat higher price to procure all his purchases. This is termed as *impact cost*, as indicated earlier.

In this option, the investor would gain if the prices do fall by a margin which exceeds the costs involved in the trading operations. However, if the prices were to actually rise, he would stand to lose.

In option 2, the impact cost and transaction costs are likely to be much lower. Trading in a derivatives market is generally cheaper than trading in a cash market. If the share prices do fall, he would lose on the value of the portfolio but gain on the futures contracts since he would have sold futures at a relatively higher price, while if the share prices go up, he would lose on the futures contracts and gain in terms of the portfolio value. Thus, he is "protected" in option 2.

(b) The portfolio of the investor has a beta value equal to 1.10149 as shown calculated in Table 3.3.

Table 3.3

Calculation of Portfolio Beta

Security	*Price of the Share*	*No. of Shares*	*Value*	*Weightage* w_i	*Beta* β_i	$w_i\beta_i$
A	29.40	400	11,760	0.012	0.59	0.00708
B	318.70	800	254,960	0.256	1.32	0.33792
C	660.20	150	99,030	0.100	0.87	0.08700
D	5.20	300	1,560	0.002	0.35	0.00070
E	281.90	400	112,760	0.113	1.16	0.13108
F	275.40	750	206,550	0.208	1.24	0.25792
G	514.60	300	154,380	0.155	1.05	0.16275
H	170.50	900	153,450	0.154	0.76	0.11704
	Total		994,450			1.10149

(c) Calculation of theoretical values of the futures contracts:

It is given that cost of capital = 20% p.a. Accordingly, the continuously compounded rate of interest = ln (1 + 0.20) = 0.18232. For the February contracts, $t = 58/365 = 0.1589$ while for the March contracts, $t = 89/365 = 0.2438$. Further, $F = S_0\, e^{rt}$. Thus,

For February contracts, $F = 986e^{(0.18232)\ (0.1589)}$

$= 986 \times 1.02939 = 1014.98$

For March contracts, $F = 986e^{(0.18232)\ (0.2438)}$

$= 986 \times 1.0455 = 1030.32$

(d) Value of a March contract = 1019 × 200 = Rs 203,800

No. of futures contracts required to be sold may be calculated by using the following formula:

No. of contracts

$$= \frac{\text{Value of spot position requiring hedging}}{\text{Value of a futures contract}} \times \text{Portfolio beta}$$

(i) *when total portfolio is to be hedged:*

$$= \frac{\text{Rs } 994{,}450}{\text{Rs } 203{,}800} \times 1.10149$$

$= 5.39$ or 6 contracts

(ii) *when 90% of the portfolio is to be hedged:*

$$= \frac{\text{Rs } 994{,}450 \times 0.90}{\text{Rs } 203{,}800} \times 1.10149$$

$= 4.84$ or 5 contracts

(iii) *when 120% of the portfolio is to be hedged:*

$$= \frac{\text{Rs } 994{,}450 \times 1.20}{\text{Rs } 203{,}800} \times 1.10149$$

$$= 6.45 \text{ or } 7 \text{ contracts}$$

(e) For calculating the number of futures contracts required to be sold to lower the beta to 0.7, we have
value of the portfolio, P = Rs 994,450
current beta of the portfolio, $\beta_p = 1.10149$
desired beta value, $\beta'_p = 0.7$, and
value of a futures contract = 986 × 200 = Rs 197,200

$$\text{Now, No. of contracts to sell} = \frac{P(\beta_p - \beta'_p)}{F}$$

$$= \frac{994{,}450\,(1.10149 - 0.7)}{197{,}200}$$

$$= 2.02 \text{ or } 2 \text{ contracts}$$

FUTURES ON STOCKS

Like futures on commodities, futures contracts on shares of individual stocks of companies are also traded in some countries including Australia, England, Hong Kong, India, Sweden etc. In such contracts, the underlying happens to be a certain number of shares of a particular company. In general, futures on individual stocks are unimportant in the world trading markets and they have not been very successful. However, in India the introduction such contracts in November 2001 has met with a good reception from the market participants, to begin with.

A futures contract on a stock is one where the party with long position agrees to buy a certain number of shares of a company at a certain price at a certain date in future and the party with short position agrees to deliver the same and receive the amount. The contract may also be cash-settled so that no physical delivery is made. Like other futures contracts, when two parties agree for a trade, the clearing corporation steps in and assumes a counter-party position to each of them. Each of the parties has to pay initial upfront margin to the clearing corporation (through their brokers/trading members). Then, as time passes, their positions are marked-to-the-market depending upon the market price of the futures contract traded between the parties. If the market price increases, the account of the long is credited and that of the short is debited, while if the price of futures decreases, the short is credited and the long is debited. Accordingly, additional margin is called for from the party whose account is debited, on a day-to-day basis. This is continued until the date of maturity arrives when either the delivery is executed against payment or the difference between the spot value and the contracted price is settled in cash and their accounts are accordingly credited or debited.

Sample Futures Contract

The specifications for futures contracts trading on the National Stock Exchange of India, NSE, are given in Box 3.7. As of now, such contracts are allowed to be traded on a total of 31 securities as shown in Box 3.8. It may be noted that the contract size, in terms of the number of shares involved, is not uniform for all the stocks. This is because it is stipulated by SEBI that the value of a contract, when initiated, should not be less than Rs 2 lakhs. Accordingly, the contract size is determined in keeping with the prices of the shares. It can be easily visualised that these sizes are subject to revision in case significant share price changes occur. Further, it has been laid by SEBI that single stock futures contracts shall be permitted upto a maximum maturity of 12 months. It was also stated that, initially, such contracts shall have maturity of three months. Therefore, at any point in time atleast three single stock futures contracts would be available for trading. As of now, however, exactly three contracts on a particular underlying are available.

SEBI has also laid down guidelines for modification of contract specifications arising out of corporate actions. The corporate actions mean and include dividend, bonus, rights shares, issue of shares as a result of stock split, stock consolidations, schemes of mergers/de-mergers, spin-offs, amalgamations, capital restructuring and such other privileges or events of a similar nature announced by the issuer of the underlying securities. Detailed guidelines about the margin system and position limits of the traders in respect of such contracts have also been provided.

Box 3.7 ***Contract Specifications for Futures on Individual Stocks***

Item	*Specification*
Security Description	As per Note 1, Box 3.8
Underlying Unit	Individual scrips as per SEBI list (given in Note 1, Box 3.8)
Contract Size	As per Note 1, Box 3.8. See also Note 2.
Price Steps	Re 0.05
Trading Hours	9.55 a.m. to 3.30 p.m.
Trading Cycle	A maximum of three month trading cycle—the near month (one), the next month (two) and the far month (three). New contract is introduced on the next trading day following the expiry of near-month contract.
Last Trading/Expiration Day	The last Thursday of the expiry month, or the preceding trading day if the last Thursday is a trading holiday.
Settlement	In cash on T+1 basis.
Final Settlement Price	Closing price of the underlying security in the capital market segment of the National Stock Exchange on the expiration day of the futures contract.
Daily Settlement Price	Closing price of futures contract. Computed on the basis of the last half-an-hour weighted average price of such contract in the F&O segment. In case of non-trading during the last half-hour, the daily settlement price to be computed as $F = Se^{rt}$, where r is the rate of interest (MIBOR).
Settlement Day	Last trading day.
Margins	Upfront initial margin on daily basis.

Source: NSE

Note 1 At present, SEBI allows trading of futures contracts in a total of 31 individual securities. These are given in Box 3.8. Also given in the table are the symbols of the securities and the contract size for each of these.

Note 2 The value of a futures contract on an individual stock cannot be less than Rs 2 lac at the time of its introduction. The permitted lot size for the futures contracts on individual securities must be in multiples of 100 and fractions, if any, are rounded off to the next higher multiple of 100.

Box 3.8 ***List of Securities on which Futures Contracts are Available***

S. No.	*Name*	*Symbol*	*Lot Size*
1.	Associated Cement Co. Ltd.	ACC	1500
2.	Bajaj Auto Ltd.	BAJAJAUTO	800
3.	Bharat Petroleum Corporation Ltd.	BPCL	1200
4.	Bharat Heavy Electricals Ltd.	BHEL	1100
5.	BSES Ltd.	BSES	1100
6.	CIPLA Ltd.	CIPLA	200
7.	Digital Equipment (I) Ltd.	DIGITALEQUIP	400
8.	Dr. Reddy's Laboratories	DRREDDY	200
9.	Grasim Industries Ltd.	GRASIM	700
10.	Gujarat Ambuja Cement Ltd.	GUJAMBCEM	1100
11.	Hindustan Lever Ltd.	HINDLEVER	300
12.	Hindustan Petroleum Corporation Ltd.	HINDPETRO	1000
13.	Hindalco Industries Ltd.	HINDALCO	1300
14.	HDFC Ltd.	HDFC	300
15.	ICICI Ltd.	ICICI	2800
16.	Infosys Technologies Ltd.	INFOSYSTCH	100

S. No.	*Name*	*Symbol*	*Lot Size*
17.	ITC Ltd.	ITC	300
18.	Larsen & Toubro Ltd.	L&T	1000
19.	Mahindra & Mahindra Ltd.	M&M	1600
20.	Mahanagar Telephone Nigam Ltd.	MTNL	2500
21.	Ranbaxy Labs Ltd.	RANBAXY	500
22.	Reliance Petroleum Ltd.	RELPETRO	600
23.	Reliance Industries Ltd.	RELIANCE	4300
24.	Satyam Computer Services Ltd.	SATYAMCOMP	1200
25.	State Bank of India	SBIN	1000
26.	Sterlite Optical Technology Ltd.	STROPTICAL	600
27.	TELCO Ltd.	TELCO	3300
28.	Tata Power Co. Ltd.	TATAPOWER	1800
29.	Tata Iron and Steel Co. Ltd.	TISCO	1600
30.	Tata Tea Ltd.	TATATEA	1100
31.	Videsh Sanchar Nigam Ltd.	VSNL	700

Pricing of Futures Contracts on Stocks

In the normal markets, the futures contracts are priced according to the cost of carry model. In terms of this, the pricing of futures mimics a process by which a risk-averse seller of the contracts buys the security at current price, holds it till the date of maturity of the contract, incurring an interest cost in the process. The dividends, if any, resulting from holding the security, during the currency of the contract, represent negative cost (called carry returns) are netted from the interest cost and the net cost is effectively the cost of maintaining a risk-free position. Accordingly, the valuation of futures is done as follows:

When no dividend is expected from the underlying stock,

$$F = S_0 e^{rt}$$

where F is the value of futures contract, S_0 is the spot value of stock, r is the continuously compounded risk-free rate of return, and t is the time to maturity (in years).

When dividend is expected from the underlying stock,

$$F = (S_0 - I)e^{rt}$$

where I is the discounted value of the dividend receivable from the stock, and other symbols are same as defined above.

Example 3.8

A share is currently selling at Rs 208.80. Calculate the price of October futures contract on this share assuming the risk-free rate of return to 8 percent and the time to maturity as 56 days. Take the market lot to be 100.

Here S_0 = 208.80, continuously compounded rate of return = ln(1.08) = 0.077, time to maturity = 56/365 = 0.1534.

Accordingly,

$$F = S_0e^{rt}$$
$$= 208.80e^{(0.077)\,(0.1534)}$$
$$= 208.80 \times 1.012 = 211.281$$

With the market lot equal to 100, the value of the futures contract works out to be 100 × 211.281 = Rs 211,281.

Example 3.9

Re-work the value of futures contract in Example 3.8 assuming that a dividend of Rs 2.60 per share is expected in 20 days from now.

Present value of the dividend, $I = De^{-rt}$

$$= 2.60e^{-(0.077)\,(20/365)}$$
$$= 2.59$$
$$F = (S_0 - I)e^{rt}$$
$$= (208.80 - 2.59)e^{(0.077)\,(56/365)}$$
$$= 208.661$$

With this, the value of a futures contract = 100 × 208.661 = Rs 208,661.

It is easy to visualise that carrying cost is typically positive, with the result that futures are normally priced higher than the spot price.

Only in the event of very low interest rate and/or expectation of very high dividend would the cost of carry work out to be negative, forcing the futures prices to be quoted at a discount. It is interesting to observe that in India, where trading in futures contracts in a total of 31 stocks began in the second week of November, 2001, many of the futures contracts were seen to be trading at levels lower than the then current prices of the underlying securities, in the first month of their trading. This is despite the fact that neither the interest rates were very low nor substantial dividends expected on the securities. This phenomenon of negative basis (futures price minus spot price) is rather uncommon and is probably witnessed here since the market is in its infancy. Such mispricing is likely to be corrected as the market attains maturity.

Financial Statistics The business dailies regularly publish information on trading of futures contracts on individual stocks. An extract of such data is given in Box 3.9. The information available includes details of a contract, the previous closing price, the trading in terms of the quantity, value and number of contracts and the open interest in terms of number of shares.

Box 3.9 ***Derivatives Trading Quotations***

FUTURES

EQUITY FUTURES ON BSE

Contracts, (Pr.Cl.) Prices (Traded Qty., Value in Rs. Lks, No. of Contracts)	Open Int.	Exp. Date
ACC (155.90) 160.00, 156.00, 157.75 [3000, 4.74, 2]	10500	31/01/200
ACC (158.58) 160.00, 160.00, 158.65 [1500, 2,40, 1]	3000	28/02/2002
BHEL (141.94) 145.68 [—, —, —]	1200	31/01/2002
Digital Global (494.88) 516.00, 505.00, 515.73 [5200, 26.56, 13]	5200	31/01/2002
Dr. Reddy's (940.47) 965.17 [—, —, —]	800	31/01/2002
Grasim (277.94) 289.25 [—, —, —]	700	31/01/2002
Infosys (4095.00) 4294.00, 4100.00, 4294.00 [1600, 66.43, 16]	1500	31/01/2002
L & T (192.43) 198.00, 192.10, 192.98 [80000, 15.55, 8]	16000	31/01/2002
M&M (87.46) 92.00, 92.00, 90.81 [2500, 2.30, 1]	0	31/01/2002
MTNL (123.73) 121.00, 118.50, 121.09 [3200, 3.83, 2]	1600	31/01/2002
Ranbaxy Labs (724.50) 718.00, 710.00, 710.00 [1000, 7.14, 2]	1000	31/01/2002
Reliance Inds. (305.25) 303.00, 298.00, 298.10 [1200, 3.61, 2]	2400	31/01/2002
Reliance Petro. (29.44) 29.75, 28.80, 29.20 [51600, 15.09, 12]	288100	31/01/2002
Reliance Petro. (29.64) 30.00, 30.00, 29.28 [4300, 1.29, 1]	30100	28/02/2002
Satyam (237.79) 258.90, 242.00, 256.51 [69600, 174.17, 54]	28800	31/01/2002
Satyam Opt. (162.00) 173.00, 162.00, 172.77 [15600, 26.54, 26]	17400	31/01/2002
Sterlite Opt. (164.30) 175.00, 172.00, 175.00 [1800, 3.13, 3]	2400	28/02/2002
TELCO (100.44) 100.75, 100.00, 101.22 [6600, 6.62, 2]	85800	31/01/2002
TELCO (101.01) 101.80 [—, —, —]	23100	28/02/2002
TELCO (88.32) 91.75, 88.00, 91.97 [12600, 11.35, 7]	14400	31/01/2002
TISCO (88.82) 93.50, 90.55, 92.50 [7200, 6.64, 4]	9000	28/02/2002
VSNL (215.57) 220.66 [—, —, —]	700	31/01/2002

EQUITY FUTURES ON NSE

ACC (—) 158.40, 159.90, 155.50 [777000, 1227.03, 518]	1273500	31/01/2002
ACC (—) 158.60, 159.00 157.60 [10500, 16.63, 7]	13500	31/01/2002
Bajaj Auto (—) 400.00, 400.00 380.10 [12800, 49.56, 16]	20000	31/01/2002
Bajaj Auto (—) 380.00, 380.00, 380.00 [1600, 6.08, 2]	0	28/03/2002
BHEL (—) 143.50, 146.30, 143.10 [121200, 175.31, 101]	258000	31/02/2002
BHEL (—) 145.00, 146.00, 145.00 [4800, 6.98, 4]	0	28/03/2002
BPCL (—) 192.55, 192.55, 185.00 [6600, 12.40, 6]	15400	31/01/2002
BSES (—) 203.75, 205.90, 203.75 [2200, 4.51, 2]	7700	31/01/2002
BSES (—) 178.45, 199.85, 178.45 [17600, 33.29, 16]	0	28/02/2002
(—) 1110.00, 1170.10, 1070.00 [3600, 40.95, 18]	6400	31/01/2002
Global (—) 495.00, 516.80, 494.00 [1665600, 8432.09, 4164]	662000	31/01/2002
(—) 504.00, 514.65, 498.10 [7200.3643, 101]	9200	28/02/2002

Source: *The Economic Times*, January 16, 2002

Utility of Individual Stock Futures

The futures on individual stocks are as useful to hedgers, speculators and arbitrageurs as any other futures contracts including those on stock indices. An investor who has a long position in a particular security can obtain a hedge cover by taking a short position in the futures in case he fears that the market in general and/or the particular security he holds is likely to witness a southward movement. Similarly, a short position in a security can be hedged with a long position in futures. It may be noted that with the stock index futures, the hedgers can remove market risk from their portfolio and have effective stock picking. To illustrate, a long position in ACC and short position in index cultures would remove the market risk and expose the investor to the ACC-specific risks and returns. But, with availability of stock futures on ACC, a long ACC in cash market and short ACC in futures market would be a perfect hedge with no price or credit risk.

Single stock futures are a leveraged product and they allow an access to the performance of a security without owning it or paying a full price of it. Thus, an investor, who believes that the price of a given security is likely to rise in the days to come, can make a profit by taking long position in the futures contract and reversing the position later on when the prices do rise. Of course, one can profit by investing in the security and selling it later. But investing in the security requires large sums while long position in futures can be taken by about one-fifth of that amount (if the initial margin is, say 20%). Similarly, if the price is likely to fall, advantage can be taken of this, by holding short position in futures on security rather than short selling the security (shares) and borrowing. Should the price of the security in question move in the desired direction, substantial profits can be made with small investment. Of course, if the change is in the opposite direction, substantial losses would be incurred. Thus, futures represent a highly levered instrument with high degree of risk for use by speculators.

When futures appear to be over- or under-priced in relation to the spot prices, opportunities to arbitrage (to earn risk-less profits) may exist. To illustrate, suppose a share is selling at Rs 208 while the near-month futures contract on this, due in 16 days is selling for Rs 209.40. Now, if the risk-free rate interest is 8%, the investor will do well to borrow funds at 8%, buy share in the spot market at Rs 208 and short futures at Rs 209.40. On maturity, he would reverse both his positions, make a profit of Rs 1.40, which would mean an annualised return of 15.35%, which is in excess of the borrowing rate. This results in a net profit which is risk-less.

TEST YOUR UNDERSTANDING

Mark the following statements as T (True) or F (False).

1. _______ The stock index futures were first introduced at CBOT in USA.
2. _______ Stock index futures are financial futures.
3. _______ Stock index futures are settled either in cash or through delivery of the underlying securities, at the discretion of the exchange.
4. _______ A stock index attempts to trace changes in the value of a hypothetical portfolio of stocks.
5. _______ Index numbers of stock prices reflect the changes on account of corporate actions like bonus issue, rights issue etc.
6. _______ Initial index value is always taken to be 100.
7. _______ The sensitive index number of The Stock Exchange, Mumbai, is Sensex, which is based on prices of 50 securities.
8. _______ Dollex is the dollar-linked version of the Sensex.
9. _______ S&P CNX Nifty was designed to serve as a basis of index-based derivatives.
10. _______ S&P CNX Nifty is based on the prices of 50 securities only.

11. _______ S&P CNX Nifty is a market-capitalisation weighted index, and so is the BSE Sensex.
12. _______ Stock index futures are valued using the cost-of-carry model, wherein carry cost is the interest on the contract value and carry return is the value of dividends receivable between the dates of valuation and settlement.
13. _______ Stock index futures are meant basically to serve needs of speculators who can earn high profits from these.
14. _______ Stock index futures are useful to an investor who could take a view on the market as a whole and not on individual specific securities.
15. _______ Speculators take view on prices but arbitrageurs do not.
16. _______ Arbitrageurs' actions have no effect on the market-efficiency.
17. _______ An arbitrageur can make profits only when the positions taken by him are all held till maturity.
18. _______ Stock index futures are not good means of hedging since they are only cash-settled.
19. _______ Market risk exists only for those securities that are included in the index.
20. _______ Systematic factors affect the market as a whole and they are the cause of market risk.
21. _______ A long position in a stock also implies a long position in the index, to an extent.
22. _______ For an index, beta may be less than, equal to or greater than 1.
23. _______ Stock index futures can be used for hedging purposes of holdings of only those shares that are included in the index.
24. _______ Low-beta stocks are more profitable in bullish conditions, while high-beta stocks are more suitable in bearish conditions.
25. _______ The systematic risk of a security is measured as the product the variance of the market returns and the square of beta value of the security.
26. _______ Hedging by stock index futures implies controlling the market risk.
27. _______ Systematic risk of a portfolio can be reduced through hedging with stock index futures.
28. _______ The simple average of the beta factors of constituent

securities of a portfolio yields the beta of the portfolio itself.

29. _______ If portfolio beta exceeds unity, the portfolio value would rise faster than the market and, therefore, out-perform the market.
30. _______ When portfolio managers believe that the stock market is offering a relatively high expected return for a given level of risk, they should attempt to raise the beta values of their portfolios.
31. _______ Stock index futures can be used for effecting changes in the portfolio betas.
32. _______ To have a risk-minimising hedge, the number of futures contracts to trade is given by,
    Number of contracts
    $$= h^* \times \frac{\text{No. of units underlying one futures contract}}{\text{Amount of spot position requiring hedging}}$$
33. _______ To reduce the value of the portfolio beta, the number of futures contracts required to be sold is given by,
    $$\text{Number of contracts to sell} = \frac{P(\beta_p - \beta'_p)}{F}$$
    where, P refers to the value of the given portfolio
    β_p is the value of the beta of the portfolio
    β'_p is the desired value of beta
    F is the value of a futures contract
34. _______ Futures on individual stocks were the first derivative product introduced in India.
35. _______ Trading in futures on single stocks is on a significantly larger scale than the trading in futures on stock indices, the world over.
36. _______ Settlement of futures contracts on individual stocks is done through physical delivery only.
37. _______ The cost of carry being essentially positive, the futures price on single stocks can never be lower than their spot prices.
38. _______ Single stock futures represent a leveraged product and they allow an access to the performance of a stock without owning it or paying a full price for it.
39. _______ Arbitrage opportunities arise when futures are seen to be under-priced in relation to the spot prices, and not when they are over-priced.

40. _______ Futures on individual stocks are useful to hedgers and speculators but not arbitrageurs.

EXERCISES

1. What are the major stock indices in India? Discuss in detail about the Sensex and S&P CNX Nifty indices.
2. How are futures contracts on stock indices valued using the cost of carry model when (i) no dividends are expected, and (ii) dividends are expected on securities included in the index?
3. Explain how speculators and arbitrageurs can profitably use stock index futures.
4. What do you understand by beta of a security? Explain the method of its calculation.
5. Differentiate between systematic and unsystematic risk. Do you agree that hedging with stock index futures controls both these types of risk?
6. Explain how the stock index futures are used for adjusting the beta value of a portfolio (i) upward, and (ii) downward.
7. Write a detailed note on hedging (i) a long position in stocks, and (ii) a short position in stocks, using stock index futures.
8. What are single stock futures? How are they priced?
9. How are futures on individual stocks different from futures on stock indices in terms of their use for hedging purposes?
10. Using the following data, obtain the value of a futures contract to an index:

    Spot value of the index = 1216
    Risk-free rate of return = 7% p.a.
    Time to expiration = 146 days
    Contract multiplier = 200
11. A stock index is currently at 820. The continuously compounded risk-free rate of return is 9% per annum and the dividend yield on the index is 3 per cent per annum. What should the futures price for a contract with 3 months to expiration be?
12. Assume that a market-capitalisation weighted index consists of five stocks only. Currently, the index stands at 970. Obtain the price of a futures contract, with expiration in 115 days, on this index having reference to the following additional information:
    (a) Dividend of Rs 6 per share expected on share B, 20 days from now.

(b) Dividend of Rs 3 per share expected on share E, 28 days from now.

(c) Continuously compounded risk-free rate of return = 8% p.a.

(d) Lot size: 300

(e) Other information:

Company	*Share Price (Rs)*	*Market Capitalization (crores of Rs)*
A	22	110
B	85	170
C	124	372
D	54	216
E	25	200

13. On April 5, 2002, BSXMAY2002 (the futures contracts on the BSE SENSEX expiring on 30.05.2002) were selling at 3540.10 while the spot index value was 3500.57. Using these values, obtain the annualised risk-free rate of return implied in the futures.
14. For a certain security with beta = 1.3, the variance of daily returns is found to be 12.4. The standard deviation of daily returns on an index is found to be 1.8. Obtain a measure of the risk faced by holder of this security who decides to hedge with the index in question.
15. From the following information, obtain the portfolio beta:

Security	*No. of Shares*	*Price per share (Rs)*	*Beta*
1	2500	38	1.32
2	1800	107	0.65
3	6400	62	0.92
4	5700	22	1.56

16. The current spot price of a 100-rupee share is Rs 302.60. Obtain the fair price of December futures contract on this share assuming the risk-free rate of return to be 9 per cent and the market lot size as 250. The maturity date is 73 days from today. How would the value of the contract be affected if a dividend of 8 per cent is expected in 30 days' time?
17. Consider the portfolio of Mr Anand given here:

	Number of shares	*Share price as on April 18, 2002*
CIPLA	4000	1029.75
Hind Lever	5200	208.40
ICICI Ltd.	6600	61.20
Infosys Tech.	2400	3958.95
NIIT Ltd.	5600	308.80
Tata Engg.	1500	128.05
Zee Telefilm	4000	168.00

(i) Calculate the beta of his portfolio, using information given in Box 3.6.
(ii) The May futures on BSE Sensex are quoted at 3444.60. Assuming the market lot to be 100, calculate the number of contracts Mr Anand should short for hedging his portfolio against possibly falling markets.

CHAPTER

4

Options Contracts and Trading Strategies

In the preceding chapters, we discussed about the nature and characteristics of forward and futures contracts. We now consider options contracts. The present chapter deals with the characteristics of options contracts, the risk and return features of options, and various trading strategies involving options. The next chapter focuses on the question of valuation of options.

Options, like futures, are also speculative financial instruments. An option is a legal contract which gives the holder the right to buy or sell a specified amount of underlying asset at a fixed price within a specified period of time. It gives the holder the *right* to buy (or sell) a designated asset. The holder is, however, *not obliged* to sell (or buy) the same. This is in contrast to forward and futures contracts where both the parties have a binding commitment.

There are two parties in an options contract—one party takes a *long* position, that is, it buys the option, while the other one takes a *short* position, that is, it sells the option. The one who takes a short position is the one who *writes* the option, and is called the *writer* of the option.

It is significant to note that although options are standardized, no physical certificate is created when options are written. All transactions are simply book-keeping entries.

CHARACTERISTICS OF OPTIONS CONTRACTS

Call Options and Put Options

Options may be categorized as *call* options and put options. A call option is a contract which gives the owner the *right to buy* an asset for a certain price on or before a specified date. For example, if you buy a call option on a certain share *XYZ*, you have the right to purchase 100 shares (assuming of course, that the option involves 100 shares) of *XYZ* at a specified price any time between today and a specified date. The fact that the owner of the option has no obligation to exercise it implies that he has a limited liability. Should the price of the asset fall below the specified price such that it is not profitable for him to buy it, he may decide not to acquire the underlying asset.

On the other hand, a put option gives its owner the *right to sell* something for a certain predetermined price on or before a specified date. Thus, if you buy a put option on shares of *XYZ*, you have the right to sell 100 shares of this company at the specified price at any time between today and the specified date. Of course, you may not like to exercise your option if the price of this share increases beyond the specified price.

The positions of the buyer and seller in call and put options are given below.

Option Type	*Buyer of Option (Long Position)*	*Writer of Option (Short Position)*
Call	Right to buy asset	Obligation to sell asset
Put	Right to sell asset	Obligation to buy asset

American vs European Options

The definitions of options, both call and put, given above apply to the *American*-style options. An American option can be exercised by its owner at *any time on* or *before* the expiration date. Besides the American type, there are *European*-style options as well. In the case of European options, the owner can exercise his right only *on* the expiration date, and not before it. It may be pointed out, however, that most of the options traded in the world, including those in Europe, are American-style options.

Physical Delivery vs Cash-Settled Options

When an option is exercised on or before the date of expiry, it may be settled by transferring the specified underlying asset by short to long in case of call and by long to short in case of a put option, at the agreed price. Thus, in a call option contract involving stock, a specified number of shares are transferred by the short to the long. This is settlement of the contract through physical delivery.

An options contract may also be designed so as to be settled by cash payment. In such cash settlement contracts, the traders make/receive payments to settle any losses or gains on exercise/maturity of the contract instead of making physical delivery.

Assets Underlying Options

The asset that can be bought or sold with an option is known as the *underlying asset*, or simply, the *underlying*. There is a wide variety of assets on which options are traded the world over. The assets range from agricultural commodities including wheat, live cattle and live hogs to foreign currencies, and from interest rates to individual stocks and stock indices. For instance, the Chicago Mercantile Exchange in USA deals with options on items listed below:

(i) Agricultural commodities including feeder cattle, live cattle, live hogs, broiler chickens, and random length lumber,
(ii) Foreign currencies including the British pound, Canadian dollar, French franc, Japanese yen, Swiss franc, Deutsche mark, Australian dollar, Currency Forward etc.,
(iii) Interest rates including Eurodollar, Euromark, 90-day Treasury bill, one-year Treasury bill etc,
(iv) Stock indices covering S&P 500 Index, S&P Midcap 400 Index, Nekkei 225 Index, Major Market Index, Russel 2000 Index and FT-SE 100 Share Index.

For each type of options contract, contract sizes are provided. For example, in options on stocks, one contract generally gives the holder the right to buy or sell 100 shares. In case of options on foreign currency, similarly, the size of the contract varies with the currency underlying it.

A Sample Commodity Options Contract

A sample options contract on wheat traded at Chicago Board of Trade (CBOT) is presented in Box 4.1. Evidently, one contract involves 5,000 bushels of a specified variety of wheat or alternatives as provided by the exchange. The price of one contract moves in units of $ 12.50.

Box 4.1 ***Specifications for Options Contract on Wheat***

Trading Unit	5000 bushels
Symbol	W
Deliverable Grade	No. 2 Soft Red, No. 2 Hard Red Winter, No. 2 Dark Northern Spring at par, and other permissible substitution
Price Quotation	Cents and quarter cents per bushel
Tick Size	1/4 cent per bushel, \$ 12.50 per contract
Contract Months	Mar, May, Jul, Dec
Last Trading Day	Seven business days before the last business day of the contract month

Source: CBOT

Index Options Index options are also very popular. In case of options on indices, a contract usually provides for a certain multiple of the index. For instance, contract specifications for TOPIX (Tokyo Stock Price Index) stipulate the contract unit to be Yen 10,000 *times* TOPIX. Similarly, the S&P 100 and S&P 500 are the indices most popularly traded indices in the USA. One contract in such cases provides to buy or sell 100 times the index at the specified strike price. To illustrate, we may consider one contract on the S&P 100 with a strike price of 262. In case it is exercised when the index is at 280, the writer of the option would pay the holder a sum of $(280 - 262) \times 100 = \$1800$. The index value used is the value as at the end of the day, when the exercising instructions are given. Index options are also traded in India. They are available on the Sensex of The Stock Exchange, Mumbai, and S&P CNX Nifty of the NSE.

Options on Futures Many exchanges provide for trading of options on futures as well. In such an option, the underlying asset is a futures contract. The futures contract normally matures after the expiration of the option. When the holder of a call option decides to exercise it, he/she acquires from the writer (i.e. the seller) of the option a long position in the underlying futures contract *plus* a cash amount equal to the excess of the futures price over the exercise price. Similarly, when the holder of a put option exercises, he/she acquires a short position in the underlying futures contract and a cash amount equal to the excess of exercise price over the futures price. In each case, the futures contract has a zero value and can be closed out immediately. Evidently, then, the pay-off from a futures option is the same as the pay-off from a stock option with the stock price being replaced by the futures price. In USA, such contracts are extensively traded on assets like treasury bonds, soybeans, crude oil, live cattle, gold, Eurodollars etc.

Stock Options Although a variety of options are traded the world over, our focus in the following discussion will be primarily on options on stocks (shares of companies). That is to say, we shall be concerned here basically with the call and put options on shares of companies, traded in the exchanges. Besides, options on stock indices and options on futures are discussed in Chapter 6.

Sample Contract of Options on Individual Stocks

Specifications of a sample contract on individual stocks, as traded in the Indian markets, is given in Box 4.2. Options on individual stocks are traded at the National Stock Exchange (NSE) and The Stock Exchange, Mumbai (BSE). A glance at the contract specifications reveals the following:

(a) As of now, option contracts are permitted on a total of 31 stocks.

(b) The options are American style so that they can be exercised at any time before the expiry of the contract.

(c) The contracts on different stocks involve different number of shares. They depend on the prices of the underlying securities. At initiation, a contract has to be worth at least Rs 2 lac in rupee terms.

(d) For determining the gain/loss on a contract at the end of a day, the closing price of the underlying security in the cash market segment of the exchange is considered.

(e) Settlement is done on a T + 1 basis. This means once an option is exercised (or deemed so), the settlement of the contract is done by the following trading day. The settlement does not involve transfer of shares. It is done on a cash basis.

The other characteristics of the contracts are detailed at appropriate places.

Box 4.2 ***Contract Specifications for Options on Individual Stocks***

Item	*Specification*
Underlying Unit	Individual scrips as instructed by SEBI (given in Box 4.3)
Ticker Symbol	As specified in Box 4.3
Contract Multiplier	As specified in Box 4.3
Strike Prices	Shall have a minimum of five strikes (2 in-the-money, one near-the-money, and 2 out-of-the-money)
Premium Quotation	Rupees per share
Last Trading Day	Last Thursday of the contract month. If it is a holiday, the immediately preceding business day
Expiration Day	Last Thursday of the contract month. If it is a holiday, the immediately preceding business day *Note:* Business day is a day during which the underlying stock market is open for trading.
Contract Month	1, 2, and 3 months, e.g. in the month of July: July, August and September contracts would be available for trading. New contract is introduced on the next trading day following the expiry of near-month contract.
Exercise Style	American
Settlement Style	Cash (In cash on T + 1 basis)
Trading Hours	9.30 a.m. to 3.30 p.m.
Tick Size	0.01
	Closing price of the underlying security in the cash segment of The Stock Exchange, Mumbai. The following algorithm is used for calculating the closing value of these stocks in the cash segment.

	• Weighted average price of all the trades in the last fifteen minutes of the continuous trading session. • If there are no trades during the last fifteen minutes, then the last traded price in the continuous trading session would be taken as the official closing price.
Exercise Notice Time	It would be a specified time (Exercise Session) every day. All in-the-money options by certain specified ticks would deemed to be exercised on the day of expiry unless the participant communicates otherwise in the manner specified by the Derivatives Segment.
Settlement Day	Last trading day
Margins	Upfront initial margin on daily basis

Source: The Stock Exchange, Mumbai

Box 4.3 ***List of Securities on which Options Contracts are Available***

S. No.	*Name*	*Symbol*	*Lot Size*
1.	Associated Cement Co. Ltd.	ACC	1500
2.	Bajaj Auto Ltd.	BAJ	800
3.	Bharat Petroleum Corporation Ltd.	BPC	1100
4.	Bharat Heavy Electricals Ltd.	BHE	1200
5.	BSES Ltd.	BSE	1100
6.	CIPLA Ltd.	CIP	200
7.	Digital Equipment (I) Ltd.	DIG	400
8.	Dr. Reddy's Laboratories	DRR	400
9.	Grasim Industries Ltd.	GRS	700
10.	Gujarat Ambuja Cement Ltd.	GAC	1100
11.	Hindustan Lever Ltd.	HLL	1000

12.	Hindustan Petroleum Corporation Ltd.	HPC	1300
13.	Hindalco Industries Ltd.	HND	300
14.	HDFC Ltd.	HDF	300
15.	ICICI Ltd.	ICI	2800
16.	Infosys Technologies Ltd.	INF	100
17.	ITC Ltd.	ITC	300
18.	Larsen & Toubro Ltd.	LNT	1000
19.	Mahindra & Mahindra Ltd.	MNM	2500
20.	Mahanagar Telephone Nigam Ltd.	MTN	1600
21.	Ranbaxy Labs Ltd.	RBX	500
22.	Reliance Petroleum Ltd.	RPL	4300
23.	Reliance Industries Ltd.	RIL	600
24.	Satyam Computer Services Ltd.	SAT	1200
25.	State Bank of India	SBI	1000
26.	Sterlite Optical Technology Ltd.	SOT	600
27.	TELCO Ltd.	TEL	3300
28.	Tata Power Co. Ltd.	TPW	1600
29.	Tata Iron and Steel Co. Ltd.	TIS	1800
30.	Tata Tea Ltd.	TAT	1100
31.	Videsh Sanchar Nigam Ltd.	VSN	700

Expiration Date

Standardized options have specified dates mentioned for maturity. The date mentioned in an options contract is called *expiration date* or the *maturity date*. After the maturity date, an option has no worth. Different types of options have different expiration dates.

Generally, the maximum life of an option on stocks is nine months. The expiration date for contracts on TOPIX options on the Tokyo Stock Exchange in Japan is the business day prior to the second Friday, except that the expiration date for March, June, September and December contracts is the second Friday. For the exchanges in the U.S.A. on the other hand, the expiration date falls on the Saturday following the third Friday of the month of expiry. Generally, three life cycles are used there for options, so that each stock option falls into one of the three cycles that determines its expiration months. The three cycles and the months included in various cycles are indicated below:

- *January cycle*—January, April, July, and October
- *February cycle*—February, May, August, and November
- *March cycle*—March, June, September, and December

For each cycle, the expiration months are as given in Table 4.1. With reference to the above information and the information in the table, we see that there are always options that expire in four months available; of which two months are the upcoming ones and two others are distant ones. For example, in the January cycle given in the table, it may be observed that from March 24, 2003, (i.e. the Monday following the third Friday) to April 18, 2003 (which is the third Friday of the month), options expiring in April, May, July and October would be traded. Note that while options expiring in March would already have been expired on the third Friday of March, 2003 and hence would not be available in the current period, the options with expiry in April (i.e. current month) and May (next month) would be available and so will be the options with expiry in July and October (see list above showing months included in various cycles). In Table 4.1, options expiring in May have been shown italicized to indicate that they would be the newly introduced options in this period. In the same way, from April 21, 2003, the Monday following the third Friday, to May 16, 2003, the options in this cycle with expiry in the months of May, June, July and October would be traded. The options with expiry in April would have expired during the period under consideration and the ones with June would have been introduced.

In India at present, a total of three series of contracts are available for trading on a given day—the near month contracts, next-month contracts and distant-month contracts. To illustrate, in the month of September of a given year, the contracts expiring in September, October and November can be traded before last Thursday of the month when the September contracts would expire. From the following day, the December contracts would be introduced so that the October contracts become near-month contracts and the

November and December contracts being the next month and the distant-month contracts.

Table 4.1

Option Cycles

From Monday after 3rd Friday of	*Upto 3rd Friday of*	*Months Available*			
1. January cycle:					
January	February	Feb	*Mar*	Apr	Jul
February	March	Mar	Apr	Jul	*Oct*
March	April	Apr	*May*	Jul	Oct
April	May	May	Jun	Jul	Oct
May	June	Jun	Jul	Oct	*Jan*
June	July	Jul	*Aug*	Oct	Jan
July	August	Aug	*Sep*	Oct	Jan
August	September	Sep	Oct	Jan	*Apr*
September	October	Oct	*Nov*	Jan	Apr
October	November	Nov	*Dec*	Jan	Apr
November	December	Dec	Jan	Apr	*Jul*
December	January	Jan	*Feb*	Apr	Jul
2. February cycle:					
January	February	Feb	*Mar*	May	Aug
February	March	Mar	*Apr*	May	Aug
March	April	Apr	May	Aug	*Nov*
April	May	May	*Jun*	Aug	Nov
May	June	Jun	*Jul*	Aug	Nov
June	July	Jul	Aug	Nov	*Feb*
July	August	Aug	*Sep*	Nov	Feb
August	September	Sep	*Oct*	Nov	Feb
September	October	Oct	Nov	Feb	*May*
October	November	Nov	*Dec*	Feb	May
November	December	Dec	*Jan*	Feb	May
December	January	Jan	Feb	May	*Aug*
3. March cycle:					
January	February	Feb	Mar	Jun	*Sep*
February	March	Mar	*Apr*	Jun	Sep
March	April	Apr	*May*	Jun	Sep
April	May	May	Jun	Sep	*Dec*
May	June	Jun	*July*	Sep	Dec
June	July	July	*Aug*	Sep	Dec
July	August	Aug	Sep	Dec	*Mar*
August	September	Sep	*Oct*	Dec	Mar
September	October	Oct	*Nov*	Dec	Mar
October	November	Nov	Dec	Mar	*Jun*
November	December	Dec	*Jan*	Mar	Jun
December	January	Jan	*Feb*	Mar	Jun

Exercise Price

It is the price at which the parties with the long and short positions buy and sell the underlying asset. For example, in a December call on shares of a company with a strike price of Rs 90, the implication is that the party with the long position shall, at its option, buy 100 shares (if the call involves 100 shares) of the company at a rate of Rs 90 per share. The "strike price" of Rs 90 is also called the exercise price.

In the case of options on stocks, the exercise prices on which options on a particular share are to be traded are selected by the exchange. Typically, exercise (strike) prices just above and below the current market price of the underlying share are opened for trading. If the price of the share becomes higher than the highest strike price, the exchange would introduce a new series of options prices for all expiration months with a strike price just above the old highest strike price. Similarly, if the price of the share becomes lower than lowest strike price, a new series of options prices for various expiration months with a strike price just below the old lowest strike price would be issued by the exchange.

It may be noted that the standardized options have uniform exercise prices in certain increments. In the American options markets for instance, the options traded have uniform striking prices in the increments of \$ 2.50 or \$ 5, depending upon the price of the underlying stock. Generally, strike price intervals of \$ 2.50 are used for stocks priced below \$ 25 or for stocks with relatively low volatility. In case of stocks which quote at high prices, may be \$ 200 or more, the strike price intervals of \$ 10 are also used.

For trading in the Indian markets, an exchange provides for a minimum of five strike prices for every option type, namely call and put, during the trading month. Two of the contracts with strike prices above, two of them having strike prices below and one contract with exercise price equal to the current price of the security. The strike price intervals for options are as given here:

Price of Underlying	*Strike-price Interval*
≤ Rs 100	5
> Rs 100 and ≤ Rs 200	10
> Rs 200 and ≤ Rs 500	20
> Rs 500 and ≤ Rs 1000	30
> Rs 1000 and ≤ Rs 2500	50
> Rs 2500	100

New contracts with new strike prices for existing expiration dates are introduced for trading on a day, based on the previous day's underlying closing values, as and when required. For deciding on the strike price for options equal to the current price, the closing value of the underlying security is rounded off to the nearest multiplier of the strike price interval.

Option Premium

A glance at the rights and obligations of the buyers and sellers reveals that options contracts are skewed. One may naturally wonder as to why the seller (the writer) of an option should be always obliged to sell/buy an asset whenever the other party desires. The answer is that the writer of an option receives a consideration for the obligation he/she undertakes on himself/herself. This is known as the *price* or the *premium* of the option. Option contracts are created when a buyer and a seller agree on a price. The buyer pays the premium to the seller which belongs to the seller whether the option is exercised or not. If the owner of an option decides *not* to exercise the option, the option expires worthless, the amount of premium becomes the profit of the option writer, while if the option is exercised, the premium gets adjusted against the loss the writer incurs upon such exercise.

Comparison of Market Price of the Asset and the Exercise Price: In-the-Money, At-the-Money and Out-of-the-Money Options

At any time, an option may be *in-the-money*, *at-the-money* or *out-of-the-money*. A call option is said to be *in-the-money* if the price of the stock (which we shall assume is the underlying asset) is greater than the exercise price, while if the stock price is smaller than the exercise price, the call is said to be *out-of-the-money*. For the put options, the reverse holds, so that if the exercise price of a put is greater than the stock price, then the put is said to be *in-the-money* and *out-of-the-money* if the former is a lower than the latter. In each case, however, the option is said to be *at-the-money* if the stock price matches with the exercise price. These concepts are tabulated below, wherein S_0 indicates the present value of the stock (i.e. the value at a given point of time) and E is the exercise price:

Condition	*Call Option*	*Put Option*
$S_0 > E$	In-the-Money	Out-of-the-Money
$S_0 < E$	Out-of-the-Money	In-the-Money
$S_0 = E$	At-the-Money	At-the-Money

Intrinsic Value and Time Value

The premium or the price of an option is made up of two components, namely, the *intrinsic value* and the *time value*. The intrinsic value is also termed as the *parity value* and the time value as the *premium over parity*.

For an option, the *intrinsic value* refers to the amount by which it is in money if it is in-the-money. Therefore, an option which is out-of-the-money or at-the-money has a zero intrinsic value.

For a call option which is in-the-money, then, the intrinsic value is the excess of stock price (S_0) over the exercise price (E), while it is zero if the option is other than in-the-money. Symbolically,

Intrinsic Value of a Call Option = Max $(0, S_0 - E)$.

In case of an in-the-money put option, however, the intrinsic value is the amount by which the Exercise Price (E) exceeds the Stock Price S_0, and zero otherwise. Thus,

Intrinsic Value of a Put Option = Max $(0, E - S_0)$.

The *time value* of an option is the difference between the premium of the option and the intrinsic value of the option. For a call or a put option, which is at-the-money of out-of-the-money, the entire premium amount is the time value. For an in-the-money option, time value may or may not exist. In case of a call which is in-the-money, the time value exists if the call price, C, is greater than the intrinsic value, $S_0 - E$. Generally, other things being equal, the longer the time of a call to maturity, the greater shall the time value be.

This is also true for the put options. An in-the-money put option has a time value if its premium exceeds the intrinsic value, $E - S_0$. Like for call options, put options which are at-the-money or out-of-the-money have their entire premia as the time value. Accordingly,

Time Value of a Call = C – {Max $(0, S_0 - E)$}, and

Time Value of a Put = P – {Max $(0, E - S_0)$}

Example 4.1

Consider the following data about calls on a hypothetical stock:

Option	*Exercise Price*	*Stock Price*	*Call Option Price*	*Classification*
1	Rs 80	Rs 83.50	Rs 6.75	In-the-money
2	Rs 85	Rs 83.50	Rs 2.50	Out-of-money

The first call is in-the-money while the second one is out-of-the-money, as may be observed from the stock prices and the respective exercise prices. Now, we may show how the market prices of the two calls can be divided between intrinsic and time values.

Option	S_0	E	C	*Intrinsic Value* $max\ (0, S_0 - E)$	*Time Value* $C - max\ (0, S_0 - E)$
1	83.50	80	6.75	3.50	6.75 – 3 = 3.75
2	83.50	85	2.50	0	2.50 – 0 = 2.50

Options and the OCC

The provisions specified in the options contracts are guaranteed by the Options Clearing Corporations (OCC). The buyers and sellers of options do not deal with each other directly. Instead, the clearing corporations act as an intermediary between them, by issuing standardized options and by ensuring that the the options contracts are honoured. It should, however, be understood that an option clearing corporation by itself does not buy and sell options. The OCC comes into picture only after two parties trade a contract. It takes an opposite position to each of the traders—a short position in respect of the party with the long position and a long position against the party with a short position. Thus, the buyer of an option relies on the OCC for fulfilment of contractual obligations. Similarly, the option writer has an obligation to the OCC.

Open Interest

Every time a trader takes a long or short position in an options contract, it either adds to his existing interest in the option or reduces it. To illustrate, if an investor already holds a net long position in an options contract, a new long position will add and a new short position will reduce his exposure in the contract. However, at any given point in time, the total outstanding long positions in respect of an options contract are exactly equal to the total outstanding positions in it. The number of outstanding positions at a given time is known as open interest. The open interest in an options contract is an index of its liquidity. The financial press regularly publishes information on the open interest in addition to the usual price data. A sample of such data as published in India is given in Box 4.4.

Options to Option Holders

Once a call or a put option is bought and sold, the holder of it may take one of three courses of action, on a given day. They are:

1. Do nothing.
2. Close out the position in the options market. This may be done by reversing the transaction so that, for example, one who is long, the call option (i.e. one who owns a call) may write a matching call option, or the one who has written a call earlier may buy one. Also, the owner of a call or put may sell it at the current market price.
3. Exercise the option if it is an "American" one. In case of a call option, the call writer would have to deliver the underlying asset and the holder of the call would pay an amount equal to the exercise price. Similarly, if the owner of an American put decides to exercise the option, the seller shall be obliged to buy the underlying asset and pay the owner an amount equal to the exercise price.

Box 4.4 ***Published Information on Option Prices***

Contracts, (Str.Pr.) Premium [Traded Qty., Notion Value in Rs. Lks, No. of Contracts]	Open Int.	Exp.Date
EQUITY OPTIONS ON BSE		
Call Options		
BHEL (180) 161.60 [–, –, –]	1200	25/04/2002
ITC (630) 15.38 [–, –, –]	300	30/05/2002
Reliance Inds. (300) 287.05 [–, –, –]	1800	25/04/2002
Satyam (280) 259.55 [–, –, –]	1200	25/04/2002
Satyam (260) 259.55 [–, –, –]	1200	25/04/2002
Sterlite Opt. (140) 133.25 [–, –, –]	4200	25/04/2002
Put Options		
Digital Global (510) 680.75 [–, –, –]	800	25/04/2002
Sterlite Opt. (130) 133.25 [–, –, –]	600	25/04/2002

EQUITY OPTIONS ON NSE

Call Options

ACC (140.00) 12.00, 12.00, 12.00 [1500, 2.28, 1] .... 18000 ... 25/04/2002
ACC (150.00) 3.50, 3.50, 1.00 [150000, 228.96, 100] .... 277500 ... 25/04/2002
ACC (160.00) 0.10, 0.10, 0.05 [97500, 156.06, 65] .... 517500 ... 25/04/2002
ACC (170.00) 0.05, 0.05, 0.05 [6000, 10.20, 4] .... 240000 ... 25/04/2002
ACC (150.00) 6.40, 7.25, 6.10 [63000, 98.77, 42] .... 184500 ... 30/05/2002
ACC (160.00) 3.00, 3.30, 2.75 [33000, 53.78, 22] .... 124500 ... 30/05/2002
ACC (170.00) 1.30, 1.30, 1.05 [22500, 38.52, 15] .... 45000 ... 30/05/2002
Bajaj Auto (480.00) 3.00, 3.00, 3.00 [800, 3.86, 1] .... 1600 ... 25/04/2002
Bajaj Auto (480.00) 15.00, 15.00, 15.00 [800, 3.96, 1] .... 800 ... 30/05/2002
BHEL (160.00) 2.00, 2.00, 200 [1200, 1.94, 1] .... 8400 ... 25/04/2002
BHEL (170.00) 0.50, 0.50, 0.05 [20400, 34.71, 17] .... 88800 ... 25/04/2002
BHEL (190.00) 0.05, 0.05,0.05 [1200, 2.28, 1] .... 216000 ... 25/04/2002
BHEL (200.00) 0.05, 0.10, 0.05 [7200, 14.41, 6] .... 157200 ... 25/04/2002
BHEL (160.00) 12.90, 12.90, 800 [15600, 26.44, 13] .... 14400 ... 30/05/2002
BHEL (170.00) 7.30, 7.30, 3.70 [129600, 22.693, 108] .... 17400 ... 30/05/2002
BHEL (180.00) 4.00, 4.00, 2.00 [52800, 96.52, 44] .... 111600 ... 30/05/2002
BHEL (190.00) 1.50, 1.50, 1.50 [1200, 2.30, 1] .... 3600 ... 30/05/2002
BHEL (200.00) 1.00, 1.00, 1.00 [3600, 7.24, 3] .... 3600 ... 30/05/2002
BPCL (280.00) 4.05, 4.05, 1.00 [20900. 59.14, 19] .... 42900 ... 25/04/2002
BPCL (300.00) 0.05, 0.05, 0.05 [2200, 6.60, 2] .... 141900 ... 25/04/2002
BPCL (320.00) 0.05, 0.05, 0.05 [5500, 17.60, 5] .... 214500 ... 25/04/2002
BPCL (340.00) 0.05, 0.05, 0.05 [13200, 44.89, 12] .... 182600 ... 25/04/2002
BPCL (360.00) 0.05, 0.05, 0.05 [2200, 7.92, 2] .... 79200 ... 25/04/2002
BPCL (260.00) 32.00, 32.00, 32.00 [1100, 3.21, 1] .... 6600 ... 30/05/2002
BPCL (280.00) 16.25, 17.00, 11.00 [59400, 17.468, 54] .... 130900 ... 30/05/2002
BPCL (300.00) 8.45, 8.60, 8.60, 6.20 [45100, 138.67, 41] .... 154000 ... 30/05/2002
BPCL (320.00) 3.90. 3.90. 2.90 [15400, 49.79, 14] .... 94600 ... 30/05/2002
BPCL (340.00) 1.50, 1.50, 1.00 [12100, 41.29, 11] .... 66000 ... 30/05/2002
Cipla (1000.00) 0.50, 0.50, 0.50 [200, 2.00, 1] .... 800 ... 25/04/2002
Cipla (1050.00) 0.25, 0.25, 0.25 [400, 4.20, 2] .... 9400 ... 25/04/2002
Cipla (1000.00) 31.20, 31.20, 26.00 [2600, 26.76, 13] .... 3800 ... 30/05/2002
Cipla (1050.00) 13.50, 13.50, 11.15 [600, 6.37, 3] .... 1000 ... 30/05/2002
Digital Global (570.00) 112.00, 115.00, 91.00 [3200, 21.33, 8] .... 4400 ... 25/04/2002
Digital Global (600.00) 100.00, 100.00, 92.00 [1200, 8.36, 3] .... 5600 ... 25/04/2002
Digital Global (630.00) 60.10, 62.00, 55.00 [5200, 35.84, 13] .... 10800 ... 25/04/2002
Digital Global (660.00) 43.90, 45.00, 22.00 [33200, 229.04, 83] .... 47600 ... 25/04/2002
Digital Global (690.00) 12.05, 16.05, 0.25 [72000, 501.26, 180] .... 93600 ... 25/04/2002
Digital Global (720.00) 3.75, 4.75, 0.50 [17200, 124.25, 43] .... 50800 ... 25/04/2002
Digital Global (630.00) 78.00, 78.00, 69.75 [1200, 8.44, 3] .... 3200 ... 30/05/2002
Digital Global (660.00) 50.50, 50.50, 46.00 [8400, 59.42, 21] .... 13600 ... 30/05/2002
Digital Global (690.00) 31.65, 35.80, 27.10 [36000, 259.44, 90] .... 38800 ... 30/05/2002
Digital Global (720.00) 20.00, 20.00, 13.50 [25200, 185.71, 63] .... 37600 ... 30/05/2002
Digital Global (750.00) 15.00, 15.00, 8.10 [1200, 9.13, 3] .... 1200 ... 30/05/2002
Dr. Reddy's (1050.00) 6.50, 8.00, 2.00 [2400, 25.33, 6] .... 13600 ... 25/04/2002
Dr. Reddy's (1100.00) 0.10, 0.10,0.10 [400, 4.40, 1] .... 30000 ... 25/04/2002
Dr. Reddy's (1050.00) 31.00, 32.20, 31.00 [2800, 30.28, 7] .... 5600 ... 30/05/2002
Dr. Reddy's (1100.00) 15.00, 15.00, 15.00 [400, 4.46, 1] .... 3600 ... 30/05/2002
Dr. Reddy's (1150.00) 8.10, 8.10, 8.10 [400, 4.63, 1] .... 400 ... 30/05/2002
HLL (200.00) 9.50, 10.00, 9.50 [3000, 6.29, 3] .... 11000 ... 25/04/2002
HLL (220.00) 0.05, 0.05, 0.05 [4000, 8.80, 4] .... 163000 ... 25/04/2002
HLL (210.00) 0.65, 1.25, 10 [27000, 56.89, 27] .... 73000 ... 25/04/2002
HLL (230.00) 0.05, 0.05, 0.05 [2000, 4.60, 2] .... 122000 ... 25/04/2002
HLL (220.00) 3.20, 3.20, 2.00 [17000, 37.82, 17] .... 65000 ... 30/05/2002
HLL (210.00) 6.00, 6.05, 4.90 [19000, 40.93, 19] .... 56000 ... 30/05/2002
HLL (200.00) 15.00, 15.00, 12.00 [2000, 4.27, 2] .... 3000 ... 30/05/2002
HLL (960.00) 7.00, 7.00, 0.10 [16900, 44.53, 13] .... 39000 ... 25/04/2002

Put Options

ACC (150.00) 0.03, 0.35, 0.05 [42000, 63.08, 28] ... 286500 ... 25/04/2002
ACC (140.00) 1.00, 1.00, 1.00 [7500, 10.58, 5] ... 9150 ... 30/05/2002
ACC (150.00) 3.25, 3.25, 2.95 [37500, 57.39, 25] ... 57000 ... 30/05/2002
BHEL (170.00) 2.95, 3.95, 2.00 [4800, 8.30, 4] ... 46800 ... 25/04/2002
BHEL (180.00) 15.00, 15.00, 15.00 [1200, 2.34, 1] ... 57600 ... 25/04/2002
BHEL (160.00) 3.30, 3.80, 3.00 [15600, 25.51, 13] ... 12000 ... 30/05/2002
BHEL (170.00) 7.50, 9.90, 6.55 [38400, 68.36, 32] ... 46800 ... 30/05/2002
BPCL (280.00) 1.20, 3.40, 0.75 [34100, 95.17, 31] ... 75900 ... 25/04/2002
BPCL (300.00) 14.95, 14.95, 14.95 [1100, 3.46, 1] ... 81400 ... 25/02/2002
BPCL (320.00) 36.00, 40.00, 36.00 [2200, 7.88, 2] ... 14300 ... 25/04/2002
BPCL (260.00) 2.90, 4.00, 2.90 [13200, 34.75, 12] ... 45100 ... 30/05/2002
BPCL (280.00) 9.00, 12.00, 9.00 [46200, 133.90, 2] ... 88000 ... 30/05/2002
BPCL (300.00) 21.10, 25.50, 21.10 [9900, 32.03, 9] ... 23100 ... 30/05/2002
BPCL (320.00) 44.00, 44.00, 44.00 [1100, 4.00, 1] ... 3300 ... 30/05/2002
Cipla (1000.00) 8.00, 8.00, 8.00 [200, 2.02, 1] ... 400 ... 25/04/2002
Cipla (1000.00) 25.00, 25.00, 25.00 [200, 2.05, 1] ... 200 ... 30/05/2002
Digital Global (600.00) 0.10, 0.20, 0.10 [2000, 12.00, 5] ... 53200 ... 25/04/2002
Digital Global (630.00) 0.15, 0.20, 0.10 [1600, 10.08, 4] ... 61200 ... 25/04/2002
Digital Global (660.00) 1.00, 1.20, 0.20 19200, 60.80, 23] ... 57600 ... 25/04/2002
Digital Global (690.00) 5.00, 10.00, 3.00 144400, 308.93, 111] ... 42400 ... 25/04/2002
Digital Global (720.00) 20.10, 30.00, 20.10 [800, 5.96, 2] ... 7200 ... 25/04/2002
Digital Global (600.00) 5.00, 8.45, 5.00 [1600, 9.71, 4] ... 1600 ... 30/05/2002
Digital Global (630.00) 12.50, 14.00, 12.50 [3600, 23.16, 9] ... 4400 ... 30/05/2002
Digital Global (660.00) 20.00, 26.00, 19.25 [5200, 35.51, 13] ... 6800 ... 30/05/2002
Digital Global (690.00) 30.00, 43.50, 30.00 [9600, 69.83, 24] ... 10400 ... 30/05/2002
HLL (210.00) 1.50, 2.50, 0.60 [12000, 25.38, 12] ... 46000 ... 25/04/2002
HLL (210.00) 4.95, 4.95, 4.00 [12000, 25.76, 12] ... 13000 ... 30/05/2002
HLL (200.00) 3.00, 3.00, 2.00 [9000, 18.22, 9] ... 12000 ... 30/05/2002
HPCL (260.00) 0.70, 1.0,, 0.50 [28600, 74.57, 22] ... 67600 ... 25/04/2002
HPCL (280.00) 18.70, 20.00, 18.70 [2600, 7.78, 2] ... 122200 ... 25/04/2002
HPCL (270.00) 3.00, 5.50, 3.00 [15600, 42.78, 12] ... 14300 ... 25/04/2002
HPCL (300.00) 35.00, 35.00, 35.00 [1300, 4.36, 1] ... 22100 ... 25/04/2002
HPCL (240.00) 2.20, 3.25, 2.20 [39000, 94.58, 30] ... 71500 ... 30/05/2002
HPCL (260.00) 6.50, 10.25, 6.50 [48100, 129.20, 37] ... 140400 ... 30/05/2002
HPCL (280.00) 20.00, 23.90, 20.00 [10400, 31.34, 8] ... 53300 ... 30/05/2002
HPCL (300.00) 40.00, 40.00, 40.00 [1300, 4.42, 1] ... 6500 ... 30/05/2002
ICICI (60.00) 4.40, 4.40, 4.40 [2800, 1.80, 1] ... 92400 ... 25/04/2002
ICICI (55.00) 1.80, 2.00, 1.80 [16800, 9.56, 6] ... 16800 ... 30/05/2002
ICICI (60.00) 5.00, 5.00, [2800, 1.82,1] ... 2800 ... 30/05/2002
Infosys (3700.00) 3.00, 5.00, 1.00 [1100, 40.72, 11] ... 25400 ... 25/04/2002
Infosys (3800.00) 10.00, 20.00, 5.00 [11600, 442.18, 116] ... 25500 ... 25/04/2002
Infosys (3900.00) 50.00, 109.00, 50.00 [4900, 194.71, 49] ... 6700 ... 25/04/2002
Infosys (4000.00) 125.20, 200.00 125.20 [700, 29.24, 7] ... 4500 ... 25/04/2002
Infosys (3500.00) 38.95, 38.95, 38.95 [100, 3.54, 1] ... 200 ... 30/05/2002
Infosys (3600.00) 55.00, 55.00, 55.00 [100, 3.66, 1] ... 2900 ... 30/05/2002
Infosys (3700.00) 72.00, 86.00, 72.00 [1400, 52.91, 14] ... 3800 ... 30/05/2002
Infosys (3800.00) 110.00, 133.90, 110.00 [2800, 109.79, 28] ... 5300 ... 30/05/2002
Infosys (3900.00) 152.00, 169.95, 152.00 [300, 12.18, 3] ... 3800 ... 30/05/2002
Infosys (4000.00) 229.90, 235.00, 229.90 [300, 12.69, 3] ... 900 ... 30/05/2002
ITC (630.00) 4.75, 14.75, 2.50 [3900, 24.81, 13] ... 15000 ... 25/04/2002
ITC (690.00) 70.00, 70.00 70.00 [300, 2.28, 1] ... 3000 ... 25/04/2002
ITC (630.00) 19.00, 19.90, 17.00 [1200, 7.78, 4] ... 1200 ... 30/05/2002
L & T (170.00) 1.25, 3.00, 0.85 [19000, 32.65, 19] ... 91000 ... 25/04/2002
L & T (180.00) 10.55, 13.00, 10.50 [5000, 9.55, 5] ... 90000 ... 25/04/2002
L & T (170.00) 4.90, 6.00, 4.50 [42000, 73.56, 42] ... 98000 ... 30/05/2002
L & T (180.00) 11.50, 13.45, 11.50 [14000, 26.99, 14] ... 14000 ... 30/05/2002
L & T (190.00) 20.00, 22.00, 20.00 [7000, 14.75, 7] ... 7000 ... 30/05/2002
L & T (160.00) 1.50, 2.15, 1.50 [14000, 22.64, 14] ... 48000 ... 30/05/2002

M&M (105.00) 0.25, 0.25, 0.25 [2500, 2.63, 1]	2500	25/04/2002
M&M (105.00) 3.40, 3.40, 3.40 [2500, 2.71, 1]	7500	30/05/0002
MTNL (150.00) 5.00, 5.00, 5.00 5.00 [1600, 2.48, 1]	9600	25/04/2002
MTNL (140.00) 7.60, 8.00, 7.60 [3200. 4.73. 2]	8000	30/05/2002
MTNL (130.00) 2.45, 2.50, 2.45 [4800, 6.36, 3]	8000	30/05/2002
Ranbaxy Labs (840.00) 0.25, 0.25, 0.25 [500, 4.20, 1]	6000	25/04/2002
Ranbaxy Labs (870.00) 1.20, 1.20, 0.45 [2000, 17.42, 4]	21500	25/04/2002
Ranbaxy Labs (840.00) 6.90, 7.00, 6.05 [2500, 21.17, 5]	4500	30/05/2002
Ranbaxy Labs (870.00) 13.00, 17.00, 13.00 [1500, 13.28, 3]	3500	30/05/2002
Reliance Inds. (280.00) 0.25, 0.35, 0.05 [15000, 42.04, 25]	236400	25/04/2002
Reliance Inds. (300.00) 12.00, 12.65, 10.50 [7800, 24.29, 13]	130200	25/04/2002
Reliance Inds. (260.00) 1.25, 1.35, 1.25 [3000, 7.84, 5]	32400	30/05/2002
Reliance Inds. (280.00) 4.00, 4.45, 3.60 [33000, 93.73, 55]	82200	30/05/2002
Reliance Inds. (300.00) 13.00, 14.95, 13.00 [18600, 58.42, 31]	58800	30/05/2002
Reliance Petro. (30.00) 4.50, 4.50	12900	25/04/2002
Reliance Petro. (25.00)		

Source: *The Economic Times*, April 26, 2002

The first two choices are available to the call or put option writers also. For instance, the position of an option writer can be closed out by a reversal of the previous action by buying an option matching the one written earlier.

In the event that a call/put holder does nothing by the closure of trading on its expiration date, then the result will depend on the market price of the underlying asset on the date of expiry. For instance, for a call option, if the price of the underlying asset is lower than the exercise price, then the call would expire and become worthless. For example, if the exercise price of a call option is Rs 90 and the market price of the share involved is Rs 84 on the expiration day, then it would not be worthwhile for the holder to exercise the option. This is because, exercising the option will mean that the holder will end up paying Rs 90 for something which can be bought in the spot market for Rs 84. On the other hand, if the price of the underlying asset is more than the exercise price of a call, then it will be prudent for the call owner to exercise it and make profit from the transaction (this of course assumes that there are no transaction costs). That is on account of the fact that the owner gets for a price of, say, E, something which is more valuable than E.

Similarly, if the price of the underlying asset is more than the exercise price in respect of a put option, it becomes worthless upon expiry. Obviously, if one holds a put whereby a share can be sold to the writer for a price of Rs 47, and, suppose the share price in the market is Rs 52, then it will not make any sense to exercise the put and sell the share at the rate of Rs 47! The put option will, evidently, be advantageous to exercise if the value of the underlying asset is lower than the exercise price.

Exercise of Options

Most of the option holders do not exercise their options because they do not want to take a position in the underlying stock. Accordingly, most of the investors make a closing transaction to effectively cancel their positions. However, when an option holder does decide to exercise an option, the Option Clearing Corporation randomly assigns the exercise notice to an option writer, which is typically a brokerage firm. The brokerage firm, in turn, assigns it to one (or more of their customers who wrote the option(s).

It is important to note that once an exercise notice is issued to a particular writer, the writer is not allowed to cancel out the position by using a closing transaction. Thus, the writer of an option always carries the risk that the option may be exercised and that he/she may be called upon to make a delivery. However, this does not pose a difficulty if the underlying asset is a share which is freely traded in the market.

Covered and Naked Calls

If the owner of a call decides to exercise the call, then the writer of the call has the obligation to sell the underlying asset to the call owner at the strike price. The writer of the call would receive an amount equal to the exercise price. The call writer might, or might not, be holding the underlying asset. If a call writer owns the asset underlying the call, he/she is said to have written a *covered call.* On the other hand, if a call is written where the writer does not have the asset underlying the call option, the call is said to be a *naked call.* In the event of a decision of the call owner to exercise the option in the latter case, the seller of the call has to buy the underlying asset at its prevailing market price and give it to the call owner. For a call option on a certain share, the required number of shares would be bought and delivered.

Similarly, when the put positions are opened, the put buyer gives the put premium to the put writer. If the owner of a put option chooses to exercise the option, the put writer is obliged to accept the underlying asset at the strike price.

Margin Requirements

As in the case of futures contracts, the performance of options contracts is also assured by the options exchanges (the OCC). When the buyer of an option enjoys the right of its performance on the exchange, the exchange has, in turn, to make sure that the contract will be honoured. Thus, for example, if I write a naked call, my broker would need a guarantee in some form that I would have the necessary funds to be able to deliver the asset, should the buyer of the option choose to exercise the call, and in turn assure the exchange of the performance of the contract. For this, *margin* requirements exist as a form of collateral to ensure that the writer of a naked call can fulfill the terms of the contract.

Accordingly, the writers of options are required to meet the margin requirements. The requirements vary depending upon the brokerage firm, the price of the underlying asset, the price of the option, and whether the option is a call or a put. As a general rule, initial margins are at least 30% of the stock price when the option is written, *plus* the intrinsic value of the option. The amount of margin has an influence on the degree of financial leverage that the investor has and, consequently, on the returns and risk on the position.

BUYER/SELLER ATTITUDES

Call buyers as bullish because they hope that the price of the underlying asset will increase. If you buy a call option on a share, with a strike price of Rs 150 per share, then you would be happy when the price increases to, say Rs 160, and happier when it rises to, say, Rs 180. Other things being equal, an option to buy the share at Rs 150 is obviously more valuable when it is selling at Rs 160 than when it is selling for Rs 150, and the higher the price beyond Rs 150, the more valuable would the call be. The call writer, who writes a naked call, expects the price of the underlying asset to fall. In such an event, the writer retains the premium as profit for undertaking to write the call.

In contrast to these, the put buyers are bearish—hoping that the price of the underlying asset would scale down—while the writers of the put options are bullish in nature. Put options are a waste when the market price of the asset exceeds the exercise price and so whereas the put buyers would like to see the prices falling, their writers like it the other way round.

OPTION PRICING

We have discussed earlier 'the' option price or the option premium. This is because, to begin with, we assumed that there are no transactions costs involved in trading in the options—whether buying or selling. In such a situation, an investor can buy or sell shares and options at a single price, without paying any commissions and buying/selling can be done instantaneously. In reality, however, at any time, there are two prices on an options—*bid* price and *ask* price, with the ask price being greater than the bid price. The bid price is the price at which one is prepared to buy an option while the ask (or asked) price is the price at which one is prepared to sell it. These prices are quoted by market makers, the exchange members who provide liquidity to the market. In case the market makers were not there, an investor proposing to sell options would have to wait until some buyer came along and proposed to buy the quantity offered at a suitable price. The market makers lend a great deal of liquidity by providing a continuous market to the buyers and sellers. The difference between the ask and bid prices is the *bid-ask spread*, which is the source of profit for the market makers.

By assuming that the options are bought and sold at a single price, we are assuming, in effect, that the bid-ask spread does not exist. There is another factor to be considered here. In a perfectly competitive market, it is possible to buy or sell *any* quantity of an asset at the ruling price without affecting the price. However, the options markets generally do not have the depth and liquidity to be perfectly competitive so that if a large quantity is sought to be bought/sold, it would affect the option price most likely. This is what is known as the *price pressure*.

Thus, reference to merely the price of an option is tantamount to implicitly assuming the absence of bid-ask spread and the existence of perfect competition in the options market. We return to a discussion on these concepts later.

Call Option at Expiration

If the price of the underlying asset is lower than the exercise price on the expiration of a call option, the call would expire unexercised. This is because no one would like to buy an asset which is available in the market at a lower price. If an out-of-the-money call did actually sell for a certain price, the investor can make an arbitrage profit by selling it and earning a premium. The buyer of the call is then unlikely to exercise this option, thus allowing the call seller to retain the premium. In the event of (an irrational) exercise of such a call, the call writer would buy the asset from the market at the prevailing price, S_1, and sell to the holder of the call at a rate of E, thereby making a profit of $E - S$, in addition to the call premium received earlier.

On the other hand, if the call happens to be in-the-money, it will be worth its intrinsic value, equal to the excess of asset price over the exercise price. If the call price happens to be lower than the intrinsic value, it will be profitable to buy the call at C, exercise it immediately, by paying an amount equal to E for the asset to be sold immediately in the market at a price of S_1 and thereby make a profit equal to $S_1 - E - C$, because $S_1 > E$, and $C < (S_1 - E)$. Similarly, if an in-the-money call option is selling at a value greater than the difference between the asset price and the exercise price, an arbitrage profit can be made by selling an option, buying the asset and, finally, delivering the asset on exercise.

Example 4.2

A call option involving 200 shares, due to mature, is selling for Rs 3.25 on a share which is selling in the market at Rs 66. The option has an exercise price equal to Rs 62.

Here, the call is priced lower than its intrinsic value. An arbitrageur may buy the call for 200 shares by paying Rs 650, exercise it and get the shares by paying Rs 12,400. The 200 shares may be sold immediately in the market to get Rs 13,200. It would yield a net profit of Rs 13,200 – Rs 12,400 – Rs 650 = Rs 150.

Example 4.3

Suppose that a call option involving 100 shares is selling for Rs 5.25 when the share price is Rs 64 and exercise price is Rs 60.

Here, an arbitrageur can sell the call on 100 shares to receive Rs 525 and buy the shares for Rs 6400. When the call, being in-the-money, is exercised, shares can be delivered for Rs 6000. This would result in an arbitrage profit of Rs 6000 + Rs 525 – Rs 6400 = Rs 125.

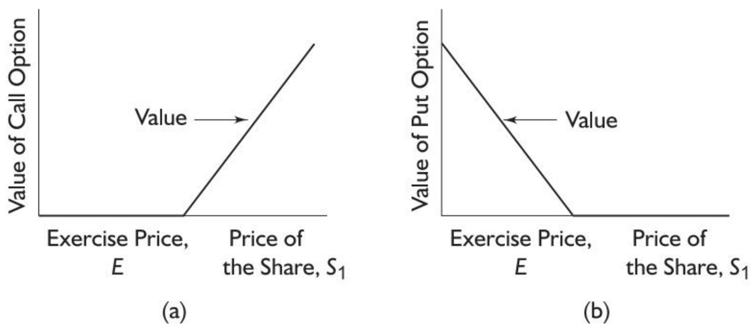
Thus the price of a call on expiration is a function of the share price at the expiration, S_1, and the exercise price, E. This is equal to zero when $S_1 \leq E$ and $S_1 - E$ when $S_1 > E$.

Put Option at Expiration

We may determine the value of a put option at expiration in a manner similar to that for a call option. Thus, when at expiration the price of the underlying asset is greater than the exercise price, the put will expire unexercised. This is because there is no point in exercising an option to sell, for instance, a share for, say Rs 65 when it is selling in the market for Rs 70. Thus, a rational investor would not exercise an out-of-the-money option. If such an option was indeed selling in the market for some price P, it is better for the holder to sell it and gain the cash flow. Further, if such an option was actually (irrationally, of course) exercised, it would benefit the seller of the call because he could pay E for the asset and sell it in the market for a higher price S_1. On the other hand, if a put option is in-the-money, then it must sell for $E - S_1$. Assuming that it was selling at a price higher than the difference between the exercise price and the asset price, then arbitrage profit could result. For example, suppose that a put option is selling at Rs 4.80, while the underlying share is priced at Rs 67 and the exercise price in the put is Rs 70. Now, an arbitrageur can sell an option for 100 shares and receive Rs 480, get the shares for Rs 7,000 when the option is exercised, sell the shares in the market at Rs 67 per share to receive a sum of Rs 6,700. This would result in a net gain of Rs 67,000 + Rs 480 – Rs 7,000 = Rs 180. If the market works perfectly, then no arbitrage opportunity would be possible and the put would be selling for no more than the difference between the exercise price and the stock price.

Thus the price of a put option on expiration is a function of the asset price at expiration, S_1, and the exercise price, E. This is equal to zero when $S_1 \geq E$ and $E - S_1$ when $S_1 < E$.

Figure 4.1 (a) illustrates that the price of a call option is nil when the stock price falls short of the exercise price E. This is reflected in the horizontal line to the left of E. When, however, the stock price (S_1) is greater than the exercise price, the call is worth $S_1 - E$. This shown by the line at 45 degrees.



➢ **Fig. 4.1** *Call and Put Pricing at Expiration*

On the other hand, Fig. 4.1(b) shows the worth of a put option. This shows that a put option is worthless for the range of stock prices greater than *E*, the exercise price. For price below this, the worth of a put option equals the excess of exercise price over the share price.

Option Pricing before Expiration

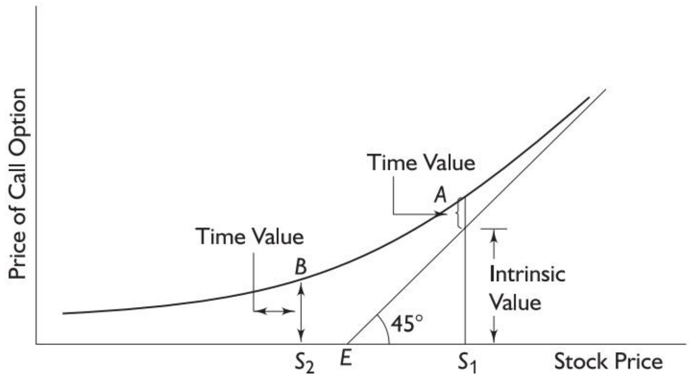
Before the expiration, the options, whether call or put, are usually sold for at least their intrinsic values. They may, or may not, have any time value. We shall first briefly describe about the pricing of the call options and then about the pricing of the put options. A detailed discussion about the determination of the premia on options can be found in Chapter 5.

Call Options Pricing A call option will usually sell for at least its intrinsic value. (An exception to this may be a European call on a share that would trade ex-dividend prior to the date of expiry—if the amount of dividend be large, the call might sell for less than its intrinsic value.) To this would be added the time value, if any: longer the time to expiry, greater is the time value. Thus, the premium on a call option is a function of the exercise price, the stock price and the time to expiry. There are other factors also which affect the price of an option. They are:

1. Variability of the prices (i.e., the variance of the distribution of stock's returns) of the underlying share, called the *volatility*.
2. Interest rate and the dividend, if any, between the current date and the date of expiration.

While the direction of the impact of these factors on the price of an option can be visualized, the way they contribute and affect the price of call options will be examined in the Chapter 5. Models, like the Black and Scholes option pricing model, have been developed over time which not only attempt to determine the price of an option on the basis of some given data but also provide a tool to find how option values will change, given a small change in one of the parameters of the system while holding all of the other parameters constant.

The price of a call option at a time before expiry can be shown as given in Fig. 4.2. The figure gives the value of an option with a certain maturity and exercise price *E*. For stock price values greater than *E*, the intrinsic value is equal to the excess of stock price over the exercise price. Thus, the minimum value of an option (equal to its intrinsic value) is shown by a 45-degree line starting at *E*, so as to have a height at any point to the right of E, equal to the excess of stock price (S) over the exercise price (E).



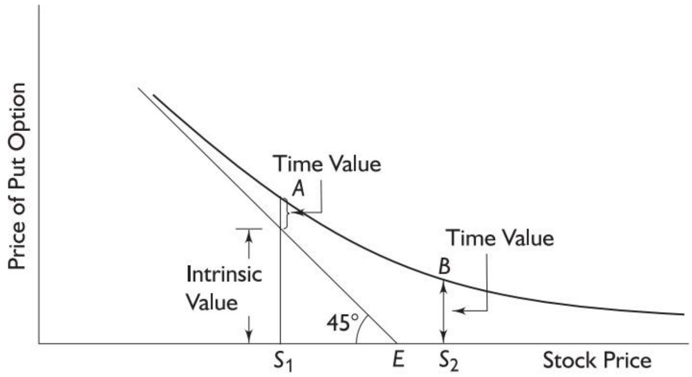
➢ **Fig. 4.2** *Call Option Pricing Before Expiration*

When the stock price is, say, S_1, the option price would be equal to S_1 A—intrinsic value *plus* time value, as shown in the figure. On the other hand, if the share is priced at S_2, the call option is out-of-the-money and valued at S_2B, comprising only of the time value.

With all parameters remaining unchanged, if the time to maturity increases, then the curve showing the option value would shift upward.

Put Options Pricing Like a call option, a put option would sell for a price that is at least equal to its intrinsic value, which is the excess of exercise price over the stock price, when the option is in-the-money. For an in-the-money option, the premium is equal to the sum of the intrinsic value and the time value (which, in turn, is a function of the time to maturity). On the other hand, the at-the-money and out-of-the-money options have intrinsic value of nil and, accordingly, their prices are reflective of only the time value.

The price of a hypothetical put option with a certain time to maturity and an exercise price of E is depicted graphically in Fig. 4.3. The curve showing the price of the option is shown in the figure above the line depicting minimum value of the option price. This line, corresponding to the intrinsic value of the option is drawn at an angle of 45 degrees at point E, to the left of it. This is because the put option is in-the-money when $E > S$. As in the case of a call option, the put option premium is equal to the intrinsic value plus the time value. An out-of-the-money option, like the one when the stock price is S_2, has a premium comprising only of the time value.



➣ **Fig. 4.3** *Put Option Pricing Before Expiration*

RISK AND RETURN ON EQUITY OPTIONS

We may now discuss about the risk and return associated with equity options contracts. More details on risks of the parties to an option contract are given in Chapter 7. The analysis here is based on the following assumptions:

(i) The options are of the European style so that they cannot be exercised before the date of maturity.

(ii) The option positions are uncovered or naked. The buyer and the writer of an option contract are assumed not to have positions in the underlying stock.

(iii) There are no taxes and no transaction costs so that a position can be taken without incurring any cost. Consideration of transaction costs (brokerage fees, etc.) and taxes would obviously reduce the gains and increase the losses in a given situation.

First we consider the call options and then the put options.

Call Options

Consider a call option on a certain share, say *ABC*. Suppose the contract is made between two investors *X* and *Y*, who take, respectively, the short and long positions. The other details are given below:

Exercise price = Rs 120
Expiration month = March, 2003
Size of contract = 100 shares
Date of entering into contract = January 5, 2003

Price of share on the date of contract = Rs 124.50
Price of option on the date of contract = Rs 10

At the time of entering in to the contract,
Investor *X* writes a contract and receives Rs 1000 (= 10 × 100)
Investors *Y* takes a long position and pays Rs 1000 for it.

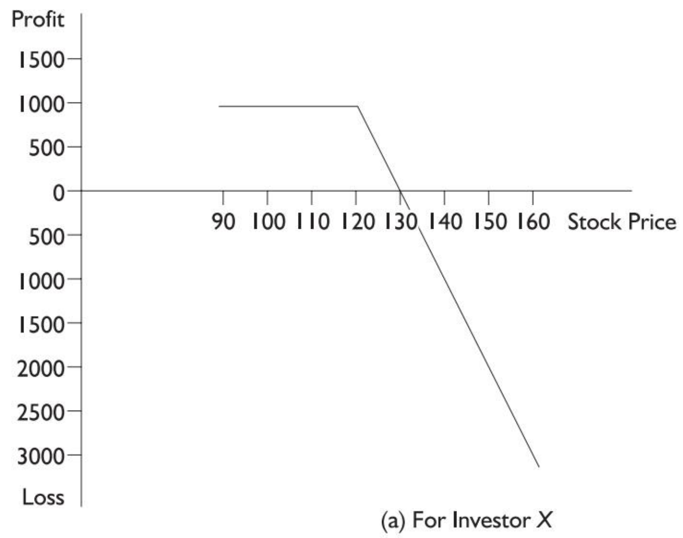
On the date of maturity, the profit or loss to each investor would depend upon the price of the share *ABC* prevailing on that day. The buyer would obviously not call upon the call writer to sell shares if the price happens to be lower than Rs 120 per share. Only when the price exceeds Rs 120 per share will a call be made. Having paid Rs 10 per share for buying an option, the buyer can make a profit only in case the share price would be at a point higher than Rs 120 + Rs 10 = Rs 130. At a price equal to Rs 130 a break-even point is reached. The profit/loss made by each of the investors for some selected values of the share price of *ABC* is indicated in Table 4.2.

Table 4.2

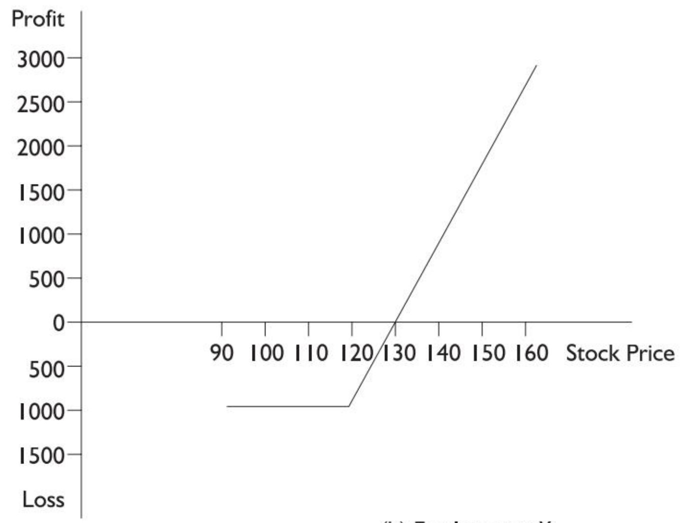
Profit/Loss Profile for the Investors—Call Option

Possible Price of ABC at Call Maturity (Rs)	*Investor X*	*Investor Y*
90	1000	– 1000
100	1000	– 1000
110	1000	– 1000
120	1000	– 1000
130	0	0
140	– 1000	1000
150	– 2000	2000
160	– 3000	3000

The profit profile for this contract is indicated in Fig. 4.4. Figure 4.4 (a) shows the profit/loss function for the investor *X*, the writer of the call, while Fig. 4.4 (b) gives the same for the other investor *Y*, the buyer of the option. It is evident that the call writer's profit is limited to the amount of call premium but, theoretically, there is no limit to the losses if the stock price continues to increase and the writer does not make a closing transaction by purchasing an identical call. The situation is exactly opposite for the call buyer for whom the loss is limited to the amount of premium paid. However, depending on the stock price, there is no limit on the amount of profit which can result for the buyer. Being a 'zero-sum' game, a loss (gain) to one party implies an equal amount of gain (loss) to the other party.



(a) For Investor *X*



(b) For Investor *Y*

➢ **Fig. 4.4** *Profit Functions: Call Option*

Put Options

In a put option, since the investor with a long position has a right to sell the stock and the writer is obliged to buy it at the will of the buyer, the profit profile is different from the one in a call option where the rights and obligations are different.

Consider a put option contract on a certain share, *PQR*. Suppose, two investors *X* and *Y* enter into a contract and take short and long positions respectively. The other details are given below:

Exercise price = Rs 110
Expiration month = March, 2003
Size of contract = 100 shares
Date of entering into contract = January 6, 2003
Share price on the date of contract = Rs 112
Price of put option on the date of contract = Rs 7.50

Now, as the contract is entered into, the writer of the option, *X*, will receive Rs 750 (= 7.50 × 100) from the buyer, *Y*. At the time of maturity, the gain/loss to each party depends on the ruling price of the share. If the price of the share is Rs 110 or greater than that, the option will not be exercised, so that the writer pockets the amount of put premium—the maximum profit which can accrue to a seller. At the same time, it represents the maximum loss that the buyer is exposed to. If the price of the share falls below the exercise price, a loss would result to the writer and a gain to the buyer. The maximum loss that the writer may theoretically be exposed to is limited by the amount of the exercise price. Thus, if the value of the underlying share falls to zero, the loss to the writer is equal to Rs 110 – Rs 7.50 = Rs 102.50 per share. The profit/loss for some selected values of the share are given in Table 4.3.

The break-even share price would be Rs 102.50 (= Rs 110 – Rs 7.50). If the price of the share happens to be lower than this, the writer would make a loss—and the buyer makes a gain. For instance, when the price of the share is Rs 100, the gain/loss for each of the investory may be calculated as shown below.

Investor X
Option premium received = 7.5 × 100 = Rs 750
Amount to be paid for shares = 110 × 100 = Rs 11,000
Market value of the shares = 100 × 100 = Rs 10,000
Net Profit(Loss) = 750 – 11,000 + 10,000 = (Rs 250)

Table 4.3

Profit/Loss Profile for the Investors—Put Option

Possible Price of PQR at Put Maturity (Rs)	*Investor X*	*Investor Y*
80	– 2250	2250
90	– 1250	1250
100	– 250	250
110	750	– 750
120	750	– 750
130	750	– 750
140	750	– 750
150	750	– 750

Investor Y

Option premium paid = 7.5 × 100 = Rs 750

Amount to be received for shares = 110 × 100 = Rs 11,000

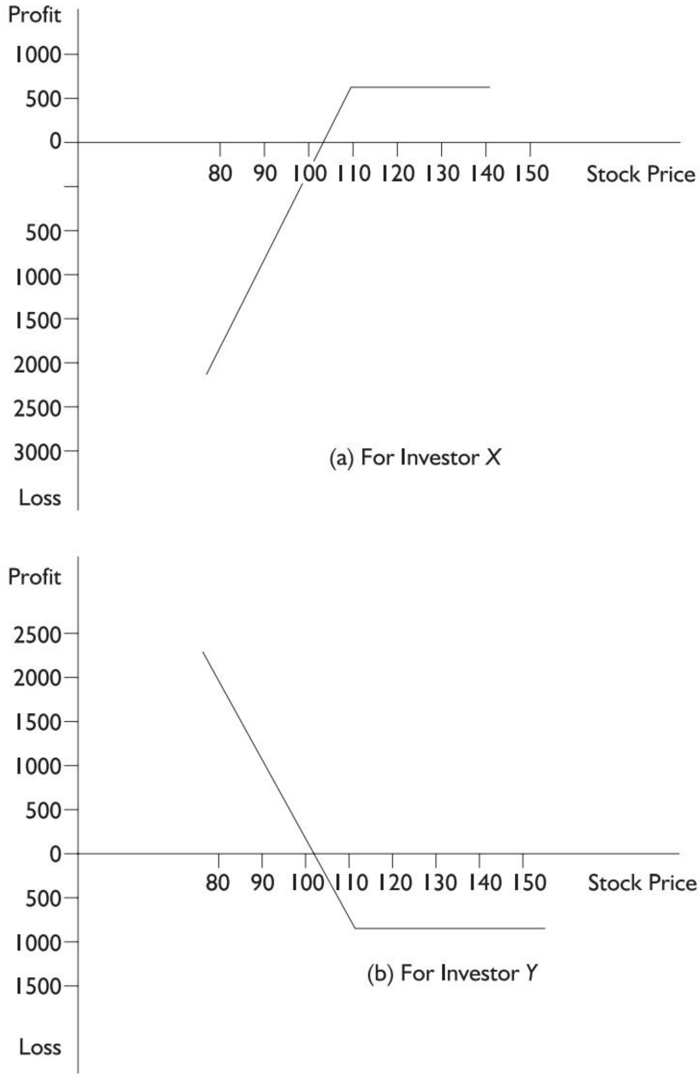
Market value of the shares = 100 × 100 = Rs 10,000

Net profit (loss) = – 750 + 11,000 – 10,000 = Rs 250

The profile of profit/loss for each of the investors is given in Fig. 4.5. Fig. 4.5(a) shows the profit/loss function for the investor *X*, the writer of the put, while the Fig. 4.5(b) gives the same for the other investor *Y*, the buyer of the option. As indicated earlier, the profiles of the two investors replicate each other.

OPTIONS TRADING STRATEGIES

We have considered above the profit/loss resulting to the investors with long and short positions in the call and put options. It is important to note that an investor need not take positions in naked options only or in a single option alone. In fact, a number of trading strategies involving options may be employed by the investors. Options may be used on their own, in conjunction with the futures contracts, or in a strategy using the underlying instrument (equity stock, for example). One of the attractions of options is that they could be used for creating a very wide range of payoff functions. We now discuss some of the commonly used strategies.



➢ **Fig. 4.5** *Profit Functions: Put Option*

To begin with, we may consider investment in a single stock option. The payoffs associated with a long or short call, and a long or short put option have already been discussed. A long call is used when one expects that the market would rise. The more bullish market sentiment or perception, the more out-of-the money option should one buy. For the option buyer in this strategy, the loss is limited to the premium payable while the profit is potentially unlimited. On the other hand, the writer of a call has a mirror image position along the break-even line. The writer writes a call with the belief or expectation that the market would not show an upward trend.

In case of the put option, a long put would gain value as the underlying asset, the equity share price or the market index, declines. Accordingly, a put is bought when a decline is expected in the market. The loss for a put buyer is limited to the amount paid for the option if the market ends above the option exercise price. The writer of a put option would get the maximum profit equal to the premium amount but would be exposed to loss should the market collapse. The maximum loss to the writer of a put option on an equity share could be equal to the exercise price (since the stock price cannot be negative).

Thus, while selling of options may be used as a legitimate means of generating premium income and purchases in the expectation of making profit from the likely bullish/bearish market sentiments, they may or may not be used alone. They may, however, be combined in several ways without taking positions in the underlying assets or they might be used in conjunction with the underlying assets for purposes of hedging, which we describe in the next section.

Hedging Using Call and Put Options

Hedging represents a strategy by which an attempt is made to limit the losses in one position by simultaneously taking a second offsetting position. The offsetting position may be in the same or a different security. In most cases, the hedges are not perfect because they cannot eliminate all losses. Typically, a hedge strategy strives to prevent large losses without significantly reducing the gains.

Very often, options in equities are employed to hedge a long or short position in the underlying common stock. Such options are called covered options in contrast to the uncovered or naked options, discussed earlier.

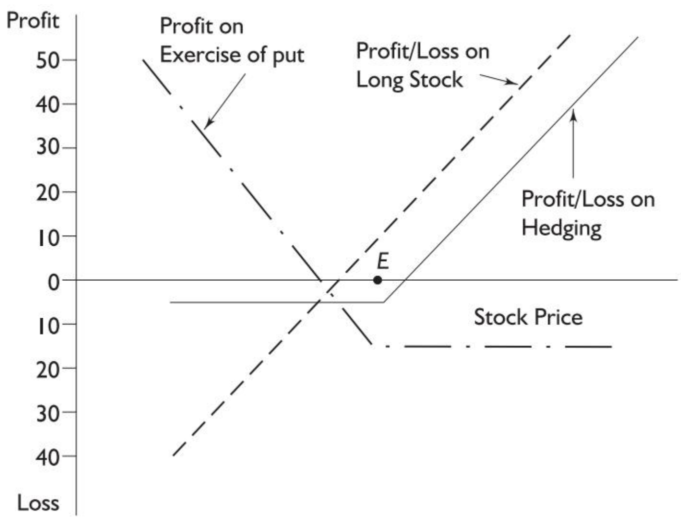
Hedging a Long Position in Stock An investor buying a common stock expects that its price would increase. However, there is a risk that the price may in fact fall. In such a case, a hedge could be formed by buying a put, i.e., buying the right to sell. Consider an investor who buys a share for Rs 100. To guard against the risk of loss from a fall in its price, he buys a put for Rs 16 for an exercise price of, say, Rs 110. He would, obviously, exercise the option only if the price of the share were to be less than Rs 110. Table 4.4 gives the profit/loss for some selected values of the share price on maturity of the option. For instance, at a share price of Rs 70, the put will be exercised and the resulting profit would be Rs 24, equal to Rs 110 – Rs 70, or Rs 40 *minus* the put premium of Rs 16. With a loss of Rs 30 incurred for the reason of holding the share, the net loss equals to Rs 6.

Table 4.4

Profit/Loss for Selected Share Values : Long Stock Long Put

Share Price	*Exercise Price*	*Profit on Exercise (i)*	*Profit/Loss on Share Held (ii)*	*Net Profit (i) + (ii)*
70	110	24	– 30	– 6
80	110	14	– 20	– 6
90	110	4	– 10	– 6
100	110	– 6	0	– 6
110	110	– 16	10	– 6
120	110	– 16	20	4
130	110	– 16	30	14
140	110	– 16	40	24

The profits resulting from the strategy of holding a long position in stock and long put are shown in Fig. 4.6. In Figs. 4.6 – 4.10, the dashed lines depict the relationship between profit and stock price for the stock in question, on the one hand, and profit and the option on the other. The solid line in each case depicts the relationship between profit and stock price for the whole portfolio. It may further be noted that the profit/loss shown is on a per share basis.



➢ **Fig. 4.6** *Hedging: Long Stock Long Put*

Hedging a Short Position in Stock Unlike an investor with a long position in stock, a short seller of stock anticipates a decline in the stock price. By shorting the stock now and buying it at a lower price in the future, the investor intends to make a profit. Any price increase can bring losses because of an obligation to purchase at a later date. To minimize the risk involved, the investor can buy a call option with an exercise price equal to or close to the selling price of the stock.

Let us suppose, an investor shorts a share at Rs 100 and buys a call option for Rs 4 with a strike price of Rs 105. The conditional payoffs resulting from some selected prices of the share are shown in Table 4.5. The payoff function associated with this policy is shown in Fig. 4.7.

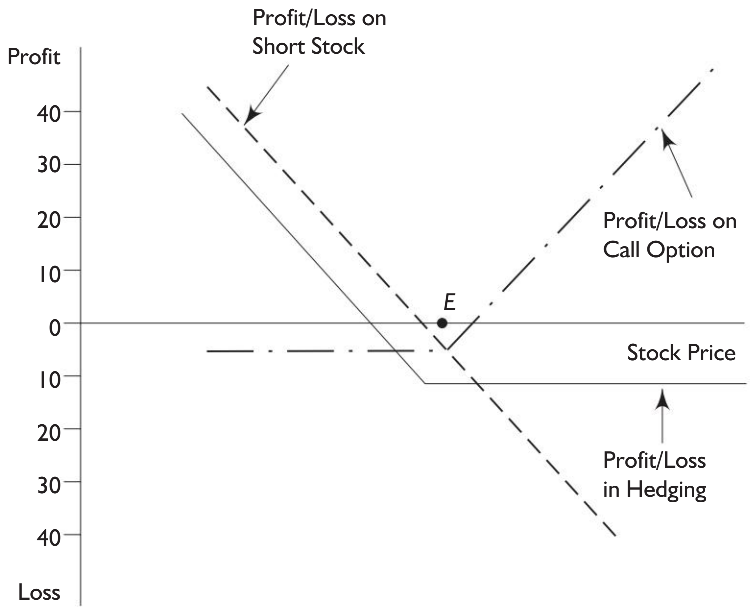
Table 4.5

Profit/Loss for Selected Share Values : Short Stock Long Call

Share Price	*Exercise Price*	*Profit on Exercise (i)*	*Profit/Loss on Share Held (ii)*	*Net Profit (i) + (ii)*
90	105	– 4	15	11
95	105	– 4	10	6
100	105	– 4	5	1
105	105	– 4	0	– 4
110	105	1	– 5	– 4
115	105	6	– 10	– 4
120	105	11	– 15	– 4

Hedging with Writing Call and Put Options

Both the strategies discussed above aim at limiting the risk of an underlying position in an equity stock. Options may also be used for enhancing returns from the positions in stock. If the common stock is not expected to experience significant price variations in the short run, then the strategies of writing calls and puts may be usefully employed for the purpose. As an example, suppose that you hold shares of a stock which you expect will experience small changes in the short term, then you may write a call on these. This is known as writing *covered calls*. By writing covered call options, you tend to raise the short term returns. Of course, you will not derive any benefit if large price changes occur because then the option will be exercised or, else, you would have to make a reversing transaction. The writing of covered calls, i.e. agreeing to sell the stock you have, is a very conservative strategy.



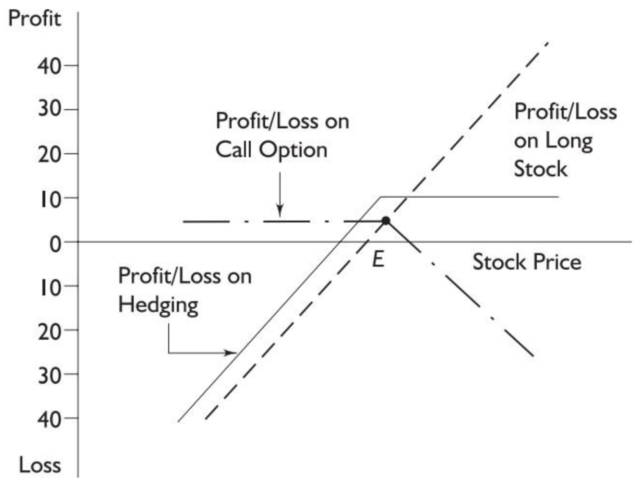
➢ **Fig. 4.7** *Hedging: Short Stock Long Call*

To illustrate the strategy of writing a covered call, consider an investor who has bought a share for Rs 100, and who writes a call with an exercise price of Rs 105, and receives a premium of Rs 3. The profit/loss occurring at some prices of the underlying share, is indicated in Table 4.6. Figure 4.8 depicts the payoff function for the strategy of writing covered calls.

Table 4.6

Profit/Loss for Selected Share Values : Long Stock Short Call

Share Price	*Exercise Price*	*Profit on Exercise (i)*	*Profit/Loss on Share Held (ii)*	*Net Profit (i) + (ii)*
90	105	3	– 10	– 7
95	105	3	– 5	– 2
100	105	3	0	3
105	105	3	5	8
110	105	– 2	10	8
115	105	– 7	15	8
120	105	– 12	20	8



➢ **Fig. 4.8** *Hedging: Long Stock Short Call*

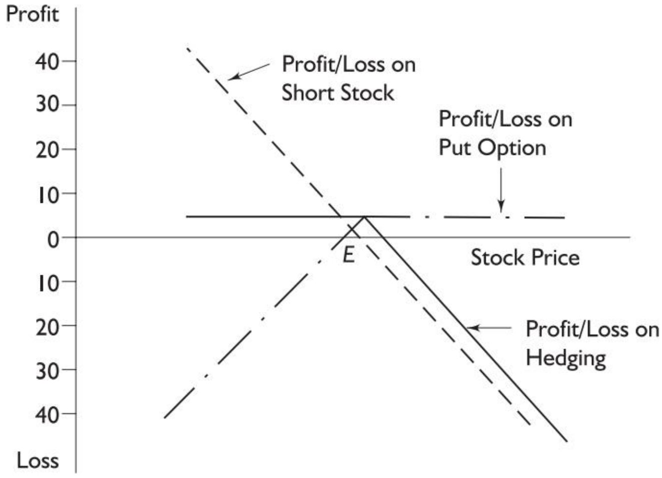
In a similar way, an investor who shorts stock can hedge by writing a put option. By undertaking to 'be the buyer', the investor hopes to reduce the magnitude of loss that would be occurring from an increase in the stock price, by limiting the profit that could be made when the stock price declines. As an example, suppose that you short a share at Rs 100 and write a put option for Rs 3, having an exercise price of Rs 100. Clearly, the buyer of the put will exercise the option only if the share price does not exceed the exercise price. The conditional payoffs resulting from some selected values of the share price are contained in Table 4.7.

Table 4.7

Profit/Loss for Selected Share Values : Short Stock Short Put

Share Price	*Exercise Price*	*Profit on Exercise (i)*	*Profit/Loss on Share Held (ii)*	*Net Profit (i) + (ii)*
90	100	– 7	10	3
95	100	– 2	5	3
100	100	3	0	3
105	100	3	– 5	– 2
110	100	3	– 10	– 7
115	100	3	– 15	– 12
120	100	3	– 20	– 17

Figure 4.9 gives a general view of the profit function associated with the policy of writing a protected put.



➢ **Fig. 4.9** *Hedging: Short Stock Short Put*

Spreads and Combinations

As indicated earlier, options can be combined in several ways—multiple calls, multiple puts or calls and puts together. We shall discuss some of the more generally used combinations.

Spreads A spread trading strategy involves taking a position in two or more options of the same type.

Bull Spreads One of the most popular spread strategies is a bull spread. A bull spread reflects the bullish sentiment of a trader and can be created by purchasing a call option on a stock and selling another call on the stock and with the same expiry but a higher exercise price. At expiry, if the stock remains below the lower strike price, both calls would expire unexercised and the loss will be limited to the initial cost of the spread. It may be recalled that other things remaining the same, a call with a lower exercise price has a greater premium. Accordingly, the price payable for buying a lower exercise price options is more than the premium receivable from writing an option with a greater exercise price and, hence, a cost is involved in buying the spread.

Further, if the stock price rules between the strike prices of the two calls, the purchased call is in-the-money while the call sold expires unexercised. Thus, the payoff equals the difference between the stock price and the (lower) exercise price. If the stock price is greater than the higher exercise price, both options are in-the-money and the payoff equals the difference between the exercise prices of the two options. To illustrate this, suppose that you buy a call option with an exercise price of Rs 50 for Rs 8 and sell one with an exercise price of Rs 60 for a premium of Rs 2, both being on the same stock and with same expiration date. Now if the price rules at Rs 50 or less, none of them would be exercised, with the result that the payoff will be nil and the net loss would be Rs 6 (Rs 8 – Rs 2). If the price of stock at the time of exercise is, say, Rs 58, then the call with an exercise price of Rs 50 shall be exercised for a payoff of Rs58 – Rs 50 = Rs 8, the net profit being Rs 8 – Rs 8 + Rs 2 = Rs 2. Finally, if the price of the stock is higher than Rs 60, both of these will be exercised and the payoff would be Rs 60 – Rs 50 = Rs 10 with the net profit equal to Rs 10 – Rs 2 = Rs 8. The payoff function for a bull spread described above is shown in Fig. 4.10, where E_1 and E_2 are the respective exercise prices of the twin calls.

The payoffs resulting from a bull spread strategy are given in Table 4.8. While E_1 and E_2 are the respective strike prices of the calls that are long and short, S_1 represents the stock price at the time of exercising the calls.

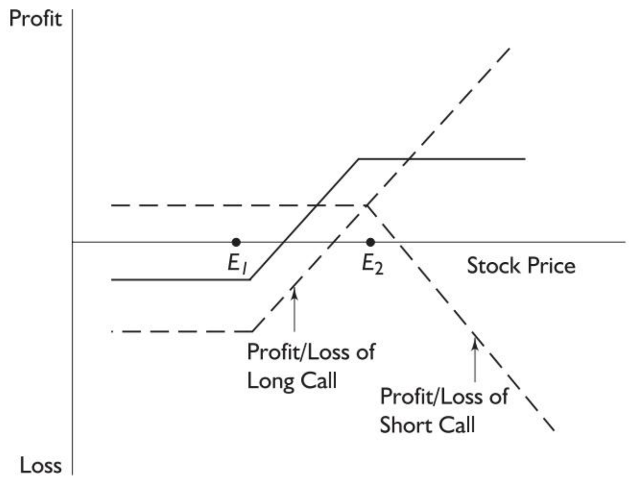
Table 4.8

Payoffs from a Bull Spread (Using Calls)

Price of Stock	*Payoff from Long Call*	*Payoff from Short Call*	*Total Payoff*
$S_1 \geq E_2$	$S_1 - E_1$	$E_2 - S_1$	$E_2 - E_1$
$E_1 < S_1 < E_2$	$S_1 - E$	0(NE*)	$S_1 - E_1$
$S_1 \leq E_1$	0(NE)	0(NE)	0

Note: ** NE: Not exercised.*

Thus, by selling a call against an otherwise naked all, the investor in a bull spread sacrifices an unlimited profit potential in return for the initial cost. If both the calls are initially out-of-the-money, then a small cost would be involved in creating the spread which would be aggressive in nature. A less bullish investor would buy an in-the-money spread for lower gearing. A spread with one call initially in-the-money and the other one initially out-of-the-money would be relatively less aggressive than a spread with both calls being out-of-the-money, while a spread created with both calls being in-the-money initially would be the most conservative.

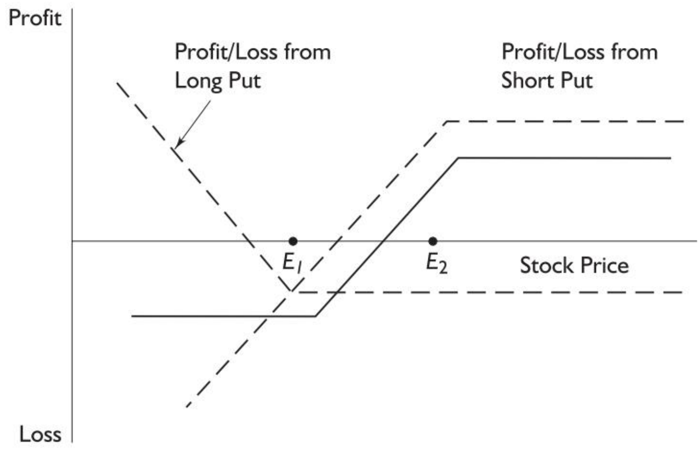


➢ **Fig. 4.10** *Bull Spread (Using Calls)*

A bull spread can also be created using puts. One put is purchased and another one is sold which is on the same stock, with the same expiry date but with a higher exercise price. On expiry, if the stock remains below the lower exercise price, both options are exercised and the position is closed for the difference between the two exercise prices. This results in an overall loss of the initial credit (higher premium received on short put minus lower premium paid on long put) *minus* the difference. If the stock price is between the two exercise prices, the put with the lower exercise price would expire unexercised resulting in a net profit equal to the initial credit *minus* the difference between the exercise price and the stock price. For the stock prices exceeding the higher exercise price, both puts expire unexercised leading to no payoffs and a net profit equal to the initial credit.

Suppose an investor buys a put option with an exercise price equal to Rs 40 for Rs 6 and writes an option identical in all respects except the exercise price that is equal to Rs 50, for a price of Rs 9. This spread gives an initial credit of Rs 3. Now, if the stock price is less than Rs 40, then both options are in-the-money and can be exercised. A commitment to buy at Rs 50 and to sell at Rs 40 implies an outward payoff of Rs 10 and a net loss equal to Rs 10 – Rs 3 = Rs 7. For a stock price in between the two exercise prices, say Rs 44, the investor has to buy the stock at Rs 50 and thus lose Rs 6 on the option. In this case, the net loss would equal Rs 6 – Rs 3 = Rs 3. Similarly, when the stock price would be more than Rs 50, none of the options will be exercised and a net profit of Rs 3 will be made.

In general, the profit function is as shown in Fig. 4.11. The payoffs associated with a bull spread created using put options are given in Table 4.9. The stock price at the time of exercise is given by S_1 and the two options have exercise prices of E_1 and E_2 ($E_2 > E_1$).



➢ **Fig. 4.11** *Bull Spread (Using Puts)*

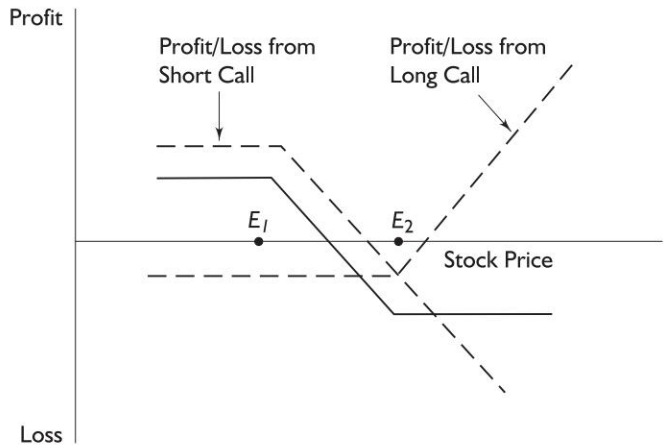
Table 4.9

Payoffs from a Bull Spread (with Puts)

Stock Price	*Payoff from Long Put Option*	*Payoff from Short Put Option*	*Total Payoff*
$S_1 \le E_1$	$E_1 - S_1$	$S_1 - E_2$	$E_1 - E_2$
$E_1 < S_1 < E_2$	0	$S_1 - E_2$	$S_1 - E_2$
$S_1 \ge E_2$	0	0	0

Bear Spreads In contrast to the bull spreads, bear spreads are used as a strategy when one is bearish on the market, believing that it is more likely to go down than up. Like a bull spread, a bear spread may be created by buying a call with one exercise price and selling another one with a different exercise price. Unlike in a bull spread, however, the exercise price of the call option purchased is higher than that of the call option sold. A bear spread would involve an initial cash inflow since the premium for the call sold would be greater than for the call bought. Assuming that the exercise prices are E_1 and E_2, with $E_1 < E_2$, the payoffs realizable from a bear spread in different circumstances are given in the Table 4.10. The profit profile is shown in Fig. 4.12.

Suppose that the exercise prices of two call options are Rs 50 and Rs 60. If the stock price, S_1, be lower than Rs 50, then none of the calls will be exercised and, therefore, no payoffs are involved. If the price were between the two exercise prices, say Rs 57, then the call written for Rs 50 would be exercised and the investor loses Rs 7, and if the price of the stock exceeded Rs 60, both the calls would be exercised and an outward payoff of Rs 10 would result. In each of the cases, the net profit would be obtained by adjusting for the initial cash inflow.



➢ **Fig. 4.12** *Bear Spread (Using Calls)*

Table 4.10

Payoffs from a Bear Spread (Using Calls)

Stock Price	*Payoff from Long Call Option*	*Payoff from Short Call Option*	*Total Payoff*
$S_1 \geq E_2$	$S_1 - E_2$	$E_1 - S_1$	$E_1 - E_2$
$E_1 < S_1 < E_2$	0	$E_1 - S_1$	$E_1 - S_1$
$S_1 \geq E_2$	0	0	0

Bear spreads can also be created by using put options instead of call options. In such a case, the investor buys a put with a high exercise price and sells one with a low exercise price. This would require an initial investment because the premium for the put with a higher exercise price would be greater than the premium receivable for the put with the lower exercise price, written by the investor. In this spread, the investor buys a put with a certain exercise price and chooses to give up some of the profit potential by selling a put with a lower exercise price. In return for the profit given up, the investor gets the price of the option sold.

The payoffs from a bear spread created with put options are given in Table 4.11 where in E_1 and E_2 are the exercise prices of the options sold and purchased respectively. The profit function is given in Fig. 4.13. It may be observed that, like bull spreads, bear spreads limit both the upside profit potential and the downside risk.

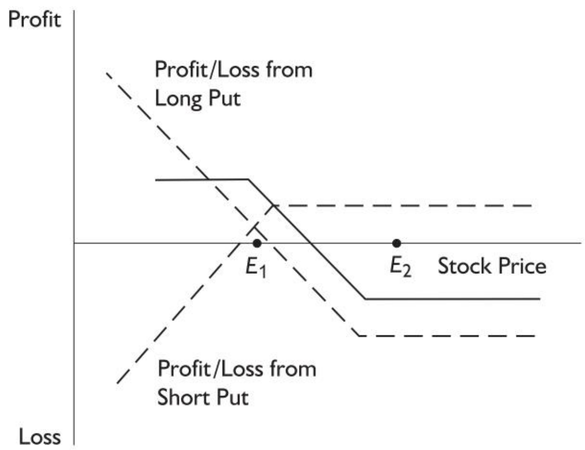


Fig. 4.13 *Bear Spread (Using Puts)*

Table 4.11

Payoffs from a Bear Spread (Using Puts)

Stock Price	*Payoff from Long Put*	*Payoff from Short Put*	*Total Payoff*
$S_1 \geq E_2$	0	0	0
$E_1 < S_1 < E_2$	$E_2 - S_1$	0	$E_2 - S_1$
$S_1 \leq E_1$	$E_2 - S_1$	$S_1 - E_1$	$E_2 - E_1$

Example 4.4

For each of the following cases, name the strategy adopted and calculate the profit/loss for different price ranges of the stock taking $S_1 \geq E_2$, $E_1 < S_1 < E_2$ and $S_1 \leq E$. Also, determine the break-even stock price in each case.

Type of Option	*Exercise Price of Option*		*Premium on Option*	
	Purchased (Rs)	*Sold (Rs)*	*Purchased (Rs)*	*Sold (Rs)*
I. Call	60	75	10	4
II. Call	80	70	5	11
III. Put	70	60	9	5
IV. Put	50	65	4	11

I. Buying a call with lower exercise price and selling a call with a greater exercise price results in *bull spread*. With price of long call, $E_1 = 60$ and price of a short call, $E_2 = 75$, the profit/loss would be as follows:

Stock Price	*Payoff from Long Call*	*Payoff from Short Call*	*Total Payoff*	*Net Profit/Loss = Payoff-Cost*
$S_1 \geq E_2$	$S_1 - 60$	$75 - S_1$	15	$15 - 6 = 9$
$E_1 < S_1 < E_2$	$S_1 - 60$	0	$S_1 - 60$	$S_1 - 60 - 6$ $= S_1 - 54$
$S_1 \leq E_1$	0	0	0	$0 - 6 = -6$

The break-even stock price would be one where net profit is equal to zero. Accordingly, $S_1 - 54 = 0$ or $S_1 = 54$. Thus, a stock price greater than Rs 54 would yield profit.

II. Buying a call with a higher exercise price and selling a call with a lower exercise price is a *bear spread* strategy. Here E_1 is the price of call sold and E_2 is the price of the call purchased. Thus, $E_1 = 70$ and $E_2 = 80$. Net premium obtained $= 11 - 5 =$ Rs 6. The profit/loss would be as shown below:

Stock Price	*Payoff from Long Call*	*Payoff from Short Call*	*Total Payoff*	*Net Profit/Loss = (Payoff+ Net Premium)*
$S_1 \geq E_2$	$S_1 - 80$	$60 - S_1$	-20	$-20 + 6 = -14$
$E_1 < S_1 < E_2$	$70 - S_1$	0	$70 - S_1$	$70 - S_1 + 6$ $= 76 - S_1$
$S_1 \leq E_1$	0	0	0	$0 + 6 = 6$

To determine break-even stock price, we set $76 - S_1 = 0$. Thus, $S_1 = 76$. Therefore, a stock price below Rs 76 would yield profit,while for stock prices above this level losses would result.

III. The sale of a lower exercise price put option and purchase of a higher value put option is also a *bear spread* strategy. With $E_1 = 60$ and $E_2 = 70$, and a net cost of Rs 4 (= Rs 9 – Rs 5), the profit/loss profile is as given below.

Stock Price	*Payoff from Long Put*	*Payoff from Short Put*	*Total Payoff*	*Net Profit /Loss*
$S_1 \geq E_2$	0	0	0	$0 - 4 = -4$
$E_1 < S_1 < E_2$	0	$60 - S_1$	$60 - S_1$	$60 - S_1 - 4 = 56 - S_1$
$S_1 \leq E_1$	$70 - S_1$	$S_1 - 60$	10	$10 - 4 = 6$

For the break-even price, $56 - S_1 = 0$. Thus, $S_1 = 56$. With stock prices below Rs 56, profit will result, while loss will result with prices greater than this.

IV. Buying a put option with exercise price equal to Rs 50 and selling a put option with a greater exercise price of Rs 65 represents a *bull spread*. This would result in a positive cash flow of Rs 11 – Rs 4 = Rs 7 to the investor up front. The profit/loss position is as given below.

Stock Price	*Payoff from Long Put*	*Payoff from Short Put*	*Total Payoff*	*Net Profit/Loss*
$S_1 \geq E_2$	0	0	0	$0 + 7 = 7$
$E_1 < S_1 < E_2$	0	$S_1 - 65$	$S_1 - 65$	$S_1 - 65 + 7 = S_1 - 58$
$S_1 \leq E_1$	$50 - S_1$	$S_1 - 65$	-15	$-15 + 7 = -8$

To obtain the break-even price, we set $S_1 - 58 = 0$, so that, $S_1 = 58$, implying that a profit would result when the stock price exceeded Rs 58 and a loss would be incurred when it fell short of Rs 58.

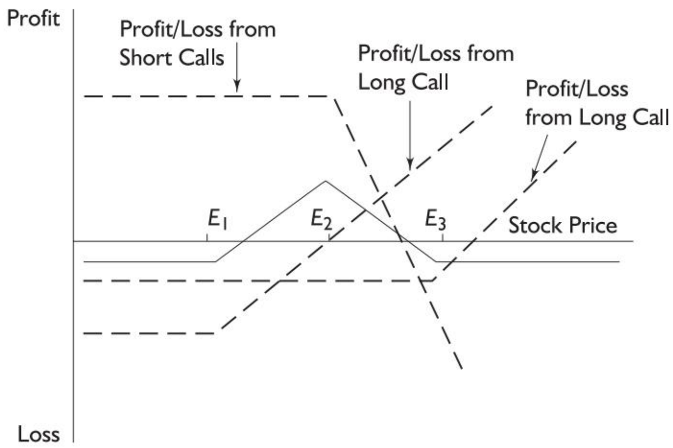
Butterfly Spreads While bull and bear spreads involve taking positions in two options, a butterfly spread results from positions in options with three different strike prices. This involves buying a call option with a relatively low exercise price, E_1, buying another call option with a relatively large exercise price, E_3, and selling two call options with a strike price, E_2 which is halfway between E_1 and E_3. The price E_2 is usually close to the current stock price, with the result that a profit results if the stock price stays close to E_2 and a small loss would be incurred if there is a significant price movement either way from it. The strategy is obviously meant for an investor who feels that large price changes are unlikely. The positions taken in the strategy involve some cost.

If E_1, E_2 and E_3 be Rs 50, Rs 60 and Rs 70 respectively, and the stock price be less than Rs 50, then, clearly, no call will be exercised. Accordingly, the total loss equals the initial cost involved. Similarly, beyond Rs 70, when *all* calls will be exercised, the total loss equals the initial cost, because the gain on the options with long position will be exactly offset by a corresponding loss on the twin options written. Gain would result when the stock price is between Rs 50 and Rs 60, and shall be higher as the price moves towards Rs 60. Beyond this price, the amount of gain would decline with an increase in the stock price up to the level of Rs 70. The payoffs for a butterfly spread are given in Table 4.12. The profit/loss profile for a butterfly spread is given in the Fig. 4.14.

Example 4.5

A certain stock is selling currently at Rs 72. An investor, who feels that a significant change in this price is unlikely, in the next three months, observes the market prices of 3-month calls as tabulated below:

Exercise Price	*Call Price (Rs)*
65	11
70	8
75	6



➢ **Fig. 4.14** *Butterfly Spread*

Table 4.12

Payoffs from a Butterfly Spread

Stock Price	*Payoff from First Long Call (E_1)*	*Payoff from Second Long Call (E_3)*	*Payoff from Short Calls (E_2)*	*Total Payoff*
$S_1 < E_1$	0	0	0	0
$E_1 \leq S_1 < E_2$	$S_1 - E_1$	0	0	$S_1 - E_1$
$E_2 \leq S_1 < E_3$	$S_1 - E_1$	0	$2(E_2 - S_1)$	$E_3 - S_1^*$
$S_1 \geq E$	$S_1 - E_1$	$S_1 - E_3$	$2(E_2 - S_1)$	0

* $S_1 - E_1 + 2E_2 - 2S_1 = 2E_2 - E_1 - S_1$, or $E_3 - S_1$ Since $2E_2 = E_3 + E_1$

The investor decides to go long in two calls—one each with exercise price Rs 65 and Rs 75—and writes two calls with an exercise price of Rs 70. Determine his payoff function for different levels of stock prices. Also, find his profit/loss when the stock price at maturity is (i) Rs 63, (ii) Rs 68, (iii) Rs 73, and (iv) Rs 80.

The decision of the investor leads to a *butterfly spread.* Buying two calls involves a payment of Rs 11 + Rs 6 = Rs 17, and writing two calls yields Rs 8 × 2 = Rs 16. Thus, cost involved with the package of options = Rs 17 – Rs 16 = Re 1. The payoffs associated with this plan are given in Table 4.13.

From the table, it is clear that when the stock price is less than Rs 65, or Rs 75 and above, the payoff will be nil, while if the price varied between Rs 65 and Rs 70, the payoff equal to the price in excess of Rs 65 and if it is in the range of Rs 70 to Rs 75, then the payoff is Rs 75 minus the stock price. Accordingly, profit/loss can be calculated for various given prices as follows.

Table 4.13

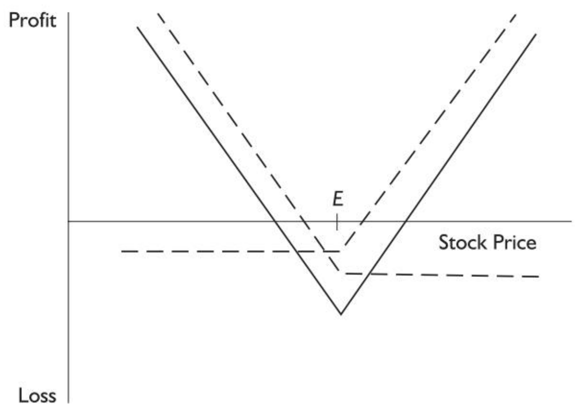
Payoffs from a Butterfly Spread

Stock Price	*Payoff from first Long Call (E_1 = 65)*	*Payoff from second Long Call (E_3 = 75)*	*Payoff from two Short Calls (E_2 = 70)*	*Total Payoff*
$S_1 < 65$	0	0	0	0
$65 \leq S_1 < 70$	$S_1 - 65$	0	0	$S_1 - 65$
$70 \leq S_1 < 75$	$S_1 - 65$	0	$2(70 - S_1)$	$75 - S_1$
$S_1 \geq 75$	$S_1 - 65$	$S_1 - 75$	$2(70 - S_1)$	0

No.	*Price*	*Total Payoff from Calls*	*Cost of Strategy*	*Net Profit/Loss*
1	63	0	(1)	(1)
2	68	3	(1)	2
3	73	2	(1)	1
4	80	0	(1)	(1)

Combinations While spreads involve taking positions in call or put options only, combinations represent option trading strategies which involve taking positions in both calls and puts on the same stock. Important combination strategies include straddles, strips, straps, and strangles.

Straddle A straddle involves buying a call and a put option with the same exercise price and date of expiration. Since a call and a put are both purchased, it costs to buy a straddle and, to that extent, a loss is incurred if the price does not move away from the exercise price since none of them will be exercised. From the profit function depicted in Fig. 4.15, it is evident that buying a straddle is an appropriate strategy to adopt when large price changes are expected in the stock—for lower prices of the stock, the put option will be exercised and for higher prices, the call option will be exercised.



➢ **Fig. 4.15** *Straddle*

Suppose an investor feels that the price of a certain stock, currently valued at Rs 85 in the market, is likely to move significantly, upward or downward, in the next three months. The investor can create a straddle by buying a call and a put option both with an exercise price of Rs 85 and an expiration date in three months. Suppose that the call costs Rs 4 and the put Rs 2. Now, if the stock price at expiration is Rs 85, then none of the options will be exercised and a loss of Rs 6 would occur. If the stock price jumps to Rs 100, then the call will be exercised resulting in a net profit of (Rs 100 – Rs 85) – Rs 6 = Rs 9, while if the price falls to, say, Rs 57 then the put option will be exercised and a net profit of Rs (Rs 85 – Rs 57) – Rs 6 = Rs 22 will result. The payoffs in respect of a straddle are given in Table 4.14.

Table 4.14

Payoffs from a Straddle

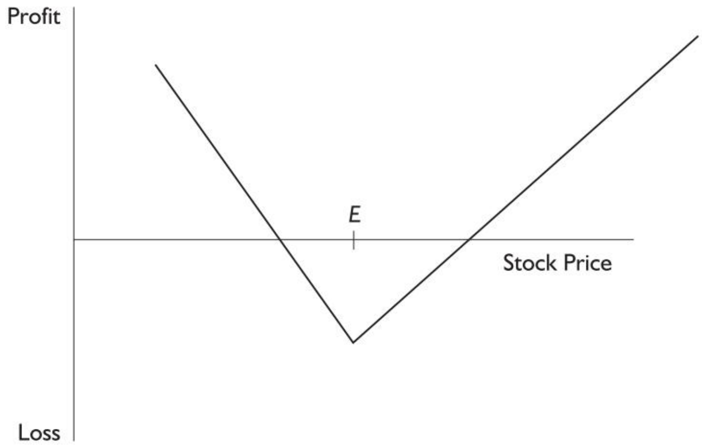
Exercise Price Range	*Payoff from Call Option*	*Payoff from Put Option*	*Total Payoff*
$S_1 \le E$	0	$E - S_1$	$E - S_1$
$S_1 > E$	$S_1 - E$	0	$S_1 - E$

This kind of strategy is an obvious one to employ in respect of the stock of a company which is subject to a takeover bid.

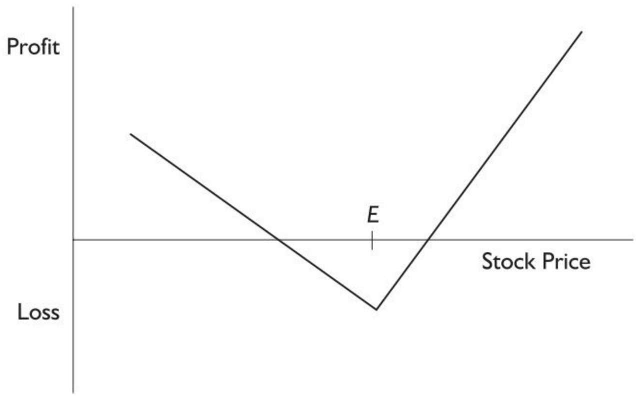
The straddle shown in Fig. 4.15 is an example of a *straddle purchase*. This is also referred to as a *bottom straddle*. A *straddle write*, or a *top straddle* represents the reverse position so that it may be created by selling a call and a put with the same expiration date and exercise price. In a straddle write, a significant profit is made if the stock price is equal to, or close to the exercise price, but large deviations of stock price from this on either side would cause large losses, which are potentially unlimited. Hence, a straddle write is a very risky strategy to adopt.

Strips and Straps Like straddles, strips and straps also involve taking long or short positions in calls and puts. A *strip* results when a long position in one call is coupled with a long position in two puts, all with the same exercise price and date of expiration. Here the investor is expecting that a big price movement in the stock price will take place but a decrease in the stock price is more likely than an increase. Since a put option is profitable when a price decrease occurs, two puts are bought in this strategy. Accordingly, the profit function for the strategy, shown in Fig. 4.16 is more steep in the lower than exercise price range and less steep in the region of higher prices.

On the other hand, if the investor is expecting that a big price change would occur in the stock price but feels that there is a greater likelihood of the price increasing rather than decreasing, the investor will consider the strategy of a strap. A *strap* consists of a long position in two calls and one put with the same exercise price and expiry date. The profit function for a strap is depicted in Fig. 4.17. The right to the exercise position of the profit function has a greater steepness than the other part.



➢ **Fig. 4.16** *Strip*



➢ **Fig. 4.17** *Strap*

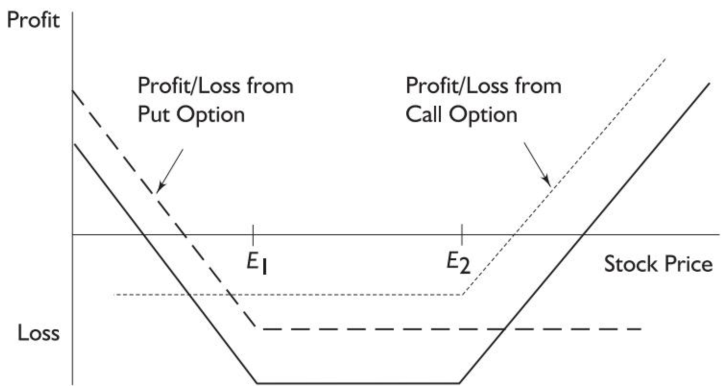
Strangles In a strangle, an investor buys a put and a call option with the same expiration date but with different exercise prices. The exercise price of the put is lower than the exercise price of the call, so that a profit would result if the stock price is lower than the exercise price of the put or if the stock price exceeds the call exercise price. Between the two exercise prices, none of the options is exercised and hence, a net loss, equal to the sum of the premia paid for buying the two options, results. It follows, then, that a strangle is an appropriate strategy for adoption when the price is expected to move sharply. The profit function, for exercise price E_1 and E_2 of put and call respectively, is shown in Fig. 4.18 and payoffs for different ranges of the stock price are given in Table 4.15.

Table 4.15

Payoff from a Strangle

Price of Stock	*Payoff from Put*	*Payoff from Call*	*Total Payoff*
$S_1 \leq E_1$	$E_1 - S_1$	0	$E_1 - S_1$
$E_1 < S_1 < E_2$	0	0	0
$S_1 \geq E_2$	0	$S_1 - E_2$	$S_1 - E_2$

Evidently, a strangle is a similar strategy to a straddle, because here as well the investor is betting that a large price change would take place but is not sure as to the direction in which the change would occur. However, in a strangle, the stock price has to move father, than in a straddle, in order that the investor makes a profit. Also, if the stock price happens to be between the two exercise prices, the downside risk is smaller with a strangle than it is with a straddle if the price is close to the exercise price.



➢ **Fig 4.18** *Strangle*

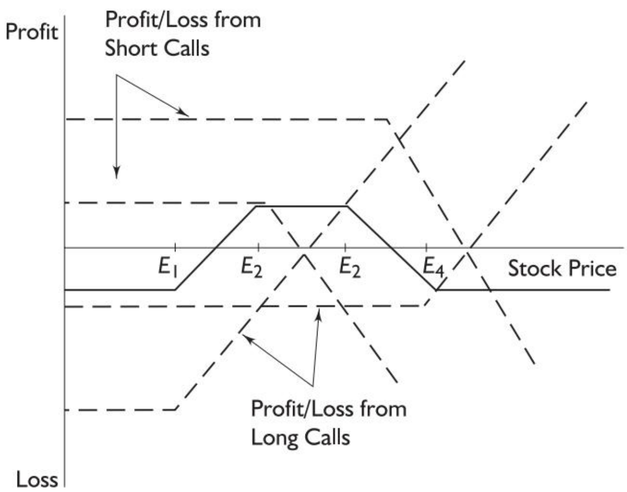
The strangle described above is also called the *bottom vertical combination* or *strangle bought* or *long strangle.* Similarly, a strangle may be sold. A *short strangle* is the choice of an investor who believes that large variations in stock price are unlikely. However, if they do occur, then larger amounts of losses are imminent.

Condors A condor is an investment strategy which involves four call options or four put options. It may be long condor or a short condor. A *long condor* involving call options is created by buying calls—one with a very low exercise price E_1 and another with a comparatively high exercise price E_4—and selling two calls options—one with a price E_2 higher than, and closer to, E_1 and the other with a price E_3 which is lower than and closer to E_4. E_1, E_2, E_3 and E_4 are chosen in such a way that

$$E_2 - E_1 = E_4 - E_3, \text{ and } E_3 - E_1 = 2(E_2 - E_1).$$

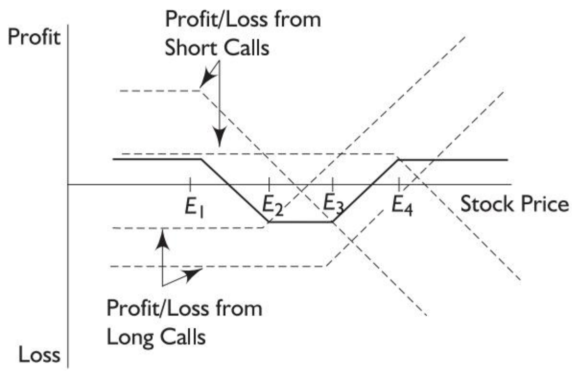
The profit function of a long condor is shown in Fig. 4.19.

A long condor using put options, can be created similarly, by buying one put with exercise price E_1 and another one with an exercise price of E_4, and selling two puts—with exercise prices of E_2 and E_3. The prices E_1, E_2, E_3 and E_4 are related to each other as in the case of a long condor with call options.



➢ **Fig. 4.19** *Long Condor*

A *short condor*, on the other hand, results by reversing the above strategy, and involving selling two calls having exercise prices of E_1 and E_4, and buying two calls with exercise prices of E_2 and E_3. Fig. 4.20 depicts the profit/loss associated with this policy.



➢ **Fig. 4.20** *Short Condor*

An examination of the profit functions for condors and strangles reveals that while profit/loss potential resulting from large deviations in stock price is very high for a strangle, it is not so in the case of a condor. In the latter case, profit/loss is limited.

Box Spreads In box spread strategy, the profit or loss made is independent of the stock price. With the objective of making a profit regardless of the stock price, a box spread may be created in many ways. For instance, it may be decided to buy one call and write one put, with an exercise price equal to E_1, and write one call and buy one put, with an exercise price of E_2 ($E_2 > E_1$). Table 4.16 shows that the payoff in respect of this strategy will be the same irrespective of the price of the stock.

Table 4.16

Payoffs from Box Spreads

Stock Price Range	*Payoffs from Options*				*Total Payoff*
	Exercise Price = E_1		*Exercise Price = E_2*		
	Call Bought	*Put Sold*	*Call Sold*	*Put Bought*	
$S_1 \le E_1$	0	$S_1 - E_1$	0	$E_2 - S_1$	$E_2 - E_1$
$E_1 < S_1 < E_2$	$S_1 - E_1$	0	0	$E_2 - S_1$	$E_2 - E_1$
$S_1 \ge E_2$	$S_1 - E_1$	0	$E_2 - S_1$	0	$E_2 - E_1$

When the stock price does not exceed the lower exercise price of E_1, none of the call options is exercised and both the puts are exercised. This results in a total payoff of $E_2 - E_1$ because the stock bought for E_1 is sold for E_2. Similarly, when the stock price is E_2 or more, none of the puts is exercised. With a right to buy the stock at E_1

and the obligation to sell at E_2, the two call options result in a payoff of $E_2 - E_1$. For the price range between E_1 and E_2, stock will be bought at E_1, using the right under long call to buy at this price, and sold for E_2, by exercising the right to sell the stock by virtue of the put option.

A box spread can also be constructed by buying a put and writing a call, with an exercise price E_1, and buying a call and writing a put with an exercise price of E_2 (E_2 being greater than E_1).

TEST YOUR UNDERSTANDING

Mark the following statements as True or False.

1. _____ Options are legalized speculative financial assets.
2. _____ Options contracts are not symmetrical with respect to rights and obligations of the parties involved.
3. _____ The writer of an options contract is obliged to the OCC for honouring the contract.
4. _____ The delivery in all options contracts is guaranteed by the OCC.
5. _____ An American option may be exercised at any time up to the date of maturity while a European option may be exercised only on maturity.
6. _____ The exercise price of an option may be greater than, equal to, or less than its strike price.
7. _____ In case of an option on a stock, the exercise price is decided by mutual consent of the parties to the contract.
8. _____ It is possible for a futures contract to be the underlying asset for an options contract.
9. _____ Option premium is adjustable against exercise price for settlement of the contract if the option is exercised on maturity.
10. _____ If the exercise price of a put option exceeds the share price, the option is termed as out-of-the-money.
11. _____ If the stock price is much greater than the exercise price of a call option, it said to be deep in-the-money.
12. _____ When the stock price is less than the exercise price, a call option is out-of-the-money and a put option is in-the-money.

13. _____ A call option has a positive or negative intrinsic value depending on whether the stock price is greater than, or smaller than, the exercise price.
14. _____ For any call option, Intrinsic value = Stock price – Exercise price.
15. _____ A put option may, or may not, have a positive intrinsic value.
16. _____ The intrinsic value of an in-the-money call option is the amount by which it is in-the-money.
17. _____ For an other than in-the-money option, the intrinsic value is equal to zero.
18. _____ The time value of an option is the excess of option premium over the intrinsic value.
19. _____ The nearer the date of maturity, the greater the time value of money.
20. _____ Most of the options do not require physical delivery as investors tend to close their positions by taking reverse positions.
21. _____ A long position in a call option may be closed out by a short position in a put option with identical exercise date and exercise price.
22. _____ A naked option is one where the option is acquired on credit, without paying for it forthwith.
23. _____ The writer of a covered call possesses the underlying asset.
24. _____ Margins are required for trading in the options market, both for taking long as well as short positions.
25. _____ The writer of a naked call option is generally required to keep a greater margin than the writer of a comparable covered call.
26. _____ The amount of margin required to be kept influences the degree of financial leverage.
27. _____ The writers of call and put options both run unlimited risk.
28. _____ A short position in a put option is indicative of the bullish sentiment of the investor.

29. _____ Arbitrage activities would ensure that at expiration, an option is sold for a price equal to its intrinsic value.
30. _____ Before expiration, options are generally sold for at least their intrinsic value.
31. _____ A long position in stock may be hedged by a long position in a put for limiting risk or by writing a call for enhancing the returns.
32. _____ The strategy of short stock and short put aims at hedging against the risk associated with price changes in the stock.
33. _____ Spreads involve taking positions in calls or puts.
34. _____ A bull spread may be created by buying a call option, with a certain exercise price, on a stock and selling another call on the same stock with a higher exercise price. The two calls have the same expiry.
35. _____ In a bull spread with two calls, the payoff resulting from exercise at maturity, is equal to the excess of the higher exercise price over the lower one, if the stock price is higher than the higher exercise price.
36. _____ To create a bull spread with puts, a put with a lower exercise price is sold and one with an identical maturity but a higher exercise price is purchased.
37. _____ A bear spread can be created only by using put options.
38. _____ A bear spread is created in an attempt to come out of the bearish phase and enter into the bullish conditions expected.
39. _____ A put option is bought for an exercise price of Rs 75. A put option is sold at an exercise price of Rs 80. The result is bull spread.
40. _____ The break-even point in a bull or bear spread always lies between the exercise prices of the two options.
41. _____ A butterfly spread results from taking positions in four options with three exercise prices—E_1, E_2 and E_3 (with E_2 lying in between E_1 and E_3)—buying a call with E_1 and E_3 each, and writing two calls with E_2.
42. _____ A bottom straddle is the same as a straddle write.
43. _____ A top straddle is created by selling a call and a put with identical exercise price and date.

44. _____ A straddle write is a very risky strategy when the market is seen to be moving.
45. _____ A strap is a long position in one call and a short position in two puts.
46. _____ A strip buyer expects a big price movement in the stock price but considers a price decline more probable than a price rise.
47. _____ A strap involves a long position in three options, two calls and one put, with identical exercise prices and dates.
48. _____ A strangle involves buying a call and a put option with the same expiration date but different exercise prices.
49. _____ An investment strategy involving four call options or four put options is known as a *condor*.
50. _____ It is decided to buy one call and write one put, with an exercise price equal to E_1, and write one call and buy one put, with an exercise price of E_2 (with $E_2 > E_1$). The outcome will be independent of the stock price.

EXERCISES

1. Differentiate between call and put options. What are the rights and obligations of the holders of long and short positions in them?
2. How are European style options different from American style options?
3. How are options contracts on commodities different from options on financial assets? Also, explain "options on futures".
4. State the underlying relationship between stock and exercise prices for the in-the-money and out-of-the-money call and put options.
5. How are 'naked' calls different from 'covered' calls? What implications do both the types of calls have in respect of the margins to be kept?
6. "Call writers and put buyers exhibit bearish sentiments". Do you agree? Explain.

7. Show graphically the call and put option pricing (i) at expiration, and (ii) before expiration, indicating clearly the intrinsic and time value components of the option values.
8. Explain the following hedging strategies:
   (a) Short stock long call (b) Long stock long put
   (c) Long stock short call (d) Short stock short put
9. Discuss the risk-return characteristics of a strategy of writing covered call options.
10. Explain the difference between spreads and combinations. Give three examples of each of them.
11. Explain, why the clients, while writing the options, are required by their brokers to deposit margins, but not while buying?
12. A company's shares have a face value of Rs 100. It now decides to split them into shares of face value equal to Rs 10.

    How would it affect the terms of a call option contract on this stock?
13. Explain the difference between buying a put option and writing a call option.
14. Differentiate between bull and bear spreads. How can each of these be created with put options?
15. How are the bear spreads created with calls and puts differentiated?
16. Illustrate the following using rough sketches:
    (a) Bull spread using call options
    (b) Long stock and short call
17. An investor bets a substantial change in the price of a stock but is not sure of the direction in which the change would take place. What different strategies involving options could he adopt? Compare the strategies.
18. How are strangles different from straddles? Explain about each of these in detail.
19. Discuss the strategy where the profit/loss made is independent of movement in the stock price.
20. You are given below information on some options. State whether each one of these is in-the-money, out-of-the-money or at-the-money.

S. No.	*Option*	*Stock Price*	*Exercise Price*
1	Call	58	55
2	Call	40	40
3	Put	112	100
4	Put	104	110
5	Put	12	15
6	Call	37	35

21. From the following data, determine for each option, the intrinsic value and the time value.

S. No.	*Option*	*Stock Price*	*Exercise Price*	*Option Price*
1	Put	36	32	5.30
2	Call	48	50	4.10
3	Call	107.50	105	8.40
4	Put	41	45	9.70

22. An investor buys a call option on 1200 shares with an exercise price of Rs 80 for Rs 7.75. What is the maximum loss that he could possibly incur on this? What is the maximum profit which could accrue to him? Also, determine the break-even stock price.

23. An investor purchases a put option involving 300 shares with an exercise price of Rs 180 for Rs 9.50. What is the maximum loss that the investor could possibly incur? What is the maximum profit which could accrue to him? Calculate the break-even stock price.

24. What strategy would the following lead to?
 A. (i) Sell one put with high exercise price, E_2
 (ii) Sell one put with low exercise price, E_1
 (iii) Buy two puts with medium exercise prices, E_0
 B. (i) Buy one call with exercise price E_4
 (ii) Buy one call with exercise price E_1
 (iii) Sell one call with exercise price E_2
 (iv) Sell one call with exercise price E_3,
 (given further that $E_1 < E_2 < E_3 < E_4$.)

25. The following information is available on call options involving 800 shares each, with two month expiration dates, on a stock:

Call	*Exercise Price*	*Call Price*
1	Rs 50	Rs 8
2	Rs 55	Rs 4.50
3	Rs 60	Rs 2

Explain how these options can be used to create butterfly spreads. Construct a table to show how profit would vary with stock price for the spread and determine the profit or loss when the price is (i) Rs 67, (ii) Rs 58, (iii) Rs 46, and (iv) Rs 54.

26. How can a butterfly spread be created by using the following three put options (with same expiration dates)?

    Option 1 : Exercise price Rs 70 Price = Rs 6
    Option 2 : Exercise price Rs 75 Price = Rs 9
    Option 3 : Exercise price Rs 80 Price = Rs 14

    Determine the range of stock prices within which losses would be made by the buyer of the options.

27. A call option on a stock with an exercise price of Rs 70 is available for Rs 6 while a put option, on the same stock with the same expiration date, with an exercise price of Rs 60 is selling for Rs 8. How can a strangle be created by using these options? Determine the profit/loss function for this strangle. For what range of stock prices would there be a profit?

28. An investor buys a combination of two puts and a call, all with exercise price of Rs 60. Assume that the call costs Rs 5 and the put Rs 6, plot the profit/loss versus the stock price at the date of expiration. Also name the strategy involved.

CHAPTER

5

Valuation of Options

In this chapter, we explore how trading prices of call and put options are determined. In this context, we will consider some models which have been put forth for assessing the prices of these assets. Various factors affecting the prices are also examined as the interrelationships between the prices of calls and puts.

As with other securities, the option premium, or the price, is determined competitively on the floor of the options exchange by the influx of buy and sell orders. It is influenced by a number of factors, some of which are listed below:

1. Price of underlying security.
2. Volatility.
3. Length of time to expiration.
4. Interest rates.
5. Tax rules with regard to gains and losses arising from option trading.
6. Margin requirements in case of uncovered option writers.
7. Transaction cost.

While some formal models are available for the valuation of options, it will be instructive to first examine the manner in which certain characteristics of options are likely to affect option values in a rational market. These characteristics are useful for counter checking the option values derived by using valuation models.

European vs American Calls It may be recalled that a European call gives its holder the right to buy stock at the exercise price on a particular date and, therefore, can be exercised only at the expiration date, while an American call can be exercised at *any time up to* the expiration date. Obviously, since an American call provides an added opportunity, its value has to be at least equal to that of a European call with the same inputs. Accordingly, as a first relationship, it may be noted that a European call with the same expiration date and exercise price as an American call cannot sell for more than the latter.

Exercise Price If we consider two calls on a stock with the same expiration date, but with different exercise prices, then the call with a higher exercise price cannot be more valuable than the one with the lower exercise price. For example, suppose two calls on a share with identical expiration dates have exercise prices of Rs 110 and Rs 120. The holder of the former call can buy the share at Rs 110, and can be in the same position as the holder of the other call who could buy the same security at Rs 120, as also the cash left over. Obviously, then, the call with a higher exercise price cannot be expected to be valued higher.

Length of Time to Expiration In case of two calls on a stock with identical exercise prices but with different expiration dates, it can readily be seen that the one with a longer time to maturity would offer the investor with all the exercise opportunities as that of the one with a shorter life, and some additional opportunities. Accordingly, it may be reasonably expected that of the two composite calls, the one with a longer life cannot be valued lower than the one with a shorter life.

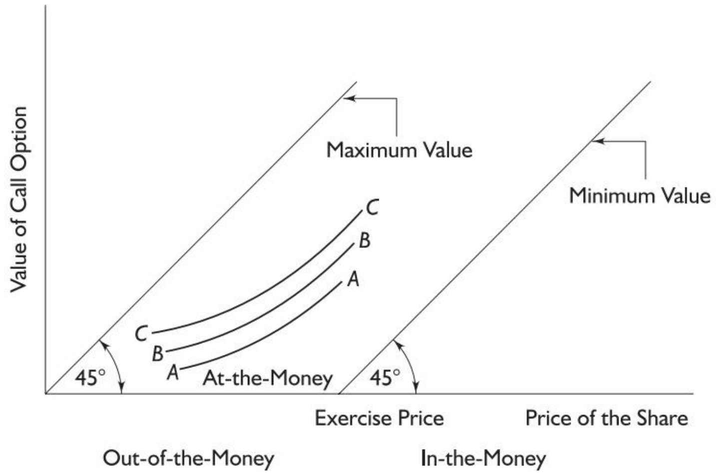
Now, let us turn to the valuation of options. We first consider a graphic approach and then the models of valuation.

A GRAPHIC ANALYSIS OF CALL AND PUT VALUES

A convenient way to examine call and put values is by way of profit/loss graphs (See Figs 5.1 and 5.2) which reflect the effect of the price of the underlying asset (here the asset is considered to be a stock) on option prices.

Call Option

Figure 5.1 illustrates a call option. A call cannot have a value greater than the value of the stock itself because of the exercise price. Obviously, it makes no sense to purchase an "option to buy" a share,

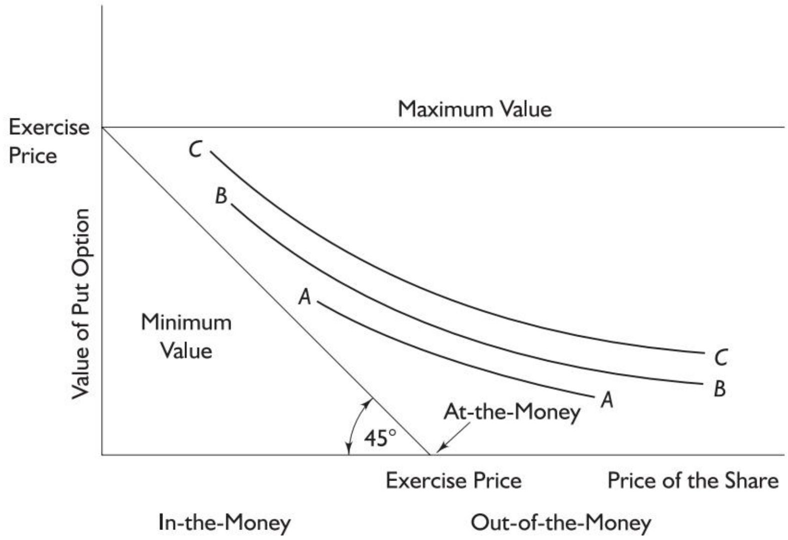


➢ **Fig. 5.1** *Call Option Values*

which is selling at Rs 200, for more than Rs 200. Thus, the stock price provides the upper bound on the value of a call option. Similarly, a call option cannot have a value smaller than its intrinsic value, where the intrinsic value is equal to the difference between the price of the stock and the exercise price (To be precise, it should be the *present value of the exercise price.* Here it is taken to be the exercise price merely for the sake of simplicity.) Thus, if a certain share is selling for Rs 50 and the exercise price is Rs 45, then it will have a maximum value of Rs 50 and a minimum value of $(S_0 - E)$ or Rs 50 – Rs 45 = Rs 5, since the call is in-the-money. For this share, if the call were at-the-money or out-of-money, its intrinsic value would be zero. Now, if the price of the share were to rise to Rs 52, then the value of the call should at least be equal to Rs 52 – Rs 45 = Rs 7, while this value would be a minimum of Rs 10 if the share price shot up to Rs 55. Thus, for an other than at or out-of-the-money call with a given exercise price, every rupee increase in the share value will lead to a corresponding increase in the call price. Accordingly, the maximum value line in Fig. 5.1 is drawn at an angle of 45 degrees from the origin, while the minimum value line is drawn at a 45-degree angle from the exercise price. Thus, a call option with a given exercise price will have a value on or above the minimum value function. Also shown in the figure are hypothetical functions *AA*, *BB* and *CC* for three calls which are identical in all respects except the times before expiration. The function *AA* represents the possible values for an option with, comparatively, the shortest time before expiration; while functions *BB* and *CC* are for options with longer times to expiration. This means that options with longer lives have higher time values than options with shorter lives. The curvature of the function indicates that although the values of in-the-money call options would be greater than those of out-of-the money options, the relationship is not linear. It may further be observed that the time value of an option is maximum when the price of the stock is at the exercise price. This excess, or time value, decreases when the price of the stock moves away from the exercise price in either direction.

Put Option

Figure 5.2 provides a graphical description of put option valuation. Like a call option, a put option also would have a minimum value equal to its intrinsic value which is the excess of exercise price over the stock price. With every rupee increase of share price, the minimum value of the option, if it is in-the-money, will decline by an equal amount. For example, assume the share price is Re 0 and the exercise price is Rs 50. The put option will have a minimum value equal to its intrinsic value of Rs 50 – Re 0 = Rs 50, equal to its exercise price. Now, if the stock price rises to Rs 20, the minimum value of the put decreases to Rs 50 – Rs 20 = Rs 30, and if the stock price is equal to the exercise price, the minimum value of the put will be Re 0. In the figure, the minimum value line is obtained by joining the points indicating exercise price on each of the two axes. On the upper side, the put can have a value at most equal to the exercise price since the stock price cannot be negative. Therefore, the maximum value



➢ **Fig. 5.2** *Put Option Values*

function is shown as a horizontal line drawn at a height equal to the exercise price. The value of a put must be on or above the minimum value function, and on or below the maximum value function. As in case of call option, an in-the-money put option will have a higher value than an out-of-the-money put and the relationship is not a linear one. Also, the put with longer lives have greater values, as demonstrated through the functions *AA*, *BB* and *CC* which differ only in terms of the length of time before expiration.

CHARACTERISTICS OF OPTION VALUES

While the graphic approach for depicting values of options is useful in gaining an initial insight into the premia that the call and put options may command, we now give a more formal way of expressing the values of these derivatives. This is followed by the two more generally used models by which the values of the options may be determined.

We first derive an expression for the minimum value of a European call option. Then, it is shown that although an American call can be exercised at any time before the expiration date, it is not prudent to do so, but the same cannot be concluded for an American put option. This is followed by a discussion of 'put-call parity' which describes how the values of call and put are related and can be stated in terms of each other. This is discussed first for the European calls and puts and then for the American calls and puts.

In the valuation of calls and puts, it is usually assumed that the stock on which they are based pays no dividend during the currency of the option. However, if a dividend can be expected, then it would affect these values. The effect of dividends is discussed after the put-call parity relationship. This discussion is followed by a consideration of the various factors which affect the values of the call and put options and then of the two models which are commonly used for the valuation of options.

Minimum Value of a European Call

It can be shown that the value of a European call is the greater of zero and the difference between the stock price and the present value of the exercise price. For this, let us consider two portfolios specified below.

Portfolio P_1

1. Buy a call.
2. Buy bonds maturing at the expiration date of the call and which at that date will have a value equal to the exercise price.

If C is the current price of the call, E is the exercise price, r is the annual interest rate, and t is the time period elapsing between the point when the call is valued and the expiration date, then the amount needed to purchase bonds is $E\,e^{-rt}$.

Portfolio P_2

Buy shares only.

Further, let S_0 be the current price of the shares purchased and S_1 be the stock price at the expiration date of the call, which may be less than, equal to, or more than the exercise price.

In Table 5.1, the key characteristics of both the portfolios are given.

Table 5.1

Characteristics of Portfolios

Portfolio	*Investment (Outflow)*	*Value at Expiration date* If $S_1 > E$	If $S_1 \leq E$
P_1 : Buy Call	$-\ C$	$S_1 - E$	0
Buy Bonds	$-\ E\,e^{-rt}$	E	E
	Total	S_1	E
P_2 : Buy Stock	$-\ S_0$	S_1	S_1

Thus, in case $S_1 > E$, the payoffs from both the portfolios are equal. However, in the event that $S_1 \leq E$, the portfolio P_1 would be as good as, or better than, the portfolio P_2. Obviously, therefore, the cost of portfolio P_1 should at least be as much as the cost of portfolio P_2. Therefore,

$$C + E\,e^{-rt} \geq S_0 \quad \text{or} \quad C \geq S_0 - E\,e^{-rt}$$

In words, the price of a call will be greater than, or equal to the difference between stock price and present value of the exercise price.

Early Exercise of an American Call

In contrast to a European call which can be exercised only on the due date, an American call may be exercised at any time before the expiration date. Notwithstanding this, it can be shown that it is never optimal to exercise an American call early, if the stock is non-dividend paying. To illustrate this, we consider an American call option on a non-dividend paying stock with an exercise date two months away when the stock price is Rs 60 and the exercise price is Rs 50. Since the option is well in-the-money, the investor might be inclined to exercise it and make profit. However, if the investor plans to hold the share beyond two months, it may not be the best strategy. It would be better to keep the call and exercise it when it is due and earn an interest on Rs 50 for two months. Since the stock does not pay any dividend, no income from it is sacrificed.

Another advantage of not exercising the call is the possibility that the stock price may go below Rs 40 during the next couple of months. At the same time, if the investor believes that the stock is currently overpriced, then, instead of exercising the option and making a profit by selling the stock, the investor would do well to sell the option to another investor who wants to hold onto the stock. Such investors would certainly exist because, otherwise, the price of the stock would not have been Rs 60. This activity would enable the investor to get a higher profit since the price at which the option can be sold will be greater than its intrinsic value of Rs 10. Consequently, it will never be more advantageous to exercise an American call before its exercise date.

Early Exercise of an American Put

In contrast to the fact that it would not be optimal to exercise an American call before the exercise date, it may be seen that it can be optimal to exercise an American put option on a non-dividend paying stock early. To illustrate this we may consider an extreme situation in which the exercise price is Rs 20 and the underlying stock is selling at a price which is nearly zero. An immediate exercise of the put option causes an immediate gain of Rs 20. If, however, the investor waits, the gain from exercising the put might be lowered (if the stock price recovers) and, in any case, it cannot exceed the present gain of Rs 20 since the stock prices cannot assume negative values. Further, a receipt of Rs 20 now is preferable to an equal amount receivable at some time in the future due to the time value of money.

In the same manner as a call option, a put option may be considered as a provision of insurance. A put option, held along with the stock, provides an insurance cover to the holder against any fall in stock price below a certain level. However, unlike the situation for a call option, it may be better for an investor to forego this insurance and exercise the put early so as to obtain the exercise price immediately. In general, a fall in the stock price, an increase in the riskfree rate of interest and decrease in the variability in the price of the underlying share make an early exercise more attractive. It may be shown that provided $r > 0$, it is always optimal to exercise an American put immediately when the stock price is sufficiently low. In case an early exercise is optimal, the value of the option will be $E - S$.

Since there exist circumstances when it is desirable to exercise an American put option early, it follows that an American put option is worth more than a comparable European put option.

Relationship Between European Call and Put Options: Put-Call Parity

A call and the underlying equity can be combined so that they have the same payoff as a put. Similarly, a put and the underlying stock can be combined to yield the same payoff as a call. This permits the put or call to be priced in terms of the other security. This relationship is the easiest to derive for European call and put options. For this, we consider two portfolios:

Portfolio P_1 One European call option
Cash for an amount of $E\,\mathrm{e}^{-rt}$

Portfolio P_2 One European put option
One share of stock worth S_0

At the expiration of options, both the portfolios have the same values as shown in Table 5.2.

Since both the portfolios have identical values on expiration, they must have equal values at present as well. Accordingly, we have,

$$C + E\,\mathrm{e}^{-rt} = P + S_0$$

Table 5.2

Determination of Terminal Values of Portfolios

Portfolio	*Cash Flow at t = 0*	$S_1 > E$	$S_1 \le E$
P_1	C	$S_1 - E$	0
	$E\,e^{-rt}$	E	E
	Total	S_1	E
P_2	P	0	$E - S_1$
	S_0	S_1	S_1
	Total	S_1	E

From this, the value of a European put with a certain exercise price and expiration date can be deduced from the value of a European call with even price and date, and vice-versa.

Obviously, when the above equation does not hold, arbitrage opportunities would be present. Suppose, for example, that the current price of a stock is Rs 50, the exercise price is Rs 48, the riskfree continuously compounded rate of interest is 10% per annum. Suppose further that the price of a 3-month European call option is Rs 6 and the price of a 3-month European put option is Rs 4. Here,

Value of portfolio $P_1 = C + E\,e^{-rt} = 6 + 48\,e^{-(0.10 \times 3/12)} = 52.81$

Value of portfolio $P_2 = P + S_0 = 5 + 50 = 55$

Thus, portfolio P_2 is overpriced in comparison to portfolio P_1. In such a case, we may buy securities in portfolio P_1 and short the securities in P_2. This involves buying the call and shorting both the put and the stock. This would create a cash flow of – Rs 6 + Rs 4 + Rs 50 = Rs 48. Its investment at the riskfree interest rate would yield Rs 48 $e^{0.1 \times 0.25}$ = Rs 49.21 in the three months' period. At the conclusion of three months, if the stock price is greater than Rs 48, then the call will be exercised and if the stock price is smaller than that, then the put option will be exercised so that, in either case, the investor would end up buying the stock for Rs 48. The net profit, therefore, is Rs 49.21 – Rs 48 = Rs 1.21.

On the other hand, if the call price is Rs 6 and the put price is Rs 2 then,

Value of portfolio $P_1 = C + E\,e^{-rt} = 6 + 48\,e^{-(0.10 \times 0.25)} = 52.81$

Value of portfolio $P_2 = P + S_0 = 2 + 50 = 52$

In this case, portfolio P_1 is overpriced relative to portfolio P_2 and, therefore, an arbitrageur can short the securities in P_1 and buy securities in P_2, to book a profit. The strategy involves an initial outlay of Rs 50 + Rs 2 – Rs 6 = Rs 46. Financed at the riskfree rate, a repayment of 46 $e^{0.1 \times 0.25}$ = Rs 47.16 would be required to be made. Since both a call and a put are owned, either of these will be exercised. The short call and long put option position would lead to the stock being sold for Rs 48. The net profit would, therefore, be Rs 48 – Rs 47.16 = Re 0.84.

Thus, the principle of put-call parity states that the prices of call and put options on an asset are related and, given the value of one, the value of the other can be obtained. The relationship can be expressed as follows:

$$C + E\,e^{-rt} = P + S_0$$

Further, it may be observed that by re-arranging the terms in the above equation, we get $C - P = S_0 - E\,e^{-rt}$. Now, if the options are at-the-money so that $S_0 = E$, and if the stock pays no dividends, then we have

$$C - P = S_0(1 - e^{-rt})$$

or $$\frac{C}{S_0} - \frac{P}{S_0} = 1 - e^{-rt}$$

On the RHS of the equation, e^{-rt} indicates the present value of Re 1. Accordingly, the expression $1 - e^{-rt}$ represents the difference between present and discounted value of rupee 1, which is nearly equal to the rate of interest. Hence, we may conclude that when the options are at-the-money and the underlying stock pays no dividends, relative call prices (C/S_0) would exceed relative put prices (P/S_0) by about the risk-free rate of interest.

Relationship Between American Call and Put Options

The put-call parity described above holds for European options only. We have already seen that for non-dividend paying stock, an American put option has a greater value than a European one. Accordingly, the value of an American put option is such that

$$P > C + E\,e^{-rt} - S_0$$

or, $$C - P < S_0 - E\,e^{-rt}$$

Now, let us consider two portfolios:

Portfolio P_1 One European call option
An amount of cash equal to E

Portfolio P_2 One American put option
One share

Further, suppose that both options have the same exercise price and expiration date. Let the cash in portfolio P_1 be invested at the riskfree rate of interest. If the put option is not exercised early, the portfolio P_2 will be worth S_1 or E, whichever is higher, at the time of exercise. On the other hand, the portfolio P_1 would be worth S_1 or E, whichever is higher, plus $E\,e^{rt} - E$. Thus, portfolio P_1 would be worth more than portfolio P_2.

Now, suppose that the put option in portfolio P_2 is exercised early at a time t_1, it implies that portfolio P_2 is worth $E\,e^{r(t_1 - t)}$ at time t_1. However, even if the call option were worthless, portfolio P_1 would be worth $E\,e^{r}$ at time t_1. It follows, then, that portfolio P_1 is worth more than portfolio P_2 in all cases. Thus,

$$C + E > P + S_0$$

or $$C - P > S_0 - E$$

or $$S_0 - E < C - P < S_0 - E\,e^{-r(t_1 - t)}$$

Effect of Dividends

In our analysis so far, we have assumed that the options that we are dealing with, are options on a stock which is non-dividend paying. We may now consider the question of dividends. It the dividend (s) payable during the life of an option can be assessed, the option valuation can be suitably modified. Thus, if D be the present value of dividends (assumed to occur at the time of ex-dividend date) during the life of the option, then the lower bound on the call value and on the put value for a European option derived earlier can be adjusted for D as follows:

$$C > S_0 - D - E\,e^{-rt}, \text{ and}$$
$$P > D + E\,e^{-rt} - S_0$$

Adding the present value of dividend(s), D, to the present value of the exercise price has the effect of reducing the value of a call and increasing the value of a put. Further, when the dividends are expected, it cannot be said that an American call will not be exercised early. At times, it may be best to exercise an American call immediately prior to an ex-dividend date because the dividend may cause the stock price to jump, making the option less attractive. Of course, it is not optimal to exercise a call at other times.

It may be shown for put-call parity (of a European option) that

$$C + D + E\,e^{-rt} = P + S_0$$

Similarly, the inequality mentioned for American option would be modified as follows:

$$S_0 - D - E < C - P < S_0 - E\,e^{-rt}$$

Factors Affecting Option Prices

There are several factors affecting the price of a stock option. They include:

1. Stock price.
2. Exercise price.
3. Time to maturity.
4. Dividends, if any, expected during the life of the option.
5. Riskfree interest rate.
6. Volatility in the stock price.

We now consider these in turn.

Stock Price When a call option is exercised, the payoff resulting therefrom equals the excess of stock price over the exercise price. Thus, a call option will be more valuable when stock price increases and less valuable when it decreases. On the other hand, for a put option, the payoff is the difference between exercise price and the stock price. As such, the higher the stock price, for a given exercise price, the lower will be the value of the option.

Exercise Price A call option with a higher exercise price cannot be expected to be valued higher than another call with the same parameters but with a lower exercise price. To understand this feature, consider calls on a stock with the same exercise date, but with varying exercise prices. For example, suppose two calls on a stock with identical exercise dates have exercise prices of, Rs 180 and Rs 190 respectively. The holder of the former call can buy the underlying security at Rs 180, and can be in the same position as the holder of the other call who could buy the same security at Rs 190, *plus* the cash left over. Obviously, therefore, the call with a higher exercise price cannot be valued higher.

Length of Time to Expiration The effect of time to expiration on the option price depends on whether the option is of the American or of the European style. The American call and put options become more valuable as the time to expiration increases. If we consider two calls on the same stock with identical exercise prices but with different exercise dates, it can be easily visualized that the one with the longer life (i.e., one with a latter expiration date) would offer the investor all the exercise opportunities as those of the one with a shorter life, and some additional opportunities as well. It may be, therefore, reasonably expected that of the two comparable calls, the one with a longer life will not be valued lower than the one with a shorter life.

However, European put and call options do not necessarily become more valuable as the time to expiration increases. This is because the owner of the option with longer life does not enjoy all opportunities open to the owner of the one with a shorter life since the option can be exercised only at maturity. For instance, if an investor has two call options—one with an expiration date in one month and the other with expiration date in two months—and a handsome dividend is expected in a month-and-a-half's time, then the price of the underlying stock is likely to decline by the second month. Accordingly, it is probable that the option with smaller time to expiration has a value greater than the value of the other option.

Dividend Dividends on stock have the effect of reducing the stock price on ex-dividend date. Therefore, this affects the value of call options adversely and of put options favourably. The effects on option prices are related to the amounts of dividends expected.

Interest Rate The impact of a riskfree interest rate on option prices is rather indirect. An increase in the riskfree rate of interest leads to an increase in expected growth rate in the stock option prices, on the one hand, and a decrease in the present value of any cash flows received by the holder of an option, on the other. Both these have an adverse impact on the value of the put options. For the call options, the first of the two effects has a larger impact than the second one, with the result that a call option price would increase with an increase in the riskfree interest rate.

Volatility A major factor affecting the price of options is volatility, which is the degree to which price of a stock or an index tends to fluctuate over a certain period of time. As volatility increases, the chance that the stock would do very good or very bad increases.

These two outcomes tend to have an offsetting effect on the holder of the stock. But the situation is different for the owner of a call or put option. For instance, the owner of the call benefits from the price increase but his downward risk is limited since the most he can lose is the option premium. Similarly, the owner of a put option profits from a decrease in the stock price and his risk in case of adverse, upward price movement is limited. Thus, the values of both calls and puts exhibit increases with increases in the degree of volatility.

MODELS OF VALUATION OF OPTIONS

There are a number of models available for valuation of options. Two of the more important ones are: binomial option pricing model and Black and Scholes option pricing model. Both the models are in respect of the European call options. The difference in the two models of option valuation stems basically from the assumptions made about how share prices change over time. While the binomial model assumes that percentage change in share price follows a *binomial distribution*, the Black and Scholes model is based on the assumption that it follows a *log normal distribution*.

It was shown earlier that it never pays to exercise an American call before its expiration if the stock involved would not pay dividend before the expiration date or if the call is dividend protected. Thus, an American call, which satisfies this condition, will be just like a European call and can be evaluated in the same manner.

The Binomial Model

The binomial model of option valuation uses a numerical approach. The model is based on the assumption that if a share price is observed at the start and end of a period of time, it will take one of the two values at the end of that period, i.e., the model assumes that the share price would move up or down to a predetermined level.

For a step-by-step development of the model, let us consider the valuation of a call one period prior to expiration. Now, suppose that a stock is currently selling at Rs 60, and that after one period it would be selling either for Rs 40 or for Rs 80. If the rate of interest, for borrowing and lending both, is assumed to be 25% for the one period, we may determine the value of the call with an exercise price of Rs 60 as follows:

Consider a portfolio consisting of writing two calls, buying one share of the stock, and borrowing Rs 32. In both the events, of the share price falling to Rs 40 or rising to Rs 80, the cash flows at the end of the period, $t = 1$, will be zero as shown in Table 5.3. It may be noted that if the stock price at $t = 1$ is Rs 40, the calls will not be exercised, while if it is at Rs 80, then a loss of Rs 40 [= (80 – 60) × 2] would be incurred on the calls. In either case, the loan of Rs 32 will be repaid together with an interest of Rs 8 (= 25% of the amount borrowed). This implies that in either case, the investor receives nothing and, therefore, the value of the calls would be such that the portfolio has a value of zero. Accordingly, we set $2C - 60 + 32 = 0$ to get $C =$ Rs 14, where C is the price of the call.

Table 5.3

Valuation of Call

Portfolio	*Flows at the beginning, t = 0*	*Flows at t = 1*	
		$S_1 = 40$	*$S_1 = 80$*
Write 2 Calls	+ 2C	0	– 40
Buy a Share	– 60	+ 40	+ 80
Borrow	+ 32	– 40	– 40
Total	$2C - 28$	0	0

It may be shown that if the call is selling at price higher or lower than Rs 14, then it is possible to make a profit. For instance, suppose that the call is underpriced and is selling for Rs 10. It is prudent, in such a case, to buy the call, shorting the stock and lending. As shown earlier, cash flow at $t = 1$ will be zero in either case but at $t = 0$, the flows are:

	Flow
Buy two calls	– 20
Short one share	+ 60
Lend	– 32
Total	+ 8

It can similarly be shown that if the call is valued at a price greater than Rs 14, then profit can be earned by creating a portfolio consisting of writing two calls, buying a share and borrowing Rs 32. To conclude, then, the call cannot sell for higher or lower than the value derived earlier. Now we can make some generalizations.

Hedge Ratio In the above example, we constructed the portfolio in such a manner that payoffs from calls and stock were the same, irrespective of the price of stock prevailing at $t = 1$. Further, resorting to lending or borrowing enabled us to have a zero return at $t = 1$. In our illustration, we used two calls and one share of stock to yield a flow of Rs 40 irrespective of whether the price went up to Rs 80 or down to Rs 40. In general terms, the number of shares of stock per call, which makes the payoff from the combination independent of the price of share is known as *hedge ratio*. In our example, the hedge ratio is 1/2 (one share of stock for two calls).

Now, let

S_0 = the stock price at $t = 0$.

S_1 = the stock price at $t = 1$.

E = exercise price of the call option.

C = call price.

u = 1 + percentage change in stock price from $t = 0$ to $t = 1$, if the stock price increases. In such a case, $S_1 = uS_0$.

d = 1 + percentage change in stock price from $t = 0$ to $t = 1$, if the stock price decreases. For this case, $S_1 = dS_0$.

α = number of shares of stock purchased per share of the call (for example, if the number of shares purchased = 15, and a call involves 100 shares, than $\alpha = 15/100 = 0.15$)

C_u = value of call if $S_1 > S_0$, $C_u = \max(uS_0 - E, 0)$

C_d = value of call if $S_1 < S_0$, $C_d = \max(dS_0 - E, 0)$

Consider the situation given in Table 5.4. To make the portfolio to be a hedged one, the flows at $t = 1$ should be made independent of the stock price. In other words,

$$-C_d + \alpha dS_0 = -C_u + \alpha uS_0$$

or $$\alpha uS_0 - \alpha dS_0 = C_u - C_d$$

Thus, $$\alpha = \frac{C_u - C_d}{S_0(u - d)}$$

Table 5.4

Portfolio Flows

Portfolio	*Flows at t = 0*	*Flows at t = 1*	
		$S_1 = dS_0$	$S_1 = uS_0$
Write a Call	C	$-C_d$	$-C_u$
Buy α shares of Stock	$-\alpha S_0$	αdS_0	αuS_0

For our example, $C_d = 0$, $C_u = 20$, $S_0 = 60$, $u = 80/60 = 4/3$ and $d = 40/60 = 2/3$. Accordingly,

$$\alpha = \frac{20 - 0}{60\left[\frac{4}{3} - \frac{2}{3}\right]} = \frac{20}{60 \times \frac{2}{3}} = \frac{1}{2}$$

Thus, in order to have the combination of calls and stock yield the same payoff, regardless of the value of stock at $t = 1$, we should buy one-half as many shares of stock as the number of calls that are written. Obviously, α represents the hedge ratio.

Using the hedge ratio of α implies that the flows at $t = 1$ are equal to $-C_d + \alpha dS_0$, or $-C_u + \alpha uS_0$. To make the value of the portfolio zero at $t = 1$, we should borrow such an amount so that the flows become $C_d - \alpha dS_0$ (or $C_u - \alpha uS_0$). If we let i equal to one *plus* rate of interest for one period of time, the amount needed to be borrowed will be $(C_d - \alpha dS_0)/i$. With the cash flows of C from writing a call, $-\alpha S_0$ from buying α stock and $(-C_d + \alpha dS_0)/i$ from borrowing, we can set their sum equal to zero (because the value of portfolio at $t = 1$ is equal to zero), to get

$$C - \alpha S_0 - \frac{C_d - \alpha dS_0}{i} = 0$$

or

$$C = \frac{\alpha i S_0 + C_d - \alpha dS_0}{i}$$

Substituting the value of α obtained above into this equation and simplifying, we get

$$C = \frac{C_u \dfrac{(i-d)}{(u-d)} + C_d \dfrac{(u-i)}{(u-d)}}{i}$$

Setting $P = (i - d)/(u - d)$, we get

$$C = \frac{C_u P + C_d(1 - P)}{i}$$

Alternatively, we may derive the value of an option by taking the present value of the various possible expiration values of the option, multiplied by the respective probabilities for those values to occur. It can be represented in the following manner.

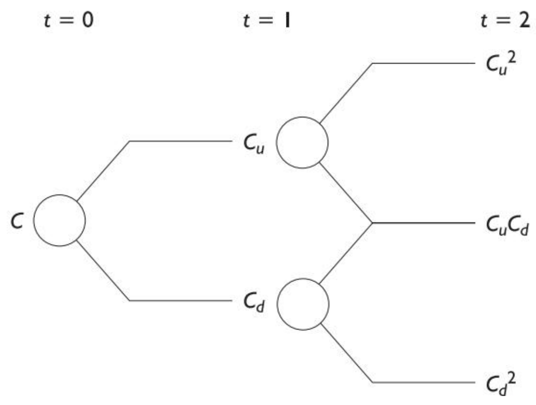
If C be the price of a call, and the value of the stock after an incremental period of time is either C_u with a probability P or C_d with a probability of $1 - P$, the expected return after one time period would be $C_u(P) + C_d(1 - P)$. If i is set equal to one *plus* riskfree rate over this time limit, then the value of the call would be:

$$C = \frac{1}{i}\,[C_u\,P + C_d(1 - P)]$$

Here $P = (i - d)/(u - d)$, where d and u are two possible rates of return on the share after an incremental period of time.

In fact, looking at the formulations for the calculation of P, it is amply clear that P and $1 - P$ are not probabilities. But their use as probabilities to derive the expected value in a situation where stock price is assumed to take only one of the two values gives the prefix 'binomial' to the valuation model.

Extension to Multiple Periods The valuation of a call option can be extended to multiple time periods. To begin with, we may consider the possibilities where an option has two periods to go for maturity. They are shown in Fig. 5.3. In this case, C_{u^2} is the value at expiration if there are two up movements in the stock price. It equals max $(u^2 S_0 - E, 0)$. C_{ud} is the value of option at expiration if there is one upward and one down movement in the stock price. It is equal to max $(ud\,S_0 - E, 0)$. Similarly, C_{d^2} is the value at expiration if two down movements are registered in the price of the share. Therefore, the value of the option at $t = 1$ can be obtained as follows:



➢ **Fig. 5.3** *Tree Diagram showing Call Option Values* if the share price is uS_0

$$C_u = \frac{PC_{u^2} + (1-P)\,C_{ud}}{i}$$

if the share price is dS_0

$$C_d = \frac{PC_{ud} + (1-P)\,C_{d^2}}{i}$$

Knowing the values at $t = 1$, we may proceed to determine the value of the option at $t = 0$ by assuming that there is only one time period to go. Accordingly,

$$C = \frac{P\,\dfrac{PC_{u^2} + (1-P)\,C_{ud}}{i} + (1-P)\,\dfrac{PC_{ud} + (1-P)C_{d^2}}{i}}{i}$$

On simplification, we get

$$C = \frac{P^2 C_{u^2} + 2P(1-P)C_{ud} + (1-P)^2\,C_{d^2}}{i^2}$$

The same approach may be extended to three or more periods. For a three period case, the value of call option, C, can be determined as follows:

$$C = \frac{P^3 C_{u^3} + 3P^2(1-P)C_{u^2 d} + 3P(1-P)^2\,C_{ud^2} + (1-P)^3\,C_{d^3}}{i^3}$$

We may generalize the results to obtain an expression for the valuation of a call n periods before maturity, as given below:

$$C = \frac{\displaystyle\sum_{j=0}^{n} \frac{n!}{j!(n-j)!}\,P^j\,(1-P)^{n-j}\,\max[0, u^j d^{n-j}\,S_0 - E]}{i^n}$$

Notice the numerator, the first part of which is simply the binomial expansion

$$(a + b)^n = C_0^n\,a^{n-0}\,b^0 + C_1^n\,a^{n-1}\,b^1 + C_2^n\,a^{n-2}\,b^2 + \cdots + C_n^n\,a^{n-n}\,b^n$$

$$= \sum_{j=0}^{n} C_j^n\,a^{n-j}\,b^j$$

while the other part gives the conditional value of the call option at each step, j.

The above expression may be simplified by considering the fact that there would be a certain minimum number of upward movements necessary for it to pay to exercise the option at the date of maturity. If we represent this number by k, then it is clear that for sequences with less than k upward movements, the call will not be exercised and it will have a value of zero at expiration.

Thus, it is evident that the summation should begin only at K. When this is done, max $(0;\ u^j\, d^{n-j}\, S_0 - E)$ should be replaced by $u^j\, d^{n-j}\, S_0 - E$. Now, the expression for valuation can be reworked and simplified to eventually lead to the following:

$$C = S_0\, B(k,\ n,\ P') - E\, i^{-n}\, B(k,\ n,\ P)$$

wherein $P = (i - d)/(u - d)$; $1 - P = (u - i)/(u - d)$, $P' = Pu/i$; and $B(k,\ n,\ P')$ is the probability of the number of up movements (successes) in the share price to be up at least equal to k out of n movements, where the probability of an up movement is P'.

From the preceding analysis it follows that the price of a call option is influenced by a number of factors including the current share price, the exercise price, the size of the up movement, the size of the down movement, the riskfree rate of return and the number of periods remaining until expiration.

The binomial option pricing model has the merit that because of the step-by-step approach, it can accommodate specific events like dividends during the life span of the option. But, while a small number of intervals make the option price determination easier, the computations tend to become tedious when a larger number of intervals is considered. No wonder, then, computers are needed for making calculations when the number of time periods involved are large. In fact, by letting the length of the period between up or down movements to become very small, and thereby making the number of periods very large, the binomial formula can be utilized to derive other valuation formulations that allow a continuous change in price. As the number of time intervals becomes higher and higher, the binomial distribution converges to a normal distribution. The Black and Scholes model discussed in the following pages is based on this concept.

Example 5.1

The current price of a share is Rs 50, and it is believed that at the end of one month the price will be either Rs 55 or Rs 45. What will a European call option with an exercise price of Rs 53 on this share be valued at, if the riskfree rate of interest is 15% per annum? Also calculate the hedge ratio.

From the given data, we may define various inputs needed for valuing an option as follows:

C_u (the value of call option if $S_1 > S_0$) $= S_1 - E = 55 - 53 =$ Rs 2

C_d (the value of call option if $S_1 < S_0$) $= \max(S_1 - E, 0)$

$= \max(45 - 50, 0) = 0$

$u = S_1/S_0$ when the stock price increases (i.e., $S_1 > S_0$) $= 55/50$

$= 1.1$

$d = S_1/S_0$ when the stock price decreases (i.e., $S_1 < S_0$) $= 45/50$

$= 0.9$

$i = 1$ *plus* riskfree rate of return applicable for the time interval

$= 1 + (0.15/12) = 1.0125$

(since the annual rate is given to be 15%)

Accordingly, the value of a call would be:

$$C = \frac{C_u \dfrac{(i-d)}{(u-d)} + C_d \dfrac{(u-i)}{(u-d)}}{i}$$

$$C = \frac{2\dfrac{(1.0125 - 0.9000)}{(1.1000 - 0.9000)} + 0\dfrac{(1.1000 - 1.0125)}{(1.1000 - 0.9000)}}{1.0125}$$

$$= \frac{0.2250}{0.2025} = \text{Rs } 1.11$$

Further, we know that hedge ratio,

$$\alpha = \frac{C_u - C_d}{S_0(u-d)}$$

Substituting the known values in this equation,

$$\alpha = \frac{2 - 0}{50(1.10 - 0.90)} = 0.2$$

Thus, the price of the call option = Rs 1.11 and hedge ratio = 0.2.

We may illustrate the binomial valuation model using a multi-period case with an example. It is kept simple in that discounting is not resorted to.

Example 5.2

Suppose that an index is at 3000 and it will change with equal probability by either 10 or 8 in each time interval. Now, consider an American put option on this index with exercise price of 3010, which would expire in three periods. The problem is to determine the fair value of the option at each step.

For this, we first determine the various index possibilities by means of a tree. Once the tree depicting various possibilities is drawn up, we may determine the possible values of the option at expiry. This would enable us to calculate fair values for the option at any point on the index value tree. This is done by comparing the value of holding and the value of immediate exercise at each node and then selecting the optimum value. The process is then repeated at each node towards the origin, including the base of the tree. This enables us to determine the fair price of the option at any point and the optimal point where it may be exercised, as it is an American option.

For the given data, the index tree showing the movement of index over time is shown in Fig. 5.4. From the figure, it is clear that the index values after the three-period interval would be 3030 (all up movements), 3012 (two up and one down movements), 2994 (one up and two down movements) and 2976 (no up movements).

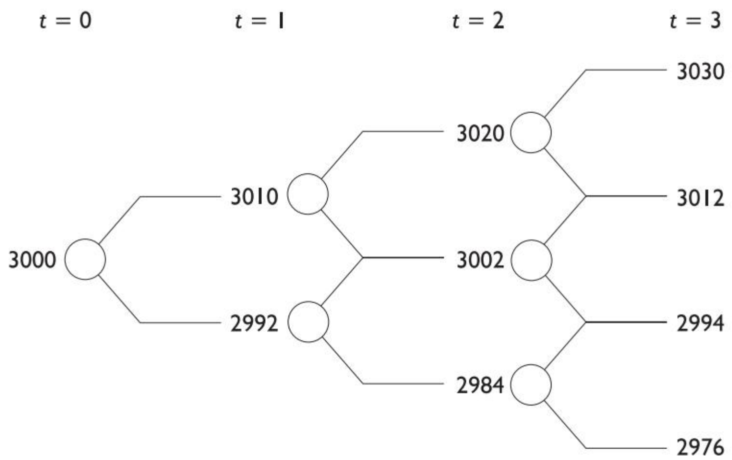
At $t = 3$, the put will eventually have the following values:

1. For index values 3030 and 3012; $P = 0$ (being a put option it will not be exercised when $S_1 > E$).
2. For index value 2994; $P = 3010 - 2994 = 16$.
3. For an index of 2976; $P = 3010 - 2976 = 34$.

At $t = 2$, one time step before the expiry, the option would have the following values:

1. If the index is at 3020, the next step will result in the put option of 3010 expiring unexercised (possible indices being 3030 and 3012). At 3020, the put value is zero, since the index is higher than the exercise value. Therefore, at this point, the option is worthless.

2. In the event the index is at 3002, the option has even chances of either becoming worthless or worth 16 on expiry. Thus, the expected value is $0.5 \times 0 + 0.5 \times 16 = 8$. Immediate exercise of the option will also yield $3010 - 3002 = 8$. Thus, at this point, the value of the option $= 8$.



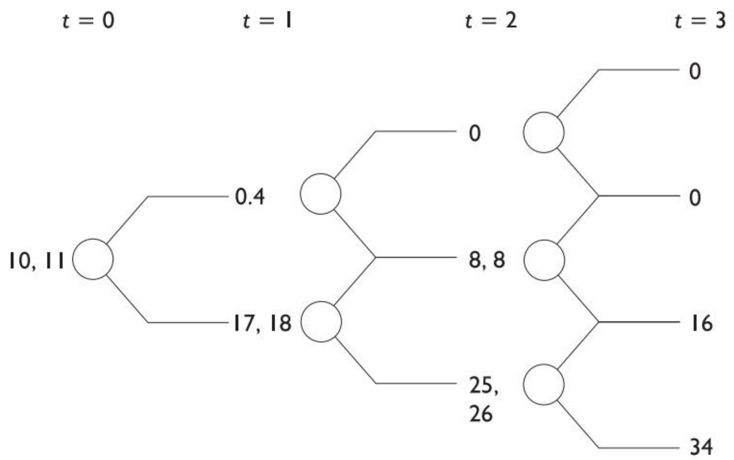
➢ **Fig. 5.4** *Tree Diagram showing Index Movement*

3. When the index is at 2984, the option has an expected value of $0.5 \times 16 + 0.5 \times 34 = 25$. An immediate exercise of this option, on the other hand, will yield 3010 – 2984 = 26. As this is preferable, the option should be exercised and this is taken as the correct option value.

Continuing in the same manner, at $t = 1$, when the index is at 3010, the option, if exercised immediately, will yield nothing, while its expected value would be equal to $0.5 \times 0 + 0.5 \times 8 = 4$. The value of the option can, therefore, be taken to be 4. Similarly, in the event of the index being at 2992, the expected value equals $0.5 \times 8 + 0.5 \times 26 = 17$, and its immediate exercise results in a value of 3010 – 2992 = 18. Thus, the correct value of the option is 18.

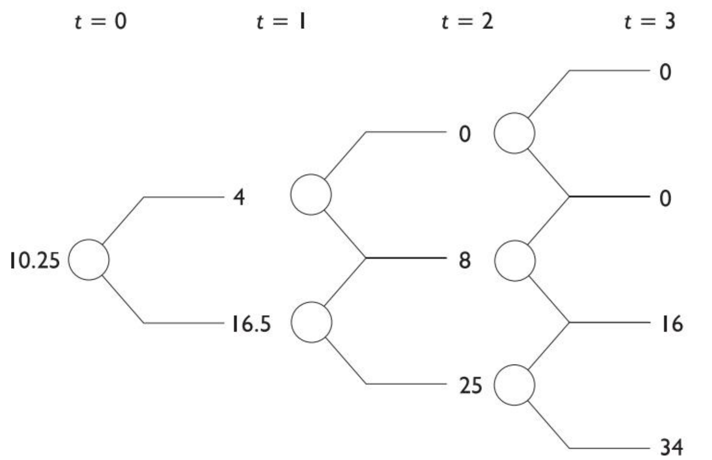
To complete the process, the value of the put at the base of the tree is $0.5 \times 4 + 0.5 \times 18 = 11$, while its prompt exercise would give 3010 – 3000 = 10. Consequently, the appropriate value of the option is 11 at $t = 0$.

The values of the option at various points are contained in the tree diagram given in Fig. 5.5. At each node, from $t = 0$ through $t = 2$, two values are shown: the one resulting from immediate exercise and the other depicting the expected value. In each case, the higher of the two values involved is taken and used for making calculations. Note that all calculations are made in a backward manner.



➢ **Fig. 5.5** *Tree Diagram showing Put Option Values*

If the option in the above example would have been a European one whose early exercise is not possible, the call valuation could be done more easily. For the example under consideration, the value would be 10.25, as shown in the tree diagram given in Fig. 5.6. The European put is thus cheaper 0.75 than the American put—the differential being the extra cost of exercise facility in the latter case.



➢ **Fig. 5.6** *Tree Diagram showing Values of European Style Option*

The Black and Scholes Model

In 1973, Fisher Black and Myron Scholes propounded a model for valuation of options. According to the Black and Scholes formulation, the value of a call option is calculated as follows:

$$C = S_0\, N(d_1) - E\, e^{-rt}\, N(d_2)$$

where $$d_1 = \frac{\ln(S_0/E) + (r + 0.5\sigma^2)t}{\sigma\sqrt{t}}$$

$$d_2 = \frac{\ln(S_0/E) + (r - 0.5\sigma^2)t}{\sigma\sqrt{t}}$$

Also, $$d_2 = d_1 - \sigma\sqrt{t}$$

C = current value of the option

r = continuously compounded riskfree rate of interest

S_0 = current price of the stock

E = exercise price of the option

t = time remaining before the expiration date (expressed as a fraction of a year)

s = standard deviation of the continuously compounded annual rate of return

$\ln(S_0/E)$ = natural logarithm of (S_0/E)

$N(d)$ = value of the cumulative normal distribution evaluated at d

Assumptions Underlying Black and Scholes Model The Black and Scholes valuation model is based on certain assumptions. These are:

1. The option being valued is a European style option, with no possibility of an early exercise. Comparable American call options are more valuable because they provide greater flexibility of exercise. However, this is not a major pricing consideration since only a few calls are exercised before the last few days of their life. This is simple to understand because an option holder who exercises the option early virtually throws away the time value remaining on the call. Thus, if one holds a call option at Rs 58, one can always buy shares at this rate by virtue of the call. Now, if the share is currently selling at, say, Rs 70 one may be tempted to exercise the option and make a profit of Rs 1200 (on 100 shares). But what is important to understand is that the better alternative in such a case would be to sell it in the market where it will fetch a minimum price of Rs 1200, its intrinsic

value. In last few days before the expiry of the option, the time value is negligible. Thus, the valuation is nearly same for an American option as well.

2. There are no transaction (dealing) costs and there are no taxes. This of course, is not true. There are commissions and other costs to be paid by the investors which may be substantial at times and therefore, affect the true cost of an option position. Since such costs and the tax impact vary among investors, it is likely to result in a different cost of an option to different investors.

3. The risk-free interest rate is known and constant over the life of the option.

4. The market is an efficient one. This implies that as a rule, the people cannot predict the direction of the market or any individual stock. Market efficiency is a central paradigm in modern finance theory. Of course, doubts are always expressed whether the assumption is indeed valid. Though, efficient market theory may not provide a very good explanation of investor behaviour, it surely gives a better explanation than others.

5. The underlying security pays no dividends during the life of the option. Thus, the model would yield the same price for options with identical inputs on two securities which are same in all respects, except that they have different dividend yields. It can be easily visualised that the higher the yield of dividend, the lower the call premium and thus, the market prices of the calls are not likely to be the same.

However, the fact that different securities do pay dividends does not render the model useless. Once the option value is determined using the model, the value is adjusted for the dividend expected on the security. This is explained later in the chapter.

6. The volatility of the underlying instrument (may be the equity share or the index) is known and is constant over the life of the option.

7. The distribution of the possible share prices (or index levels) at the end of a period of time is log normal or, in other words, a share's continuously compounded rate of return follows a normal distribution. Essentially, this means that the share (or index) in question has the same likelihood to double in value as is it to halve,

with the added implication that the share prices (or indices) cannot become negative.

An Intuitive Idea of the Valuation Model To have a basic idea about the Black and Scholes model, let us reconsider the formula $C = S_0 N(d_1) - Ee^{-rt} N(d_2)$ and sub-divide it into two components as $S_0 N(d_1)$ and $Ee^{-rt} N(d_2)$. In the first component, S_0 is the current price of the stock which, in terms of the theory of finance, is the discounted value of the expected price at any point in time in the future, while $N(d_1)$ is the probability that, at expiration, the stock price shall exceed the option exercise price. Similarly, contents in the second component of the equation may be viewed as the present value of having to pay the exercise price on the expiration day. Thus, the value of a call option is equal to the difference between the expected benefit from acquiring the stock now and paying the exercise price on expiration day.

Using the Black and Scholes Formula An examination of the formula reveals that the inputs required to value an option are: current price of the stock (S_0), exercise price of option (E), time remaining before expiration of the option (t), riskfree rate of interest (r), standard deviation of the continuously compounded annual rate of return (σ) on the stock/index and a normal probability table. The first three of these are easily observable while an idea about the riskfree rate of interest may be had by taking the rate of return on a government security that has a maturity date closest to the expiration date of the call.

However, there is some problem with regard to the standard deviation, which is the measure of volatility. As a first step, let us see how is the value of the standard deviation of the continuously compounded annual rate of return may be calculated using historical data on stock returns. The calculation of standard deviation involves the following steps:

1. Calculate *price relative* for each week using one year, or a fraction of a year's, historical weekly data. The price relative for a week is the ratio of the price at the weekend plus dividends, if any, to the price at the beginning of the week.

2. Find natural logarithms of each of the price relatives. This is the continuously compounded rate of return per week.

3. Calculate standard deviation of the series of continuously compounded rate of return as follows:

(a) Calculate the mean rate of return,

$$\bar{X} = \frac{\Sigma X}{n}$$

(b) Find the total of squared deviations of rates of return from the mean rate of return,

$$\Sigma(X - \bar{X})^2$$

(c) Use the following rule:

$$\sigma = \sqrt{\frac{\Sigma(X - \bar{X})^2}{n}}$$

Alternatively,

$$\sigma = \sqrt{\frac{\Sigma X^2}{n} - \bar{X}^2}$$

4. Convert the continuously compounded weekly standard deviation to a yearly standard deviation by multiplying it by the square root of 52.

Similar calculations can be done by using the data on daily prices. In that event, the continuously compounded daily standard deviation can be converted into the required standard deviation by multiplying by the square root of the number of trading days in the year. Also, if monthly data are used, then the required value is obtained by multiplying the monthly (standard deviation) value by square root of 12.

To understand the calculation of standard deviation, let us consider the hypothetical closing prices of a share over the last 15 weeks as given in the Table 5.5 Using the values in the second column, price relatives (*PR*) are obtained by dividing the closing price of a given week by the closing price of the preceding week. Accordingly, the first price relative is 42.50/40.00 = 1.0625, the second one is 41.70/42.50 = 0.9812, and so on. The fourth column in the table contains the natural log values of the price relatives. This represents the series of continuously compounded weekly rates of return. The mean and standard deviation of this series are calculated next, which work out to be 0.0103 and 0.0406 respectively.

$$\text{Mean} = \frac{0.1441}{14} = 0.0103$$

Standard deviation,

$$\sigma_w = \sqrt{\frac{0.02454205}{14} - (0.0103)^2} = 0.0406$$

The annual volatility can be obtained by converting the weekly standard deviation value into a yearly one by multiplying by $\sqrt{52}$. Accordingly,

$$\text{Annualized volatility} = \text{Weekly volatility} \times \sqrt{52}$$

$$= 0.0406 \times \sqrt{52} = 0.2928$$

Table 5.5

Calculation of Standard Deviation

Week	*Closing Price*	*Price Relative (PR)*	*ln PR = X*	X^2
1	40.00			
2	42.50	1.0625	0.0606	0.00367236
3	41.70	0.9812	– 0.0190	0.00036100
4	42.20	1.0120	0.0119	0.00014161
5	43.50	1.0308	0.0303	0.00091809
6	48.70	1.1195	0.1129	0.01274641
7	45.30	0.9302	– 0.0724	0.00524176
8	44.90	0.9912	– 0.0088	0.00007744
9	46.20	1.0290	0.0286	0.00081796
10	46.20	1.0000	0.0000	0.00000000
11	45.80	0.9913	– 0.0087	0.00007569
12	45.60	0.9956	– 0.0044	0.00001936
13	45.70	1.0022	0.0022	0.00000484
14	45.30	0.9912	– 0.0088	0.00007744
15	46.20	1.0199	0.0197	0.00038809
		Total	0.1441	0.02454205

The value of annualized volatility as derived above — termed the standard deviation of the distribution of continuously compounded annual rate of return, σ — is used in computing the value of a call option on a scrip.

Strictly, the Black and Scholes model requires the usage of σ as it is likely to be over the life span of the option. However, the model is derived under the assumption that rates of return are identically distributed over time. If this assumption were indeed to hold, then satisfactory estimates of standard deviation can be made from the historical data. The volatility measured on the basis of historical data is termed as *historical volatility*.

The historical volatility, together with the current market analysis and perception of the market serves as the basis of making estimate of the future volatility. The historical volatility measured on the basis of recent past data is generally taken as a reasonable estimate of the *projected volatility.*

Calculation of Call Option Value

The calculation of call option value using Black and Scholes model is demonstrated below.

Example 5.3

Consider the following information with regard to a call option on the stock of *ABC* company.

Current price of the share, S_0 = Rs 120

Exercise price of the option, E = Rs 115

Time period to expiration = 3 months. Thus, $t = 0.25$ years

Standard deviation of the distribution of continuously compounded rates of return, $\sigma = 0.6$

Continuously compounded riskfree interest rate, $r = 0.10$

With these inputs, the value of the call using Black and Scholes formula can be calculated as follows:

We first obtain the values of d_1 and d_2 as shown below:

$$d_1 = \frac{\ln(120/115) + (0.10 + 0.5 \times 0.6^2)(0.25)}{0.6\sqrt{0.25}} = 0.37$$

$$d_2 = \frac{\ln(120/115) + (0.10 - 0.5 \times 0.6^2)(0.25)}{0.6\sqrt{0.25}} = 0.07$$

From the table of the area under a normal curve, Table A2, we observe that for $z = 0.37$ $(= d_1)$, the area = 0.1443 and for $z(= d_2) =$ 0.07, the area = 0.0279. These values give the areas between mean and the specified values of d_1 and d_2. Here we need the total areas under the normal curve to the left of d_1 and d_2, which are respectively 0.5 + 0.1443 = 0.6443 and 0.5 + 0.0279 = 0.5279. Thus,

$$N(d_1) = N(0.37) = 0.6443,$$

$$N(d_2) = N(0.07) = 0.5279$$

The value of the call is

$$C = 120 \times (0.6443) - \frac{115}{e^{0.10(0.25)}}\,(0.5279) = \text{Rs } 18.11$$

The use of the Black and Scholes formula has given the value of the call on *ABC* to be equal to Rs 18.11 for the data given in the example. Let us suppose that this call is selling at Rs 16.50. If the formula does give correct value of the call, then the call is undervalued in the market. In such an event, one can take advantage by purchasing the call. As an alternative, the investor can protect himself against unfavourable price changes by buying the call and selling the stock short.

Calculation of Put Option Value

Using the put-call parity, we can determine the put option value on *ABC* as follows:

$$\begin{aligned} P &= C + E\,e^{-rt} - S_0 \\ &= 18.11 + 115\,e^{-(0.10)\,(0.25)} - 120 = \text{Rs } 10.27 \end{aligned}$$

Thus, to obtain the put option value, we first calculate a theoretical call option value using the Black and Scholes model and use the result as an input in the put-call parity model. Obviously, the value so derived is the put option that would exist without arbitrage opportunities.

In fact, it is not necessary to calculate the call option value before the put option value may be derived. The Black and Scholes model can be combined with the put-call parity model to directly obtain the put option value. This is given below:

$$P = Ee^{-rt}\,N(-\,d_2) - S_0\,N(-\,d_1)$$

with all variables defined as earlier.

To consider again the Example 5.3, we have, E = Rs 115, $r = 0.10$, $t = 0.25$, S_0 = Rs 120, $d_1 = 0.37$ and $d_2 = 0.07$.

Accordingly, $N(-\,d_1) = N(-\,0.37) = 0.3557$ and

$$N(-\,d_2) = N(-\,0.07) = 0.4721$$

Now,

$$\begin{aligned} P &= 115 \times e^{-0.10 \times 0.25} \times 0.4721 - 120 \times 0.3557 \\ &= 52.95 - 42.68 = \text{Rs } 10.27 \end{aligned}$$

This value is identical to the one obtained earlier.

Recall that a call option with stock price exceeding the exercise price is an in-the-money option. With S_0 = Rs 120 and E = Rs 115, the intrinsic value of call is Rs 120 – Rs 115 = Rs 5. The time value of the option equals Rs 18.11 – Rs 5 = Rs 13.11. On the other hand, with S_0 = Rs 120 and E = Rs 115, a put option is out-of-the-money. Therefore, its intrinsic value is nil and the value of Rs 10.27 represents only the time value.

It may be noted that if the call and the put options involve a contract of 100 shares, then the buyer of a call option in the above case will be required to pay a sum of Rs 1,811, while a put option buyer will pay Rs 1,027 for one option. The values of C and P are essentially for a single share.

Sensitivity Analysis We have already discussed various factors affecting the values of options. Now, we examine the effects of changes in various parameters determining the option values in the context of the Black and Scholes model.

The begin with, consider the information given in Example 5.3. Let us term this information as the basic data. Then, basic data is:

Stock price, S_0 = Rs 120

Exercise price, E = Rs 115

Length of time before expiration = 3 months

Thus, $t = 0.25$ years

Standard deviation of the distribution of continuously compounded rate of return, $\sigma = 0.6$

Continuously compounded riskfree rate of interest, $r = 0.10$

From this data, we have,

Value of the call option = Rs 18.11

Value of the put option = Rs 10.27

To trace the effects of changes in different parameters on the call and put option values, the various parameter values in the basic data are changed and the call and put option premia are recalculated. It may be noted that all the changes in the parameter values are to be considered independently so that for a particular new parameter value all other values would be the same as in the basic data. The results for certain selected values are given in Table 5.6. The following points may be noted:

1. Other things being equal, an increase in the stock price results in an increase in the value of a call option because it becomes deeper in-the-money and, hence, its intrinsic value increases. On the other hand, the put option value registers a decline.

When the stock price becomes very large, a call option becomes liable to be certainly exercised and is akin to a forward contract with a delivery price equal to E. Thus, such a call would be expected to be priced at $S_0 - E\,e^{-rt}$. In the Black and Scholes formulation, large values of S_0 will result in large values of d_1 and d_2, and $N(d_1)$ and $N(d_2)$ would both be close to 1. For the put option, on the other hand, the large values of S_0 would result in a price close to zero.

2. An increase in the exercise price from Rs 115 to Rs 118 reduces the intrinsic value of the call option. Thus, the call premium reduces with this. The put option value, on the other hand, increases because at this exercise price, it is out-of-the-money to a lesser degree.

3. When the exercise price is taken to be Rs 125 against the stock price of Rs 120, the call option becomes out-of-the-money. Hence its value reduces. At this rate, the entire premium is on account of the time value. In contrast to the call option, the put option is in-the-money with an intrinsic value equal to Rs 125 – Rs 120 = Rs 5. Out of the total premium of Rs 14.93, the time value of the put option is Rs 14.93 – Rs 5 = Rs 9.93.

Table 5.6

Effect of Changes in Various Parameters

New Parameter Value	*Value of Option (In Rupees)*	
	Call	*Put*
Basic Data	18.11	10.27
$S_0 = 124$	20.78	8.94
$E = 118$	16.15	11.24
$E = 125$	13.02	14.93
$t = 4$ months	20.81	12.04
$r = 12\%$	18.40	10.00
$\sigma = 0.7$	20.34	12.50

4. Longer the duration of an option to maturity, greater is the time value of the option. Accordingly, both the call and the put option values are seen to be up with an increase in the duration from 3 to 4 months.

5. A rise in the riskfree rate of interest has a favourable impact on the call option price and unfavourable impact on the price of the put option. In the valuation of a call option, the riskfree rate of interest (r) is used in all the three expressions: for calculation of d_1, d_2 and Ee^{-rt}. It may be intuitively seen that the impact of an increase in the value

of r would be much less on d_1 and d_2, and therefore on $N(d_1)$ and $N(d_2)$, than on $E\,e^{-rt}$. The overall impact would, therefore, be to suppress the value of $E\,e^{-rt}$. Consequently, the call option value will show an increase. However, the impact of the change in r, cannot be traced directly for the put option value. An increase in the riskfree rate of interest, as indicated earlier, leads to an increase in expected growth rate in the stock option prices, on the one hand, and a decrease in the present value of any cash flows received by the holder of an option, on the other. Both these effects have an adverse impact on the value of the put options. Suffice to say, then, that the increase in the value of C, the call option price, is more than offset by a decline in the present value of the exercise price, $E\,e^{-rt}$, thus lowering the value of a put option.

6. An increase in the variability of the underlying asset value makes the options more valuable. This is evident from the values of call and put options contained in the last row of Table 5.6.

On the other hand, a decline in the variability would lead to a decline in the option values. When the variability, σ, approaches zero, the stock in question would be virtually riskfree. Accordingly, its price would grow at the rate r to $S_0\,e^{rt}$ after time t and the payoff from a call option at maturity would be $S_0\,e^{rt} - E$, or zero, whichever is higher. Discounting at the rate r, the present value of the call option works out to be the higher of the two: $S - E\,e^{-rt}$, and zero. Similarly, when σ tends to zero, the put option price would be the larger of $E\,e^{-rt} - S_0$ or zero.

The sensitivity results are summarised in Table 5.7.

Table 5.7

Sensitivity of Option Premium

Parameter	*Effect of an increase in value of each parameter on the option value, holding others constant*	
	Call option premium	*Put option premium*
1. Current Stock Price	Increase	Decrease
2. Exercise Price	Decrease	Increase
3. Time to expiration	Increase	Increase
4. Interest Rate	Increase	Decrease
5. Volatility	Increase	Increase

Volatility Revisited: Calculation of Implied Volatility It is clear that volatility of the underlying plays an important role in the Black and Scholes option pricing model. It is measured in terms of the standard deviation and used as an input in the formulation. A reference to the Black and Scholes formula reveals that sigma (σ) enters the equation several times. Now, just as we can calculate the option premium for a given set of inputs including standard deviation, it should be possible for us to calculate the standard deviation (σ) when all parameters, except this, are given along with (market) price of the option, and the Black and Scholes model is assumed to work. This is *implied volatility* in the given option premium. The objective of deriving implied volatility is to use it as an aid in forecasting the future volatility.

However, it is evident from the format of the equation that although σ appears repeatedly, it cannot be conveniently isolated. Thus, we cannot obtain the value of σ from the equation directly. We may obtain its value only by trial and error process.

Several attempts have been made to produce approximations to estimate the implied volatility but they lose their accuracy as the price of the underlying moves away from the exercise price. A solution provided by Corrado and Miller is given here, that produces values very nearly correct over a reasonable range of moneyness of the options. The rule is:

$\sigma =$

$$\frac{1}{\sqrt{t}}\left[\frac{\sqrt{2\pi}}{S_0 + E e^{\ \ rt}}\left(C \pi \frac{S_0 \pi E e^{\ \ rt}}{2} + \sqrt{\left(C \ \pi \frac{S_0 \pi E e^{\ \ rt}}{2}\right)^2 \quad \frac{(S_0 \quad E e^{\ \ rt})^2}{\pi}}\right)\right]$$

For the data in Example 5.3, where S_0 = Rs 120, E = Rs 115, $t = 0.25$, $r = 0.10$ and C = Rs 18.11, we have

$$S_0 + E\,e^{-rt} = 120 + 115e^{-0.1 \times 0.25} = 232.161$$

$$S_0 - E\,e^{-rt} = 120 - 115e^{-0.1 \times 0.25}$$

$$= 7.839$$

Further,

$$\sigma = \frac{1}{\sqrt{0.25}}\left[\frac{\sqrt{2\pi}}{232.161}\left(18.11 - \frac{7.839}{2} + \sqrt{\left(18.11 - \frac{7.839}{2}\right)^2 - \frac{(7.839)^2}{\pi}}\right)\right]$$

$$= 0.60$$

This indeed is the σ value used in calculating the call option value.

For an exactly at-the-money call option, however, we can get the implied volatility by applying the following formula:

$$\sigma = \frac{0.5\,(C+P)\,\sqrt{(2\pi/t)}}{E/(1+r)^t}$$

This can be seen with the help of an example.

Example 5.4

The following data are given:

Stock price	:	Rs 120
Exercise Price	:	Rs 120
Risk-free rate of interest	:	5% p.a.
Standard deviation of continuously compounded rate of return (σ)	:	0.20
Time to maturity	:	45 days

Calculate the call and put option values using these data. Now, using the same inputs and the call and put option values, verify that $\sigma = 0.20$.

Using the given information, the call and put option values may be calculated as equal to Rs 3.73 and Rs 2.99 respectively. Now, substituting the various input values in to the formula, we may calculate the implied volatility, σ, as follows:

$$\sigma = \frac{0.5(3.73 \quad 2.99)\sqrt{2 \quad 3.1416 \quad (365/45)}}{120/(1.05)^{45/365}}$$

$$= 0.20$$

Derivatives of Black and Scholes Formulation

Having considered broadly as to how the option premium is likely to be affected when some input value changes, we may now formally state the various measures of sensitivity. Mathematically, they may be obtained by differentiating the Black and Scholes formulation for call and put options, with respect to various input parameters, namely S_0, t, r, and σ. The derivatives include delta, gamma, theta, rho and vega. We consider these now.

Delta This is a very significant by-product of the Black and Scholes model and is used extensively in the context where options form part of the portfolios. The reason for this is that the deltas provide multi-fold information. Deltas are interpreted as (i) a measure of volatility,

(ii) a measure of the likelihood that an option will be in-the-money on the expiration day, and (iii) a hedge ratio.

As a measure of volatility of the option premium, delta refers to the amount by which the price of an option changes for a unit change in the price of the underlying security or index. Mathematically, it is equal to the partial derivative of the call option premium (C) with respect to the stock price (S_0) for a call option and partial derivative of the put option premium (P) with respect to the stock price (S_0) for a put. A delta equal to 0.7 for a call option implies that for a one unit change in the stock price (or index) the option would move 0.7 points. Similarly, a delta equal to – 0.8 for a put option means that the put option premium will decline by 80 paise if the underlying stock price rises by one rupee.

In terms of the Black and Scholes model, for a call option, the delta is given by $N(d_1)$, while for a put option it is equal to $N(d_1) - 1$. For Example 5.3, $N(d_1)$ being equal to 0.6443, the delta for call option is 0.6443 and for put option, it is $0.6443 - 1 = -0.3557$. Thus, if the price of the underlying share *ABC*, rises by Re 1, the price of call option will rise approximately 64 paise while the price of the put option will fall by about 35 paise. It should be noted, however, that these estimates of changes in the option values are only approximate. These values of deltas will give us exact changes only if the changes in stock price are infinitesimally small. Since a one-rupee (or some bigger amount) change in the price is discrete, the computed prices are only estimates.

Evidently, the call delta value would always be greater than zero and less than one, since $N(d_1)$ represents area under the standard normal curve. Deep in-the-money call options would have delta close to unity while deep in-the-money put options would show a delta nearing – 1. Options that are far out-of-the-money have delta values close to zero. Thus, while deep in-the-money options tend to move in tandem with the value of the underlying asset, the far out-of-the-money options show a very low response to such changes. An analysis of the changes in delta of an option reveals that if an option is at-the-money, the decline in delta is approximately linear over time, while for an out-of-the-money option, the delta declines and approaches zero as the time passes, the decline being more pronounced as time passes. On the other hand, in-the-money options behave like the underlying stock and approaches 1.0 as the date of expiration approaches. The delta changes most rapidly for the options that are near the money. Further, as an option moves from being out-of-the-money to in-the-money, the value of delta increases (ignoring the minus sign in case of put options), the increase being greatest for the smaller dated options.

Delta as a Probability Delta is also employed as a measure of the probability that a given option will be in-the-money on the expiration day. Thus, for the call option considered in Example 5.3, which has delta equal to 0.6443, we can say that there is nearly a 64.43 percent chance that the stock price on the expiration day will be above the option exercise price of Rs 115.

Delta as a Hedge Ratio In the Black and Scholes formulation, $N(d_1)$ also gives the optimal hedge ratio. This indicates how many units of the option are necessary to mimic the returns of the underlying stock (or other asset). For our example of *ABC* shares, $N(d_1) = 0.6443$. It implies that for every call option purchased, 0.6443 of the share of the stock should be sold short, and since a call option is (generally) for 100 shares, 64.43 shares of the stock should be traded for each call. Accordingly,

Number of shares of stock per call option = 64.43, and

Number of call options per 100 shares of stock = Rec $N(d_1)$ = Rec 0.6443 = 1.55.

Accordingly, if someone owned 1000 shares of the underlying stock, then writing 15.5 (that is 16) call option contracts would result in a theoretically perfect hedge for small changes in the stock price.

Creation of Delta-Neutral Positions To put the idea more formally, let us consider a portfolio consisting of a short position in one call (European) on a stock and long position in delta units of the stock. The value of this portfolio, P_1 would be:

$$P_1 = -C + N(d_1)\,S_0$$

With our example, where C = Rs 18.11, $N(d_1) = 0.6443$ and $S_0 =$ 120,

$$P_1 = -18.11 + 0.6443 \times 120 = \text{Rs } 59.206.$$

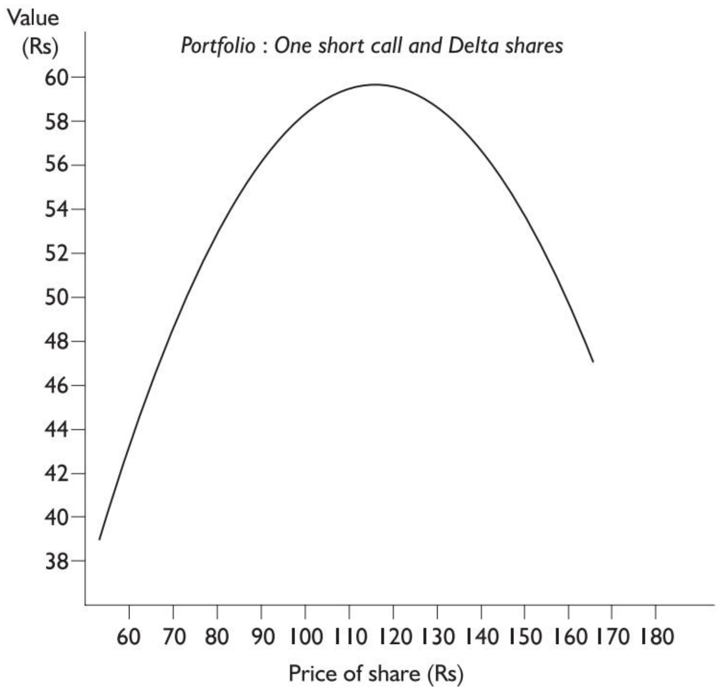
Now, if the stock price increases to Rs 121, the value of the portfolio would be

$$P_1 = -18.76 + 0.6443 \times 121 = \text{Rs } 59.200.$$

Thus, for a one-rupee change in the stock price, the value of the portfolio would change by only Rs 0.006. If the change in the price of the stock were infinitesimally small, then the portfolio value would not change at all, and if there is a large change in the stock price, the change in the portfolio value would be large. However, even for the substantial changes in the spot price of the stock, the changes in the portfolio value would be relatively small. To illustrate, if the stock price becomes Rs 130, the call price would become Rs 25.05 and the portfolio value would change as shown here:

$$P_1 = -25.05 + 0.6443 \times 130 = \text{Rs } 58.709.$$

Thus, here a Rs 10 change in the stock price brings about a Rs 0.497 change in the value of the portfolio. Figure 5.7 shows how the value of this portfolio changes with changes in the stock price.



➢ **Fig. 5.7** *Value of Delta-Neutral Portfolio*

This type of portfolio is termed as *delta-neutral portfolio* because for it, an infinitesimal change in the stock price does not produce a change in the portfolio value. Accordingly, for this portfolio, whose value is insensitive to small change in the price of stock, the delta is zero.

The Black and Scholes model is based on the assumption that the stock price changes continuously. Now, suppose that we can trade shares and options continuously (remember that delta changes with changes in stock prices) and rebalance our portfolio as stock price changes. In this rebalancing, we attempt to maintain the portfolio as a delta-neutral one. Thus, through continuous trading, we can keep our portfolio insensitive to stock price changes and, hence, risk-free. Such a risk-free portfolio should earn the risk-free rate of return.

The possibility of creating a delta-neutral portfolio is a very important one in shaping the risk profile of an investment. Thus, the stock in question may be very risky one and an investment in it may be made risk-free (delta-neutral) by using a call option as discussed earlier. Now, if the investor shorts not one, but one-half a call, then the risk would reduce, but it would not be completely eliminated. Thus, options can be used to modify the risk profile as desired.

The idea of creating delta-neutral portfolio is also important in using delta-oriented hedging strategies. The principles of hedging a single option discussed earlier can be applied as well, when a portfolio consisting of multiple options is held. In case of multiple options, the first step required is the calculation of position delta and then a hedge is created such that the position is delta-neutral.

The position delta is calculated as the weighted average of the deltas of the options held. The respective weights for various options are given by the proportionate values of the options in the total portfolio. The deltas are given positive signs for long call and short put positions, and negative for short call and long put positions. Evidently, to be meaningful, each position in the options must be on the same underlying asset although the position can include calls and puts, long and short positions, and with options involving different exercise prices and expiry dates.

Once the position delta is calculated, position in the underlying asset can be taken to make the option delta-neutral. To illustrate, if the option position had a net delta of + 0.7, then such position would be made delta-neutral by going short the underlying asset to the extent of 0.7 or 70% of the notional value of the assets represented by the option position. Thus, if the option position consisted of calls on 40,000 shares, going short 28,000 shares will make the position instantaneously delta-neutral. In terms of the Black and Scholes model, it would be possible continuously to rebalance the portfolio by altering the short position in the underlying asset to ensure that the portfolio remains delta-neutral.

Gamma The gamma represents the amount by which an options delta would move in response to a unit change in the underlying stock price or index (in language of calculus, gamma is the second derivative of the option price with respect to the stock price, S_0). Thus, it measures the proportional change in delta for a given change in the underlying asset value. A movement of delta from 0.6 to 0.7 in relation to a unit change in the underlying index, for instance, yields a gamma equal to 0.1. For an at-the-money option, gamma increases as the time to maturity decreases. Short life at-the-money options would have very high gamma values implying thereby that the value of the option holder's position is very sensitive to jumps in the stock price.

The gamma of a call option is always equal to the gamma of a put option and it can be either positive or negative. In the Black and Scholes formulation, gamma is calculated as follows:

$$\text{Gamma} = \frac{z(d_1)}{S_0 \sigma \sqrt{t}}$$

where

$$z(d_1) = \frac{e^{-d_1^2/2}}{\sqrt{2\pi}}$$

For our example, (Example 5.3), we have $S_0 = 120$, $\sigma = 0.6$, $t = 0.25$ and $d_1 = 0.37$. Accordingly,

$$z(d_1) = \frac{e^{-d_1^2/2}}{\sqrt{2\pi}} = \frac{e^{-(0.37)^2/2}}{\sqrt{2\pi}} = 0.3725$$

$$\text{Now, Gamma} = \frac{z(d_1)}{S_0 \sigma \sqrt{t}} = \frac{0.3725}{120 \times 0.6 \times \sqrt{0.25}} = 0.0103$$

Here gamma equal to 0.0103 has the implication that an increase in the stock price of Re 1.0 will increase the call delta by 0.0103. With $S_0 = 120$, the call delta at present is 0.6443. If the stock price were to rise from Rs 120 a share to Rs 121, the delta would increase to 0.6546.

Similarly, for the put option, the delta = – 0.3557 would change to – 0.3557 + 1(0.0103) or – 0.3454, with a one-rupee change in the stock price from Rs 120 to Rs 121.

Theta The theta is obtained by considering value of an option as a function of time when all other parameters of the pricing model remain constant. It is thus known as the *time decay* of the option value. Theta represents the price decay that affects an option as it ages and loses time value. It is nearly always negative for an option because as the time to maturity approaches, the option tends to become less valuable. In exhibits greatest effect before close to the expiration of the option.

Defined as the negative of the derivative of the option price with respect to time remaining until expiration, theta is obtained as follows:

For a call option

$$\text{Theta} = -\frac{S_0\, z(d_1)\sigma}{2\sqrt{t}} - E\,\mathrm{e}^{-rt}\, r\, N(d_2)$$

For a put option

$$\text{Theta} = -\frac{S_0\, z(d_1)\sigma}{2\sqrt{t}} + E\,\mathrm{e}^{-rt}\, r\, N(-\,d_2)$$

where

$$z(d_1) = \frac{\mathrm{e}^{-d_1^2/2}}{\sqrt{2\pi}}$$

Continuing with the data of Example 5.3, where $S_0 = 120$, $\sigma = 0.6$, $t = 0.25$, $E = 115$, $r = 0.10$, $d_1 = 0.37$ and $d_2 = 0.07$, we have

$$z(d_1) = \frac{\mathrm{e}^{-d_1^2/2}}{\sqrt{2\pi}} = \frac{\mathrm{e}^{-(0.37)^2/2}}{\sqrt{2\pi}} = 0.3725$$

Accordingly,

$$\begin{aligned}
\text{Theta (call)} &= -\frac{120 \times 0.3725 \times 0.6}{2\sqrt{0.25}} - 115 \times \mathrm{e}^{-0.10 \times 0.25} \times 0.10 \times 0.5279 \\
&= -\,26.82 - 5.92 \\
&= -\,32.74 \\
\text{Theta (put)} &= -\frac{120 \times 0.3725 \times 0.6}{2\sqrt{0.25}} + 115 \times \mathrm{e}^{-0.10 \times 0.25} \times 0.10 \times 0.4721 \\
&= -\,26.82 + 5.30 \\
&= -\,21.52
\end{aligned}$$

Note here that these values of theta are expressed in terms of years. A theta equal to – 32.74 suggests that if time to expiration were a year longer, then the value of the call shall be up by about Rs 32.74. Thus, with an expiration of one year and three months, the call would sell for Rs 18.11 + Rs 32.74 = Rs 50.85. It may be mentioned here that since the partial derivative evaluates changes in the call price for small changes in time, it is more accurate, as also desired, that we express the time decay as about Re 0.09 per day (obtained as Rs 32.74/365). It may be interpreted to mean that a day nearer to maturity would cause a fall of 9 paise in the price of the call option. Similarly, the put option would experience a fall of about (Rs 21.52/365) or 6 paise per day for each passing day towards maturity.

For stock prices near the exercise price, both the theta values would be quite negative as expiration approaches. However, the two thetas change differently accordingly as the options are in-the-money or out-of-the-money.

Rho The rho, which is the first derivative of an option's price with respect to the interest rate, measures the sensitivity of an option value to interest rate. This refers to the rate of change of the value of the option with respect to a unit change (say one per cent) in the interest rate.

Generally, the option values are not very sensitive to the changes in interest rates. For call options, rho is always positive while for put options, it is negative.

For a call option

$$\text{Rho} = Et\,e^{-rt}\,N(d_2)$$

For a put option

$$\text{Rho} = -\,Et\,e^{-rt}\,N(-d_2)$$

With $E = 115$, $t = 0.25$, $r = 0.1$ and $d_2 = 0.07$, for our example, we have

$$N(d_2) = 0.5279, \text{ and}$$

$$N(-\,d_2) = 0.4721.$$

Now,

$$\text{Rho (call)} = 115 \times 0.25 \times e^{-0.1 \times 0.25} \times 0.5279$$

$$= 14.80$$

$$\text{Rho (put)} = -\,115 \times 0.25 \times e^{-0.1 \times 0.25} \times 0.4721$$
$$= -\,13.24$$

The value of rho for call indicates that an increase in the return from 0.10 to 1.10 (10 to 110%) would cause the call option price to rise by Rs 14.80. Like in the case of time changes, it is desirable here to re-express changes consequent upon small changes in the interest rates. Accordingly, an increase in the risk-less interest rate from 10 to 11 percent would result in an increase in the value of call equal to Re 0.1480, or about 15 paise. Similarly, for the put option, the rho value −13.24 implies that an increase in the risk-free interest rate from 10 to 11 percent would result in a fall in the put option value equal to about 13 paise.

Vega Also known as *kappa* or *lambda*, vega measures the rate of change of the value of an option with respect to the volatility of the underlying stock. Vega is always positive and identical for call and put options. For the Black and Scholes model, Vega $= S_0\sqrt{t}\ z(d_1)$ in which $z(d_1)$ is obtained as $z(d_1) = \dfrac{e^{-d_1^2/2}}{\sqrt{2\pi}}$

In practice, volatility of the asset underlying a derivative security may not remain constant and may vary over time. This means that the value of the derivative security (the option) may change not only because of the change in the asset price but also because of movements of volatility over time. A high vega suggests that the option value is very sensitive to small changes in volatility, while a low vega implies that volatility changes over time cause relatively insignificant impact on the option prices.

For the data in Example 5.3, the vega may be obtained as under:

$$\text{Vega} = S_0\ \sqrt{t}\ \ z(d_1)$$
$$= 120 \times \sqrt{0.25} \times 0.3725$$
$$= 22.35$$

This value indicates that if σ changes from 0.6 to 0.7, the call value shall be up by Rs 2.235 (since a change from 0.6 to 1.6 causes the price to increase by Rs 22.35 as given by vega) to Rs 20.35, while a decline in σ from 0.6 to 0.5 would cause the price to fall by Rs 2.235 to Rs 15.88. The put option values would also change similarly.

DIVIDENDS, SHARE SPLITS AND BONUS SHARES

The payment of dividends, the splitting of shares and the issue of bonus shares during the currency of options affect the option prices. We shall now consider each of these in turn.

Dividends The options traded in the exchanges are usually not adjusted for the cash dividends payable on the underlying shares. Since the payment of cash bonus has an effect on the share prices, the option premia are also affected. We have already mentioned earlier in this chapter that the payment of dividends affect the price of options.

To understand the idea, let us recall that price of a share at a given point in time in equal to the present value of all dividends receivable on it in future. Thus, today's price of a share represents the present value of all dividends obtainable after today and its price at the expiration of a call would be the present value of all dividends obtainable subsequent to that day. The difference between the two prices is the present value of dividends between today and and the expiration date. Now, assuming that the dividends during the currency of the option are known with certainty, the share trades ex-dividend prior to expiration, and the ex-dividend day and the payment day are the same, the value of the call option using Black and Scholes formula may be obtained by taking the share price adjusted for the present value of the dividend(s) during the life of the option. Subtracting the present value of the dividends from the stock price has the effect of reducing the value of the call option and increasing the value of the put option.

Example 5.5

Reconsider the Example 5.3. Suppose that a dividend of Rs 2.50 will be received from the underlying share 40 days from today. You are required to calculate the values of the call and the put options in light of this information.

The inputs given are: S_0 = Rs 120, E = Rs 115, $t = 0.25$, $r = 0.10$, $\sigma = 0.06$ and a dividend of Rs 2.50 after 40 days. We first calculate the present value, D_0, of Rs 2.50 obtainable after $t = 40/365$, as follows:

$$
\begin{aligned}
D_0 &= D\,e^{-rt} \\
&= 2.50\,e^{-0.10 \times 40/365} \\
&= \text{Rs } 2.47
\end{aligned}
$$

The present value of share, S_0, adjusted for the present value of dividend, D_0, equals $S_0^* = S_0 - D_0 =$ Rs 120 – Rs 2.47 = Rs 117.53. Substituting this value of S_0, we can obtain the call option value as follows.

Calculation of $N(d_1)$ and $N(d_2)$:

$$d_1 = \frac{\ln(117.53/115)+(0.10+0.5\times 0.6^2)(0.25)}{0.6\sqrt{0.25}} = 0.31$$

Therefore, $N(d_1) = N(0.31) = 0.5 + 0.1217 = 0.6217$

$$d_2 = \frac{\ln(117.53/115)+(0.10-0.5\times 0.6^2)(0.25)}{0.6\sqrt{0.25}} = 0.06$$

Accordingly, $N(d_2) = N(0.06) = 0.5 + 0.0239 = 0.5239$

Now,

$$C = S_0^* N(d_1) - E\,e^{-rt} N(d_2)$$

$$= 117.53 \times 0.6217 - \frac{115}{e^{0.10(0.25)}}(0.5239) = \text{Rs } 14.31$$

Now, the put option premium can be calculated as follows:

$$P = C + E\,e^{-rt} - S_0^*$$

$$= 14.31 + 115 \times e^{-0.1 \times 40/365} - 117.53$$

$$= \text{Rs } 10.53$$

Stock Splits The options traded on exchanges are adjusted for the stock splits. Recall that a stock split occurs when existing shares of a company are split into a greater number of shares. A stock split occurs, for instance, when a company which has its capital divided in shares of Rs 100 each, decides to convert the capital into shares of denomination of Rs 10 each. In such a case, a 10-for-1 split occurs and 10 new shares are replaced for each existing share. Since a stock split does not affect the assets or the earning capacity of the company in any way, the wealth of the shareholders does not change. Other things remaining the same, a 10-to-1 split would cause the price of the share to be one-tenth of what it was before. Thus, any stock split would be expected to affect the price of the share proportionately. The terms of the options are adjusted to take account of any stock splits so as to reflect the expected price changes resulting therefrom. In general terms, for an b-to-a stock split, the exercise price is reduced to a/b of the original value while the number of shares are increased to b/a of the previous value. It goes without saying that in a given case, if the share price moves as expected, the positions of the buyer and the seller remain unchanged.

Example 5.6

A call is purchased to buy 100 shares at Rs 90 per share. Suppose that during the currency of the option, the company split the stock in the ratio of 5-to-2. This would cause the terms of the contract of change so that the writer will be obliged to deliver 250 (= 100 × 5/2) shares @ Rs 36 (= 90 × 2/5) per share on demand.

Bonus Shares Like in case of splitting of shares, the issuance of bonus shares also is adjusted for in the options contracts. The bonus shares imply that more shares are being issued to the existing shareholders. The issue of bonus shares, like the splitting of shares, does not affect the assets or the earning capacity of the company and the price of the shares of the company is likely to fall down. If the shareholders of a company receive 2-for-5 bonus shares, it implies that a shareholder would get two equity shares as bonus for every five shares held by him/her in the company. This is equivalent to a 7-to-5 splitting of the shares. Accordingly, other things being the same, the stock price would decline to 5/7th of its previous value. The terms of an option are adjusted to reflect the expected price decline arising from a bonus shares issue in the same manner as emanating from the splitting of shares.

Example 5.7

In respect of a call option to buy 100 shares of a company at Rs 60, suppose that the company involved issues 20% bonus shares (so that for every five shares held by a shareholder, one share is given as a bonus). This is equivalent to a 6-to-5 stock split. Accordingly, the terms of the options contract are changed, so that it gives the holder of the call option, the right to buy 120 shares of the company at a price of Rs 50.

LIMITATION OF BLACK AND SCHOLES MODEL

It may be noted that the Black and Scholes option pricing model works well for options that are near the money and for options with next striking price on either side of the stock price. However, it does not yield satisfactory results for options that are deep in-the-money or out-of-the-money. Similarly, it has been found that the model does not yield unbiased values in respect of stocks with very high or very low volatility and mispricings increase, as the time until expiration increases.

TEST YOUR UNDERSTANDING

Mark the following statements as True or False.

1. _____ The value of an American style call option will always be greater than the value of a European style option with the same characteristics.
2. _____ Other things remaining the same, greater the exercise price of a call option, greater the value will it command.
3. _____ Any call with a greater time to maturity is always valued at a higher price than a call with a shorter time to maturity.
4. _____ The upper bound on the value of a call option is provided by its exercise price.
5. _____ A call option has a minimum price that is equal to its intrinsic value.
6. _____ For a call option with a given exercise price, every rupee increase in the share price leads to a corresponding increase in the call premium.
7. _____ The curvature of the call price function indicates that although the values of in-the-money call options would be greater than those of out-of-the-money options, the relationship is not a linear one.
8. _____ The time value of an option is minimum when the price of the stock equals the exercise price.
9. _____ While the time value of a call option decreases if the price of the stock moves away from the exercise price in either direction, for a put option it increases.
10. _____ The maximum value of a put option is set by the exercise price.
11. _____ All in-the-money call (put) options with a given exercise price are more valuable (i.e., command a higher premium) than all out-of-the-money call (put) options.
12. _____ Although an American call or put option can be exercised at any time before the expiration date, it can be demonstrated that it is never optimal to exercise such as option early.
13. _____ The call and put option values are not affected whether dividend on the underlying stock is payable or not.

14. _____ Put-call parity implies that the prices of a call option and a put option which are, identical in expiry date, exercise price and the underlying stock, shall always be equal in value.
15. _____ The difference between prices of matching call and put options on a stock is equal to the difference between the current stock price and the present value of the exercise price.
16. _____ The higher the price of the underlying stock, the greater the value of a put option with a certain exercise price.
17. _____ The value of a European style call option with a greater length of time to maturity is necessarily priced higher than a comparable call with shorter time to maturity.
18. _____ Dividends exert a depressing effect on values of call options and a favourable one on put options.
19. _____ An increase in the riskfree interest rate affects a call option value positively.
20. _____ Options on stocks with volatile prices are more valuable than comparable options on stocks with relatively stable prices.
21. _____ The value of a put option is related inversely to the stock's price and length of time before expiration, and directly to the exercise price.
22. _____ Both the binomial and Black-Scholes models for valuation are in relation to the American style call options.
23. _____ The binomial model of valuation of options is based on the assumption that if a share price is observed at the start and end of a period of time, such price will take only one of the two known values at the end of the period.
24. _____ *Hedge ratio* means the number of shares of stock to be purchased per share of the call option.
25. _____ The fact that the binomial option pricing model uses a step-by-step approach, suggests that it can be extended to any number of periods without difficulty of computation.
26. _____ The Black and Scholes model of option valuation deals with the valuation of European style options.
27. _____ The Black and Scholes model assumes that there are no transaction costs and taxes.
28. _____ The total inputs required for applying the Black and Scholes model are: stock price, exercise price, time to maturity and risk-free rate of return.
29. _____ The Black and Scholes model is derived under the assumption that rates of return are identically distributed over time.

30. _____ In respect of weekly price data, Annualized volatility = Weekly volatility × 52.
31. _____ Optimal hedge ratio in the Black and Scholes model is given by $N(d_1)$.
32. _____ In terms of the Black and Scholes model, $C = S_0\, N(d_1) - E\, e^{rt}\, N(d_2)$.
33. _____ In valuation of call options, the Black and Scholes model assumes that a share's continuously compounded rate of return follows a normal distribution.
34. _____ The input sigma (σ) in the Black and Scholes model represents the standard deviation of the prices of the underlying stock.
35. _____ In terms of the BS model, the value of a call option is broadly viewed as the difference between the expected benefit from acquiring a stock now and paying the exercise price on the expiration day.
36. _____ Put option value may be calculated using Black and Scholes' formulation as equal to $E\, e^{rt}\, N(-\, d_1) - S_0\, N(-\, d_2)$.
37. _____ For Black & Scholes' options valuation formula, $d_1 = d_2 + \sigma\sqrt{t}$.
38. _____ An increase in the time to expiration would, other things remaining same, increase the values of both calls and puts.
39. _____ Increased volatility suppresses the option values.
40. _____ Implied volatility refers to the σ value implied in the B&S model corresponding to a given market price of an option with known parameters.
41. _____ Deep in-the-money call and put options have delta values close to zero.
42. _____ Delta value of a call option can be negative as well positive.
43. _____ A call option can have delta equal to 1.3.
44. _____ As a call option moves from being out-of-the-money to be in-the-money, the value of delta falls.
45. _____ Delta values for call options are positive and negative for put options.
46. _____ Delta also gives the probability that a given option will be in-the-money on the expiration.
47. _____ In a delta-neutral portfolio, *any* change in the price of the underlying stock causes no change in the portfolio value.

48. _____ The position delta of an investor in options is equal to the weighted average of the deltas of the options held.
49. _____ The B-S model does not give very satisfactory results for valuation of deep in-the-money and deep out-of-the-money options.
50. _____ For an *m*-to-*n* stock split, the exercise price of an option is reduced to *n*/*m* of the original value while the number of shares are increased to *m*/*n* of the previous value.
51. _____ The issuance of bonus shares does not affect the terms of an options contract, since it does not affect the earning capacity or the assets of the company.
52. _____ The amount by which the price of an option changes for a unit change in the price of the underlying stock is termed as *gamma*.
53. _____ *Theta* represents the price decay that affects an option as it ages and loses time value.
54. _____ Sensitivity of option value to changes in the interest rate is termed as *rho*.
55. _____ *Vega* measures the rate of change of the value of an option with respect to the volatility of the underlying asset.

EXERCISES

1. Why are American calls likely to be more valuable than the comparable European calls?
2. How are valuations of call options in respect of a stock likely to be affected by (i) different exercise prices, and (ii) lengths of time to expiration? Consider two calls with the same time to expiration that are written on the same underlying stock. The first call trades for Rs 8 and has an exercise price of Rs 95, while the second call has an exercise price of Rs 90. What is the maximum price that the second call would have? Explain.
3. Graphically depict the valuation of (i) call, and (ii) put options.
4. Show that the minimum value of a European call option shall be at least equal to the difference between the stock price and the present value of the exercise price.
5. Explain the principle of put-call parity.
6. Trace the effect of a dividend payable on the underlying share on the call and put prices.

7. Discuss the various factors affecting the prices of options. Also indicate as to how each of these would affect the price of
   (i) a call option, and (ii) a put option.
8. How do the call and put prices vary with interest rates? Also, explain in intuitive terms, the relationship between risk of the underlying stock and the option prices.
9. Discuss the binomial model for the valuation of options. Why is it called 'binomial'?
10. State the assumptions underlying the Black and Scholes model.
11. Explain the calculation of the standard deviation of the distribution of continuously compounded rate of return on the stock for use as a measure of volatility in the Black and Scholes formulation.
12. State the Black and Scholes formula for the valuation of European call options. How can the put option with the same parameters as a call option can be valued?
13. What do you understand by implied volatility? How can it be calculated?
14. Discuss the sensitivity of the B-S formulation to changes in the input values.
15. A share price is currently Rs 50. Assume that the end of six months it will be either Rs 60 or Rs 42. The risk-free rate of interest with continuous compounding is 12% per annum. Calculate the value of a 6-month European Call option on the stock with exercise price of Rs 48.
16. Using binomial pricing model, obtain the hedge ratio, α, and the call price from the following data:
    Share price = Rs 70; Exercise price = Rs 75 $u = 1.2$; $d = 0.9$; $i = 1.2$; and $N = 3$.
17. Determine the value of a call option using the Black and Scholes model:
    The share is currently selling at Rs 80 and the standard deviation of the stock's instantaneous rate of return is 0.7. The call has an exercise price of Rs 90 and has 6 months to go for expiration. The continuously compounded risk-free rate of return is 8% per annum.
18. (a) Using Black and Scholes formula, calculate the value of a European call option using the following data:
    Exercise Price = Rs 100
    Stock Price = Rs 90
    Time to expiration = 6 months

Continuously compounded risk-free rate of return = 10% per annum
Variance of continuously compounded rate of return = 0.25

(b) By *Put-Call Parity*, determine the value of Put option using data in (a) above.

19. You are given the following data on a certain share and a call option on the stock:

Share Price	Rs 67
Exercise Price	Rs 65
Time to Expiration	3 months
Risk-free Rate of Return (Continuously compounded)	8% per annum
Variance of Stock's Return	0.36

(i) Calculate the value of the option using the Black and Scholes model.
(ii) If this option is priced at Rs 7.50, what investment strategy would you suggest?
(iii) Use your answer in part (i) to calculate the value of a put option with identical exercise price and time to maturity.

20. Using the Black and Scholes model and the principle of put-call parity, obtain the values of call and put options from the following data:

Price of the Share	Rs 124
Exercise Price	Rs 130
Time to Maturity	4 months
Risk-free Rate of Return	12% per annum

Standard Deviation of the distribution of the continuously compounded rate of return on the stock = 0.5. Also state whether each of the options is in-the-money or out-of-the-money, and decompose the values of each one into intrinsic value and time value.

21. From the following data, obtain the call and put option values based on Black & Scholes' formulation:

Stock price	= Rs 206
Exercise price	= Rs 200
Time to expiration	= 47 days
Standard deviation of the continuously compounded rate of return on stock	= 0.26
Continuously compounded rate of return	= 8%

Also obtain the values of various greeks.

22. How would the option values change in Exercise 21, if a dividend of Rs 12 per share is expected to be received in 12 days' time?
23. Examine the effect of each of the following changes on the call and put option values in Exercise 21:
    (a) The stock price increases by Rs 8.
    (b) The standard deviation of the return is changed to 0.30.
    (c) The risk-free rate of return reduces by 2 percent.
24. From the information given below, estimate the volatility implied:

Stock price	= Rs 126
Exercise price	= Rs 132
Time to maturity	= 45 days
Risk-free rate of return	= 8%
Call premium	= Rs 3.30

Recalculate the volatility if the stock price matches with the exercise price.

CHAPTER

6

Options on Stock Indices, and Futures Options

In the preceding two chapters, we have discussed the general concepts related to options contracts, valuation of such contracts and some basic strategies related to options. The focus has been on options on individual stocks. The present chapter is concerned with options on stock indices and options on futures contracts.

STOCK INDEX OPTIONS

Options on stock price indices represent a very successful innovation in the history of organised options exchanges in the world. Instead of the stock a company, the underlying in such contracts is an index like Sensex, S and P CNX Nifty, Topix or S and P.

The stock index options are very useful especially for the institutional investors, because they allow the investor to make investment decisions on a specific industry, sector, or on the market as a whole, rather than on a particular company or companies.

An option, call or put, on stock index is very much like an option on stock and gives its holder the right to buy, or sell, the index at a given exercise 'price'. Thus, like any other options contract, the buyer has the rights and the seller the obligations. The buyer of an index call option gets the right to participate in the market gains over and above the pre-determined exercise price until or at the option's expiration, accordingly as it is American or European. Such an option provides an unlimited profit potential since the index can rise to any level. Similarly, an index put option buyer stands to gain, should the index level fall below the pre-determined exercise price.

Depending on the extent of downturn in the index level, the put option buyers can make substantial profit.

Like options on stock, the stock index options may be in-the-money, at-the-money or out-of-the-money, depending on the relationship between the index value and the exercise price. A call index option is in-the-money if the index value is greater than the exercise price and out-of-the-money if the index value is smaller. On the contrary, a put option is in-the-money when the spot value of the index is lower than, and out-of-the money when it is greater than, the exercise price.

In case of a call option, if the underlying index is higher than the exercise price, the buyer may exercise the option to receive an amount by which the call is in-the-money. The break-even point for the call buyer is equal to the exercise value of the index plus the premium paid. The greater the excess of index value at settlement over the break-even point, higher the profit to him. In case the value of index at settlement is lower than the break-even point, the buyer loses a part or whole of the premium paid, depending on whether the index value is above or below the exercise price. To illustrate, suppose an investor purchases a call option contract with an exercise value equal to 1210 for Rs 3. The break-even point for him would be 1213. At the settlement , if the index value is greater than 1213, the buyer makes a profit, if the index is below 1210, he loses his entire premium, while if the index value is between 1210 and 1213, he loses part of this premium. Thus, if the index value is 1211.2, he loses Rs 3 – Rs 1.2 = Rs 1.8. The maximum loss that the buyer can incur is equal to the premium paid.

In the same manner, we may determine the profit/loss profile of a put option buyer. A put option buyer stands to gain if, at the time of exercise, the index is lower than his break-even point. The break-even point in turn is equal to the exercise price *less* the premium paid. Further, the buyer loses part or all his premium if the index rules at a value greater than the break-even point. When the stock index value is greater than the exercise price, then the option is out-of-the-money and is not profitable to exercise. In such an event, the buyer loses the entire premium.

In case of call as well as put options, the option writer stands to gain (or lose) as much as the buyer loses (or gains).

While the options on stock indices are like options on individual stocks, there are two principal differences. The first is with regard to the delivery mechanism. Whereas in case of stocks, an option gives the right to take delivery (upon cash payment in case of call option) or deliver (upon receipt of cash, in case of put option) a specified number of shares of the underlying security, it is not practical to deliver shares for each component of the index, in case of options on a stock index. Such options have to be necessarily *cash-settled.*

A second way in which options on stock indices are different from options on stock is the uncertainty associated with the former of the amount that will be paid (with calls) or will be received (with puts). An investor who decides to exercise a stock index option has to notify his broker before a certain cut-off time established by the broker. Further, the closing price on the expiration day determines the actual amount of money due or to be received on account of the option exercise. Since the cut-off time may fall well before determination of the closing price, it is not sure whether the exercised option will be in-the-money at that time. Thus, the holder of a stock index option who exercises it before the closing index value for that day is known, runs the risk that the value of the index may subsequently change adversely. Accordingly, if a change causes the exercised option to be out-of-money, the exercising holder is liable to pay. For example, suppose you hold an American style call option with an exercise price of 1520 on S and P CNX Nifty and give a notice of your intention to exercise at a time when the index level is 1528.8. Now, if at the end of the day, suppose the index has slipped to 1518 then you will be required to pay Rs 200 (assuming contract size of 100) on the option. The possibility of change of in-the-money option at the time of exercise into out-of-the-money at the time of settlement is the risk associated with the index options. For this reason, the holders of such options prefer to sell the option rather than exercise.

Apart from these differences, there are some peculiarities to be noted due to the nature of the underlying in such contracts. As indicated earlier, an index measures changes in the prices of a set of securities, in relation to their prices at a certain base. The base needs changes from time to time to reflect events that affect the securities constituting the index. To illustrate, if a company issues new shares, then it cause a change in its capitalization which needs to be reflected. Similarly, some securities are dropped from the list while others are added. This obviously calls for adjustment in the capitalization values. In fact, the changes are so designed that the index changes due to changes in the prices of the constituent shares only.

Another fact to be kept in mind is that the index reflects the reported price movements in the securities underlying it. Thus, an index would be expected to reflect the market as a whole (or a particular sector) to the extent that the securities included in the index are being promptly reported and changes made in the index value. Thus, there is the possibility of somewhat stale prices being included in the computation of the index. The index may not perfectly indicate the level of market prices of stocks. Besides, it should be understood that some trading strategies involving index as the underlying, can possibly affect the value of the index and consequently, the value of stock index options. To illustrate, traders holding positions in stock index options or futures contracts hedged by positions in securities included in the index, attempt to liquidate their positions when such contracts are nearing expiry. This may significantly affect the level of index. Thus, a trader in stock index options should be aware of these possibilities and their consequences.

Sample Contracts of Options on Indices

Two sample contracts of options on indices are given in Boxes 6.1 and 6.2. Box 6.1 presents the specifications for option contract on Sensex of The Stock Exchange, Mumbai (BSE), while Box 6.2 contains details of such a contract on S and P CNX Nifty of the National Stock Exchange of India (NSE). For the options contract offered by the BSE, the underlying index is the BSE Sensitive Index of 30 scrips, popularly called the Sensex. It has a contract multiplier of INR 100, which means that change of every point of the Sensex, a contract would change in value by Rs 100 and the minimum change in the value of a contract is Rs 5 (called the tick size). Similarly, the NSE contract has the S and P CNX Nifty, based on 50 scrips, as the underlying index. Such a contract can be bought or sold in lots of 200 and that each index point is worth Re 1. Since the price steps are given to be Re 0.05, it implies that for each lot of 200, the minimum price change would be $200 \times 0.05 = \text{Rs } 10$.

The contracts offered by both the exchanges involve options of European style of exercise. In each case, three series of contracts are available for trading, including those expiring in the near-month (current), those expiring in the next month and those due to expire in the month following the next month (called the far month). As soon as a contract expires on the last Thursday of the expiry month, a new series is introduced for trading.

Box 6.1 ***Contract Specifications for the Options on Sensex***

Underlying Index	BSE 30 Sensex
Contract Multiplier	INR 100
Strike Price Intervals	Shall have a minimum of five strikes. (in-the-money, near-the-money, out-of-the-money).
Premium Quotation	Sensex points
Last Trading Day	Last Thursday of the contract month. If it is a holiday, the immediately preceding business day.
Expiration Day	The option on Sensex is European style. Last Thursday of the contract month. If it is a holiday, the immediately preceding business day. *Note:* Business day is a day during which the underlying stock market is open for trading.
Contract Month	1, 2 and 3 months
Exercise Style	European
Settlement Style	Cash
Trading Hours	9 : 30 a.m. to 3 : 30 p.m.
Tick Size	0.1 Sensex points (INR 5)
Settlement Value	Closing value of the sensex on the expiry day.
Exercise Notice Time	It would be a specified time (Exercise Session) on the last day of the contract. All in-the-money options would deem to be exercised unless the participant communicates otherwise in the manner specified by the Derivatives Segment.

Source: *The Stock Exchange*, Mumbai

Box 6.2 ***Contract Specifications for the Options on S and P CNX Nifty***

Underlying Index	S and P CNX Nifty
Contract Size	Permitted lot size shall be 200 or multiples thereof
Price Steps	Re 0.05
Price Bands	Not applicable
Style	European
Trading Cycle	The options contracts have a maximum of three-month trading cycle—the near month (one), the next month (two) and far month (three). New contract will be introduced on the next trading day following the expiry of near month contract.
Expiry Day	The last Thursday of the expiry month or the previous trading day if the last Thursday is a trading holiday.
Settlement Basis	Cash settlement on a $T+1$ basis.
Settlement Prices	Based on expiration price as may be decided by the Exchange.

Source: *The National Stock Exchange of India*

Valuation of Stock Index Options

The valuation of stock index options may be done in the same way as the valuation of options on individual stocks. In using the Black and Scholes model, the stock price (the price of the underlying security) is replaced by the index value and the standard deviation of continuously compounded rate of return is calculated using index values rather than the prices of the underlying security.

Essentially, a stock index summarises the performance of a set of stocks (30 in case of Sensex and 50 in case of S and P CNX Nifty, for example) and may be conceived as representing a portfolio of the constituent securities. Since some of the underlying securities are likely to pay dividends in course of the tenure of the option, the Black and Scholes formulation needs modification for this. However, the adjustment for dividends is different from that in case of individual stocks. Since an option on a stock index is an option on a portfolio of stocks, we need to consider dividends on the constituent individual stocks insofar as they determine the overall dividend for the portfolio. This is illustrated with the following example.

Example 6.1

Assume that a market-capitalization weighted index is based on three stocks as shown below.

Company	*Share Price (Rs)*	*Market Capitalization (Rs crores)*
A	120	12
B	50	30
C	80	24

The current value of the index is 990. It is known that 25 days from now Company A would pay a dividend of Rs 8 per share. The continuously compounded risk-free rate of return is eight percent. What adjustment would be made in the index value for using it as an input for valuing an option on this index?

Here total capitalization is Rs 66 crores, of which Rs 12 crores is accounted for by *A*. Thus, Company *A* constitutes 12/66 of the index, which implies that its value in the index is $(990 \times 12/66) = 180$. With a price of Rs 120 per share, $180/120 = 1.5$ shares of *A* are held for every unit of the index. Accordingly, dividend receivable on 1.5 shares is $1.5 \times 8 =$ Rs 12.

Now, the present value, D_0, of dividend D may be obtained as follows:

$$D_0 = De^{-rt},$$

where t is the time to payment of dividend and r is the risk-free rate of return.

With $t = 25/365$ and $r = 0.08$, we have

$$D_0 = 12e^{-(25/365)\,(0.08)}$$
$$= 11.93.$$

Hence, the spot value of the Index to be taken as the input for option valuation is $990 - 11.93 = 978.07$.

In case it may be reasonably assumed that dividend on constituent stocks is paid continuously over time (the assumption is likely to be more realistic if the number of securities is large and no seasonal patterns are found in the dividend payments), then the option valuation may be done using Mertons' model. The Mertons' model extends the Black and Scholes Model to provide a pricing model on options where the underlying pays dividends at a continuous rate, and treats the dividends as negative interest rate. The valuation of call and put options using this model is given here:

For a call option:

$$C = S_0\, e^{-\delta t} N(d_1) - Ee^{-rt} N(d_2)$$

where

$$d_1 = \frac{\ln(S_0/E) + (r - \delta + \sigma^2/2)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

In these expressions, we have

C = current value of the call option

r = continuously compounded rate of return

d = continuously compounded rate of dividend

S_0 = current value of the underlying index

E = exercise price of the option

t = time remaining before the expiration date (expressed as a fraction of a year)

σ = standard deviation of continuously compounded annual rate of return

ln = natural logarithm

$N(d)$ = value of cumulative normal distribution evaluated at d

For a put option:

$$P = Ee^{-rt} N(-d_2) - S_0\, e^{-\delta t} N(-d_1)$$

where P is the current value of the put option and other symbols are the same as explained earlier.

It is evident that if $\delta = 0$, the Merton's model is reduced to the Black and Scholes model.

Example 6.2

(a) Calculate the values of call and put options on *S* and *P* CNX Nifty using the following data:

Spot value of the index	= 1272
Exercise price	= 1280
Risk-free rate of return	= 8% p.a.
Standard deviation of the continuously compounded rate of return	= 0.2
Time to expiration	= 48 days

(b) Recalculate the call and put option values in (a) assuming continuous dividend rate on the index is 2 percent.

(a) From the given data, we have, $S_0 = 1272$, $E = 1280$, $r = 0.08$, $\sigma = 0.2$ and $t = 48/365$. We first obtain various $N(d)$ values.

$$d_1 = \frac{\ln(S_0/E) + (r + \sigma^2/2)t}{\sigma\sqrt{t}}$$

$$= \frac{\ln(1272/1280) + (0.08 + 0.2^2/2)(48/365)}{0.2 \times \sqrt{48/365}}$$

$$= 0.0948$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= 0.0948 - 0.2 \times \sqrt{48/365}$$

$$= 0.0224$$

Taking d_1 and d_2 to two decimal places, we evaluate $N(d)$.

$$N(d_1) = N(0.09) = 0.5 + 0.0359 = 0.5359$$

$$N(-d_1) = N(-0.09) = 0.5 - 0.0359 = 0.4641$$

$$N(d_2) = N(0.02) = 0.5 + 0.0080 = 0.5080$$

$$N(-d_2) = N(-0.02) = 0.5 - 0.0080 = 0.4920$$

Using these values, we have

$$C = S_0\, N(d_1) - Ee^{-rt}\, N(d_2)$$

$$= 1272 \times 0.5359 - 1280 \times e^{-0.08 \times 48/365} \times 0.5080$$

$$= \text{Rs } 38.23$$

Similarly,

$$P = E\,e^{-rt}\,N(-d_2) - S_0\,N(-d_1)$$
$$= 1280 \times e^{-0.08 \times 48/365} \times 0.4920 - 1272 \times 0.4641$$
$$= \text{Rs } 32.83$$

(b) With inputs given in (a) and dividend rate $\delta = 0.02$, we calculate $N(d)$ values. To begin with, we calculate d_1 and d_2 as follows:

$$d_1 = \frac{\ln(S_0/E) + (r - \delta + \sigma^2/2)t}{\sigma\sqrt{t}}$$
$$= \frac{\ln(1272/1280) + (0.08 - 0.02 + 0.2^2/2)(48/365)}{0.2 \times \sqrt{48/365}}$$
$$= 0.0586$$
$$d_2 = d_1 - \sigma\sqrt{t}$$
$$= 0.0586 - 0.2 \times \sqrt{48/365}$$
$$= -0.0139$$

Taking d_1 and d_2 to two decimal places, we evaluate $N(d)$.

$$N(d_1) = N(0.06) = 0.5 + 0.0239 = 0.5239$$
$$N(-d_1) = N(-0.06) = 0.5 - 0.0239 = 0.4761$$
$$N(d_2) = N(-0.01) = 0.5 - 0.0040 = 0.4960$$
$$N(-d_2) = N(0.01) = 0.5 + 0.0040 = 0.5040$$

With these values, call and put option values are obtained here:

$$C = S_0\,e^{-\delta t}\,N(d_1) - Ee^{-rt}\,N(d_2)$$
$$= 1272 \times e^{-0.02 \times 48/365} \times 0.5239 - 1280 \times e^{-0.08 \times 48/365} \times 0.4960$$
$$= \text{Rs } 36.41$$

Similarly,

$$P = Ee^{-rt}\,N(-d_2) - S_0e^{-\delta t}\,N(-d_1)$$
$$= 1280 \times e^{-0.08 \times 48/365} \times 0.5040 - 1272 \times e^{-0.02 \times 48/365} \times 0.4761$$
$$= \text{Rs } 34.36$$

Hedging As discussed previously, a stock carries both risks—unsystematic and systematic. Thus, options on a stock imply exposures to both types of risk. On the contrary, options on an index have a very little unsystematic risk. For indices like *S* and *P CNX* Nifty or Sensex, which represent well-diversified portfolios, there is negligible unsystematic risk. This feature finds attraction with the large institutional investors.

In case of options on a stock, interest in put options stems from the desire to make money from decline in the market or protection of a long position in stock, against price decline. Put options on index can similarly be used to protect a diversified portfolio against an anticipated market downfall. The underlying principle is the same: if the market does decline, the hedger hopes to make enough gain on options to offset the losses on his portfolio.

To hedge his portfolio, the investor has to decide as to which and how many of options contracts to buy, because a number of options are available on an index, like on a stock. In principle, any of the options can be used for the purpose, and the key to the number of contracts lies in delta.

As discussed earlier, the delta for a put option is negative. If an option has delta equal to – 0.43, for example, it has the implication that for point decline in the stock index by Re 1, the value of the put increases by about 43 paise.

Number of options contracts to buy

$$= \frac{\text{Value of Portfolio}}{\text{Contract Value}} \times \text{Portfolio Beta} \times \frac{1}{|\text{Delta}|}$$

Thus, as a first step, we find the total value for which protection is needed, which is given by the product of the portfolio value and its beta. It is then divided by delta. Here, the negative sign of delta is of no consequence and its absolute value is used. Finally, the number of contracts to buy can be known by dividing the value of one contract (equal to exercise price multiplied by market lot, or multiplier to convert into monetary value).

Example 6.3

An investor holds a portfolio consisting of five securities as shown below:

S.No.	*Security*	*No. of Shares*	*Price of Share*	*Beta*
1.	A	400	Rs 120	0.7
2.	B	200	Rs 32	0.8
3.	C	1000	Rs 68	1.6
4.	D	6000	Rs 230	1.2
5.	E	700	Rs 500	1.2

Fearing a market crash, the investor is considering hedging his portfolio by using December put options on *S* and *P CNX* Nifty available with exercise value 1532 and delta = – 0.432. What should he do?

To hedge his position, the investor should buy the put option. As a first step, we calculate his portfolio beta. This is shown in Table 6.1. For this, we first obtain the total value of his portfolio which is shown calculated to be Rs 18,52,400. The weightage of different securities is then calculated. Finally, the products of beta values and the corresponding weights are calculated and added together. This gives portfolio beta = 1.2006.

Table 6.1

Calculation of Portfolio Beta

Security	*No. of Shares*	*Price*	*Value (Rs)*	*Proportion (w)*	*Beta (β)*	*βw*
A	400	120	48000	0.026	0.7	0.0182
B	200	32	6400	0.003	0.8	0.0024
C	1000	68	68000	0.037	1.6	0.0592
D	6000	230	1380000	0.745	1.2	0.8940
E	700	500	350000	0.189	1.2	0.2268
	Total		1852400			1.2006

Now,

$$\text{Number of contracts to buy} = \frac{1852400}{1532 \times 100} \times \frac{1.2006}{0.4320} = 33.6$$

Thus, a total of 17 contracts (of 200 each) should be bought for hedging his portfolio value.

In addition to hedging, covered index calls may be written in order to generate income. In case of options on a stock, it is obviously possible that the underlying stock may be called by the option holders. It is different with index calls. Here no part of the portfolio can be called because such calls are only cash-settled. Thus, even if the call options are exercised, the portfolio remains intact. In any event, the writer gets the premium received on such calls.

FUTURES OPTIONS

The options on futures are similar to options on individual stocks and options on stock indices except that holders acquire the right to buy or sell futures contracts on the underlying assets rather than the assets themselves. A call option gives the holder a right to buy a futures contract while a put option gives a right to sell a futures contract. Thus, it is significant that the underlying in options on futures is a futures contract and not a commodity or financial asset represented by the futures contract. To illustrate, the buyer of a S and P CNX Nifty futures contract call option has the right to assume a *long* position in the S and P CNX Nifty futures contract at the specified exercise price. Similarly, the buyer of a S and P CNX Nifty futures put option has the right to take a *short* position in the S and P CNX Nifty futures contract at the agreed exercise price. The seller of futures option on the other hand, assumes an obligation of taking a position (in futures contract) opposite to that of the buyer of the option. Thus, the writer of a call futures option has to be ready to take a short position in the S and P CNX Nifty futures and the writer of a S and P CNX Nifty put futures option has to be ready to accept a long position in the S and P CNX Nifty futures contract.

In case of American style futures options, the exercise can take place on any trading day up to the date of expiration. Similarly, the option writers can liquidate their obligations by taking opposite positions (to the ones they hold) before exercise of their options.

An important way in which futures options differ from equity or index options is in respect of their expiration. Usually, for commodities, the option month refers to the delivery month of the futures contract while it (the option) expires on a specific date in the preceding month. The actual expiration date of a futures option varies with each contract in accordance with the stipulation laid in it in this regard. However, since futures on stock indices do not involve deliveries, and are only cash-settled, futures options on them may expire much earlier than the futures expiration. For example, it is possible to trade July option on September futures contract with the option expiring at usual time in July and if exercised, then the position in the futures contract settled in September.

While in case of options on equity or stock indices a cash exchange occurs when an option is exercised, the same does not happen in case of futures option. Instead, in a futures option, the holder acquires a long position (in case of a call) or short position (in case of a put) at a price equal to the exercise price of the option. After this, when the acquired futures position is marked-to-market, the holder of a long position can withdraw an amount equal to the excess, if any, of the current futures price over the exercise price and the holder of a short futures position can withdraw a cash equivalent to the excess of the exercise price over the current futures price, in case it is positive. In effect, the exercise of a futures option leaves the holder with a futures contract with an unrealised gain equal to the exercisable value of the option. To illustrate, suppose that on August 20, 2002, an investor buys a short S and P CNX Nifty index futures call for October expiration with an exercise price of 1530, for a premium of Rs 15.50, or Rs 3100 (the market lot of Nifty being 200, which implies that each point is worth Rs 200). Now, assume that after six weeks, the October 2002 S and P CNX Nifty futures contract is at 1575 and the investor decides to exercise his call option and acquire a long futures position at 1575. This would give the investor an unrealised profit of Rs 9000 [= (1575 – 1530) × 200]. In order to realise this gain, the investor should take a short position in October 2002 S and P CNX Nifty futures contract at 1575. Since the futures prices change continuously, the profit of Rs 9000 is not guaranteed. In case the profit realised by taking a short position by the investor, his net gain would be Rs 5900, Rs 9000 *minus* Rs 3100 paid by him for buying the option on August 20.

Sample Contract

A sample contract involving options on NIKKEI 225 stock index futures is presented in Box 6.3. The underlying in this contract, traded at SIMEX (Singapore International Monetary Exchange Limited) is a futures contract on NIKKEI 225 stock index of Japan. As of now, such contracts are not available for trading in the Indian market.

Box 6.3 ***Options on NIKKEI 225 Stock Index Futures***

Contract Size	One SIMEX Nikkei 225 Futures Contract
Ticker Symbol	Calls: CNK Puts: PNK
Contract Months	5 serial months and 5 quarterly months in the March, June, September and December cycle

Trading Hours	Singapore	7.55 am	–	10.15 am
		11.15 am	–	2.15 pm
	Tokyo	8.55 am	–	11.15 am
		12.15 am	–	3.15 pm
	London	11.55 pm	–	2.15 am
		3.15 am	–	6.15 am
	Chicago	5.55 pm	–	8.15 pm
		9.15 pm	–	12.15 am
	New York	6.55 pm	–	9.15 pm
		10.15 pm	–	1.15 am
Trading Hours on last Trading Day	Same as above			
Minimum Price	Five index points (¥ 2,500) except that fluctuation trades may occur at a price of (¥ 300) whether or not such trades result in the liquidation of positions for both parties to the trade.			
Strike Price	500 Nikkei index points interval. Strike prices will be integers divisible by 500 without remainder.			
Trading Halt	There shall be no trading in any options contract when the Nikkei 225 Stock Index Futures contract is bid or offered: (1) at its initial daily price limit, or (2) at its expanded daily price limit, except that the above provisions shall not apply on an option's last day of trading.			
Option Exercise	An option can be exercised by the buyer on any Nikkei 225 business day. In the absence of contrary instructions delivered to the Clearing House, an option in the March quarterly cycle that is in-the-money* will be exercised automatically on the day of determination of final settlement price. Similarly, an in-the-money** option that expires in a month other than those in the March quarterly cycle will be exercised automatically on the day of termination of trading.			
Last Trading Day	The day before the second Friday of the contract month.			

Expiration	The expiration day for options in the March quarterly cycle (Mar, Jun, Sep, Dec) will usually be the second Friday of the contract month. For contract months other than those in the March quarterly cycle, the options contract will expire on its last trading day.

Notes: * An option in the March quarterly cycle is in-the-money if the final settlement price of the underlying futures contract lies above the strike price in the case of call, or lies below the strike price in the case of a put.

** An option that expires in a month other than those in the March quarterly cycle is in-the-money if the settlement price of the underlying futures contract at the termination of trading lies above the strike price in the case of a call, or lies below the strike price in the case of a put.

Source: *Singapore International Monetary Exchange Limited*

Valuation of Futures Options

The Black and Scholes formula was extended by Black to provide for the valuation of futures options. This formula, like Black and Scholes model, is meant to value European style options. According to this,

$$FC = e^{-rt}\,[F \times N(d_1) - E \times N(d_2)]$$

where

$$d_1 = \frac{\ln(F/E) + 0.5\sigma^2 t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$FC =$ futures call option premium

$r =$ risk-free interest rate

$t =$ time (in years) to option expiration

$E =$ exercise price of the option

$F =$ futures price

$\sigma =$ annual volatility (standard deviation of the futures price)

$N(d) =$ cumulative normal probability density function evaluated at d

For a futures put option,

$$FP = e^{-rt}\,[E \times N(-d_2) - F \times N(-d_1)]$$

where FP indicates the futures put option premium and all other variables are defined as earlier. Alternately, using put-call parity principle, we have

$$FP = FC - e^{-rt}\,(F - E)$$

Example 6.4

Using the data given below, calculate the theoretical values of (i) call and (ii) put options on futures:

S and P CNX Nifty futures contract price	= 1625
Exercise price of the option	= 1632
Time to expiration of the option	= 60 days
Risk-free interest rate	= 7%
Volatility, σ	= 28%

Calculation of call option price

As a first step, we calculate the values of the inputs d_1 and d_2 as follows:

$$d_1 = \frac{\ln(1625/1632) + 0.5 \times 0.28^2 \times (60/365)}{0.28 \times \sqrt{(60/365)}}$$

$$= 0.02$$

$$d_2 = 0.02 - 0.28 \times \sqrt{(60/365)}$$

$$= -\,0.09$$

Accordingly,

$N(d_1) = N(0.02) = 0.5080$, and

$N(d_2) = N(-\,0.09) = 0.4642.$

Using the given and calculated values, we have

$$FC = e^{-0.07\,(60/365)}\,[1625 \times 0.5080 - 1632 \times 0.4642]$$

$$= \text{Rs } 67.14$$

Calculation of put option value

$$FP = 67.14 - e^{-0.07\,(60/365)}\,[1625 - 1632]$$

$$= \text{Rs } 74.06$$

Speculation and Hedging with Futures Options

The principles of speculation using futures options are similar to those with other options. If a speculator believes, for example, that the stock index is likely to decline significantly, he may write naked calls or buy put options. While the former involves a pre-determined, limited gain and unlimited risk, the latter involves a pre-determined maximum amount of loss but possibilities of large gains. Of course, the more favourable the exercise price, the higher the put premium as well.

Like with options on equity or stock index, hedging can be done with futures options as well. They are useful particularly to the individual investor who speculates with interest rates or stock index futures. If an investor buys a S and P CNX Nifty futures contract, he should stand to lose in case the index falls as his balance in margin account reduces being marked-to-market every day. To hedge against such potential losses, one could buy put options on S and P CNX Nifty futures. Similarly, one who is short S and P CNX Nifty futures contract can protect himself by buying call options or writing put options.

TEST YOUR UNDERSTANDING

Mark the following statements as T (True) or F (False).

1. ______ In options on indices, the underlying is a stock index like S and P 500, Nikkei 225, Sensex etc.
2. ______ Options on indices may or may not be cash-settled.
3. ______ In contracts of options on stock indices, the exercise price is a specified index value.
4. ______ The profit potential in case of a call on a stock index is unlimited.
5. ______ A call option on a stock index is out-of-the-money if the current index level is lower than the exercise price.
6. ______ On exercising a put option on stock indices, the short is obliged to buy 100 shares of each of the securities included in the index.
7. ______ The minimum contract size of 200 on S and P CNX Nifty indicates that an options contract on this index involves 200 units of all the securities included in the index.

8. ______ The break-even point for a call option buyer is the exercise value of the index minus the premium paid.
9. ______ The put buyer loses part or all his premium if, at the time of exercise, the index rules at a value greater than the exercise price.
10. ______ An investor who exercises a stock index option on a given trading day runs the risk of reduced gain, even possibly a loss, since the prices of the stocks may move adversely by the end of that day.
11. ______ If the constituent securities of an index are changed, the options written on that index cannot be exercised.
12. ______ Options on stock indices are useful for investors who want to take view on the whole market (or a particular sector if the index relates to a sector only).
13. ______ If the securities constituting the index are not expected to pay dividends over the life of option, then the valuation of such options may be done using Black and Scholes model.
14. ______ Merton's model represents an extension of Black and Scholes model to provide a pricing model on options where a security included in an index is expected to pay dividend before expiry of the option.
15. ______ For hedging a given portfolio of securities using put options on stock indices,
    Number of options contracts to short =
    $$\frac{\text{Value of Portfolio}}{\text{Contract Value}} \times \text{Portfolio Beta} \times \frac{1}{|\text{Delta}|}$$
16. ______ A futures options contract is a futures contract involving options.
17. ______ Like in case of options on indices, a cash exchange occurs when a futures option is exercised.
18. ______ If a futures option is in-the-money when exercised, it leaves the option holder with a futures contract with an unrealised gain.
19. ______ A speculator who is strongly bearish on the market, should write naked calls or buy put options on futures.
20. ______ The Black and Scholes formula extended by Merton is used for valuation of futures options.

EXERCISES

1. How are options on stock price indices different from options on stocks? Examine the rights and obligations of the parties to a (i) call option and (ii) a put option contract on a stock index.
2. Explain the peculiarities of options on stock price indices.
3. Name the options on indices available in India. Give briefly the contract specifications for such contracts. Are they American style or European?
4. Discuss the use of index options for purposes of hedging.
5. What are options on futures? How are they different from equity and index options?
6. (a) Calculate the values of call and put options on S and P CNX Nifty using the following data:

Spot value of the index	= 1430
Exercise price	= 1450
Risk-free rate of return	= 8%
Standard deviation of the continuously compounded rate of return	= 0.28
Time to expiration	= 36 days

   (b) Recalculate the values in (a) assuming continuous dividend rate on the index is 2 percent.
7. Advise an investor with a portfolio valued at Rs 21, 37, 600 and having a beta value equal to 1.28, for hedging with put options, given further:

Put exercise price	= 1470
Lot size	= 100
Put delta	= – 0.68

8. Obtain the values of call and put options on futures related to an index:

Futures contract price	= 1522
Exercise price of the option	= 1550
Time to expiration of option	= 40 days
Risk-free rate of return	= 9%
Volatility, σ	= 0.25

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CHAPTER

7

Trading, Risks and Regulations

In the previous chapters, we have discussed about the nature and valuation of futures and options contracts. In this chapter, we consider the mechanism of trading in such contracts on exchanges, including the types of orders. Further, the Nick Leeson episode is examined in order to highlight the risks associated with dealing in derivatives markets. Towards the end of the chapter, some regulatory aspects are discussed.

As already stated, options and futures are standardized contracts and like shares and debentures, they are traded on exchanges (although there are options that are traded off-exchanges on over-the-counter markets, but our focus here is only on the exchange-traded ones). The following list shows futures and options contracts traded on some of the exchanges in the world.

Exchange	*Contracts Traded*
Chicago Board of Trade (USA)	Corn, Oats, Soybeans, Gold, Silver and other commodities, Treasury notes, Major Market Index etc.
Chicago Board Options Exchange (USA)	Equities, S and P 100 stock index, S and P 500 stock index, Interest rates, Treasury bonds etc.
Hong Kong Futures Exchange (Hong Kong)	Sugar, Soybeans, Gold, Hang Seng index etc.
Kuala Lumpur Commodity Exchange (Malaysia)	Cocoa, Rubber, Tin etc.
London International Financial Futures Exchange (UK)	Government bonds, Currencies, US-treasury bonds, FT-SE 100 index etc.
Montreal Exchange (Canada)	Government bonds, Gold, Platinum etc.
National Stock Exchange	Individual stocks and S and P CNX

of India (NSE)	NIFTY
Sào Paulo Commodities Exchange (Brazil)	Live cattle, Cotton, Coffee, Corn, Soybeans, Gold, US Dollar and other currencies
Singapore International Monetary Exchange (Singapore)	Gold, Fuel oil, Currencies etc.
Sydney Futures Exchange (Australia)	Live cattle, Wool, Treasury bonds, Share index etc.
The Stock Exchange, Mumbai (BSE)	Individual stocks and SENSEX
Tokyo Commodities Exchange (Japan)	Gold, Silver, Platinum, Rubber, Cotton yarn etc.
Tokyo Stock Exchange (Japan)	Japanese Government bonds, Tokyo stock price index (TOPIX), US Treasury bonds etc.

Some of the markets of the world are 'open outcry' markets, while others are 'electronic' markets where trading is accomplished through computers. In the open outcry markets, trading takes place in a pit where a large number of people are present and contracts are traded through continuous bids and offers. Thus, such a market brings together the buyers and sellers (through their brokers) on a platform for the purposes of trading. In case of electronic trading on the other hand, there are screen-based broker dealing terminals, instead of the trading pit and the brokers' booths in the market floor. To illustrate, futures and options trading in India by NSE and BSE is electronic in nature, with the bids and offers, and the acceptances being displayed on the terminals continuously.

We may now see as to what is the mechanics of trading in these instruments, focusing on stock options and index-based futures contracts.

THE TRADING MECHANISM

Like trading in securities, the trading of derivatives involves identification of product, placing of order, confirmation and execution of order. These are discussed here. Also given is the institutional framework involved in the trading and people engaged in trading together with types of orders that can be placed.

Product Identification

While discussing the trading of options and futures contracts, let us understand that on a given trading day, various types of options and futures contracts are traded on an exchange. The various stock options traded are identified by *class*, either a call or put option, and by *series*, in terms of exercise price (or strike price) and maturity (or expiration date). As indicated earlier, the stock option contracts on an exchange are standardized with respect to the quantity of shares, the exercise price and the date of expiration. To illustrate, options contracts on individual stocks that are traded on the NSE are identified by their distinct titles. For example, OPTSTK RELIANCE 25APR2002 340.00 CA represents an American style call option contract on Reliance Industries Ltd. with exercise price equal to Rs 340 and due to expire on April 25, 2002. With all characteristics the same, the put option is indicated as OPTSTK RELIANCE 25APR2002 340.00 PA. Similarly, OPTIDX NIFTY 25APR2002 1060.00 CE represents a European style call option on the index NIFTY, of an exercise value equal to 1060 and expiring on April 25, 2002. Similarly, the futures on individual stocks and stock index futures contracts are known by the series based on the month of expiry and other details. For instance, in case of the futures contracts on S and P CNX NIFTY traded on the National Stock Exchange of India, there are 12 series, with one series for each month. At any trading day, three series are open for trading. For instance, in the month of April, the contracts expiring in April, May and June are available for trading until date of expiry of the April futures is reached on the last Thursday of the month. From the day following this, a new contract expiring in July is introduced. These are also coded to signify the kind of contract and the expiry date etc. For example, FUTIDX NIFTY 30MAY2002 stands for futures contracts on the index NIFTY expiring on May 30, 2002. Similarly, FUTSTK SATYAMCOMP 30MAY2002 signifies futures contracts on the stock Satyam Computers Ltd expiring on May 30, 2002.

Placing of order

Now we turn to the trading process. To begin with, as for every contract, there has to be a buyer and a seller for an options/futures contract. The buyer or seller, for instance, may be an individual investor looking for a speculative return or a mutual fund looking to commit large funds to a particular investment strategy. As a first step, the client would give a dealing order to a broker with whom a legal agreement for trading has to be signed. The broker is expected to ensure that the client knows the risks that are associated with such financial instruments and is aware of the obligations of entering into the trading process. Once the client has confirmed an order with the broker, the broker passes the instructions to his representative on the exchange for execution. From there, the instructions are sent by messenger to a trader on the floor of the exchange. The broker may use his own in-house dealer or an independent local acting on his behalf. In any case, the floor-dealing team enters the details of the order on a dealing slip along with a time-stamp on it. Once the order is filled in the pit, it is communicated back to where the order came from. Details of this are entered on the dealing slip which is again time-stamped. The procedure, thus, involves a number of steps but the confirmation of the orders is done in a short time due to efficient communication systems.

Execution of Order

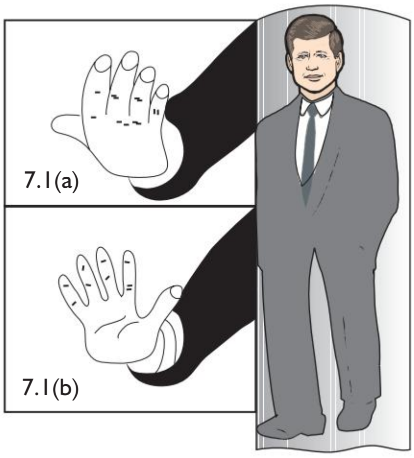
As indicated above, where the 'open outcry' system is in vogue, trading on the exchange takes place in the *pit* (or area where a certain contract is traded). There is a large number of people in the pit including brokers, traders, runners and other employees of member firms, pit observers and supervisors. A glance into an open outcry futures/options dealing pit gives the impression of total chaos, though things seem to be moving pretty rapidly—much like in traditional stock exchanges. There is a large number of dealers, wearing bright jackets in some selected colours, shouting at each other in coded terms waving their arms around with bewildering gestures. However, there is meaning to all this. On the Chicago Mercantile Exchange for instance, usually there are 3,000 to 4,000 people on the floors*. Different members wear different coloured jackets and badges that show who they are and what they can trade. Put observers are employed by the exchange. They monitor all trading during the day and enforce dealing rules and trading regulations.

The trading is done through bids and offers. The volume that a trader is prepared to trade is made known audibly or through hand signals to other traders in the pit. Similarly, acceptance of a bid or an offer is made in such a way that it is clearly heard. The market works like any auction market. Here signals play vital role in offering and accepting the bids. For instance, on the Chicago Mercantile Exchange, some of the basic hand signals used are:

(1) If the palm of hand is facing the body of the proposer, it implies that he/she intends to buy (see Fig. 7.1a).

* The MERC at work–A Guide to the Chicago Mercantile Exchange

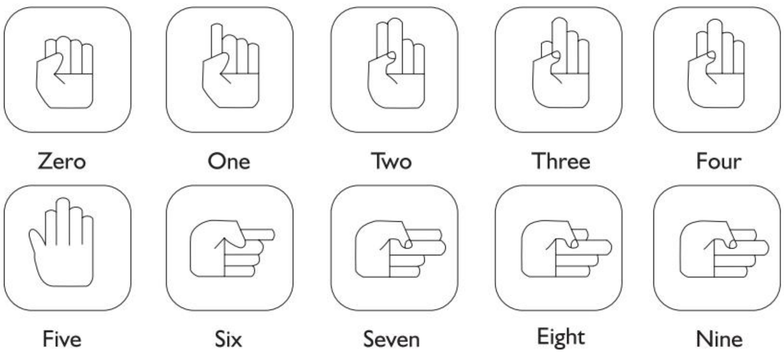
(2) When the palm of the hand is facing away from the body, the implication is that he/she is a seller (see Fig. 7.1b).



➢ **Fig. 7.1** *(a) and (b) 'Buy'and 'Sell' Signal*

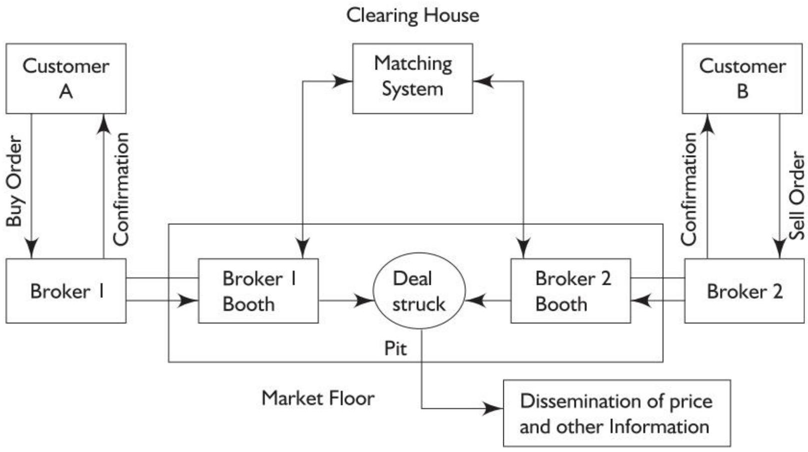
(3) Hands away from the body, arms up stretched, and fingers moving vigorously—suggest the price (to buy or sell). [To illustrate, prices one through five are quoted with vertically extended fingers, while six through nine are quoted with the fingers extended horizontally. Numbers above twenty are indicated swiftly moving sequential hand singlals using fingers and closed fist (which incidently, is a representation of zero). The singals for sizes 0 through 9 are illustrated in Fig. 7.2.

(4) Singalling hand held near the head, with hands working the same as when indicating prices, signifies the number of contracts a trader wishes to buy or sell.



➢ **Fig. 7.2** *Price/Order Signals*

Whether the bids and offers are made and accepted through voice or signals, trading is done continuously on a massive scale. Trading is monitored continuously and rules and regulations are administered for trading. The exchanges use all means to ensure that all trading done is fair and transparent. Data on trades, bids, offers, market volume are all transmitted continuously to the outside world through the display boards. The flow of orders and their confirmation are shown schematically in Fig. 7.3.

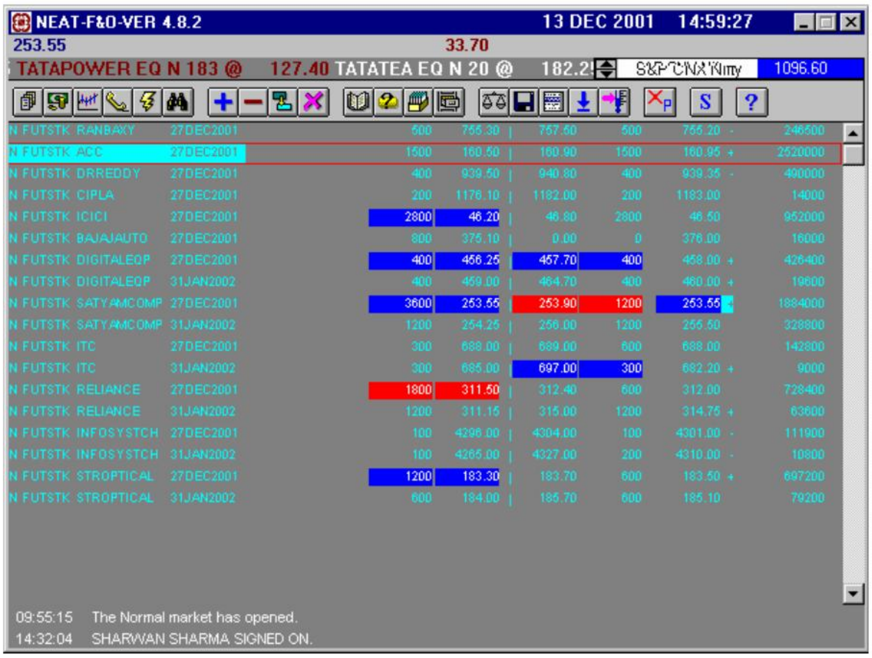


➢ **Fig. 7.3** *The Flow of Orders*

In the case of electronic trading, there is no trading pit and, of course, no brokers' booths on the market floor. The brokers are provided with screen-based terminal and orders are executed on the screen. In such a case, the bids and offers and the acceptances are displayed on the terminals continuously. To illustrate, a sample screen of an NSE terminal is shown in Fig. 7.4. It gives the information about futures contracts with expirations in Dec 2001 and Jan 2002 on selected stocks. In such on-line trading, the orders from the clients are executed by pressing relevant keys. Positions about bids and offers can also be known through appropriate keys.

Institutional Framework

We may now turn to the entities that initiate and complete trades on derivatives. While the structures on various exchanges where options (and futures) are traded are virtually the same, the description that follows is primarily of the Chicago Board Options Exchange (CBOE) of the USA, followed by an illustration from India, The National Securities Clearing Corporation (NSCCL).



➢ **Fig. 7.4** *Sample On-line Trading Terminal*

The options exchange is a membership organisation. An individual who holds a membership for himself or represents his firm/company holding the membership, may trade on the exchange. However, holding the membership by itself does not permit a member to trade on the floor. It is required for a member to first obtain a financial guarantee from a *clearing firm.* The clearing firm pledges to honour financial obligations of that trader, including the payment for or delivery of the underlying shares of the stock on an option that is exercised, in case the latter fails to meet them. A clearing firm by itself has to maintain at least the minimum capital level set by the *Options Clearing Corporation* (OCC). Every trade is submitted to the exchange by a clearing firm in the name of the individual trader. The clearing firm charges a fee from the floor trader for guaranteeing and processing the trade (which involves recording trade information and transferring it to the exchange).

The exchange verifies as to whether the trade is good so as to be regarded as a valid and tenable financial contract between the two parties. This is done by comparing the information supplied by the clearing firm of the trader who is buying, and the clearing firm of the trader who is selling. Each clearing firm submits the record of every trade containing information on whether it is buy or sell and call or put, and further, the quantity of options contracts traded, underlying stock, expiration date, exercise price, trade price, trader's identification and identification of the trader opposite, whether the trade opens a new position or is an offset of an existing position in the same series. Once the records of the two clearing firms are found matching, the trade is said to be "cleared" and accepted by the exchange. Once a trade clears, the OCC receives a report of the trade and it issues an option position to each of the clearing firms. Also, it collects the premium from the 'buying' clearing firm and transfers it to the 'selling' clearing firm.

The trades which remain unmatched due to any discrepancies, called *out-trades*, are sought to be resolved by the traders involved in them, through their clearing firms, before opening on the following day. In case the trades are so resolved, they are submitted as *of trades* bearing the date of the original trade. If the parties fail to quickly resolve an out-trade, them both the traders step back into the next day's trading at its opening and trade with other parties, thereby limiting their losses. Once the parties take desired positions, they can proceed for arbitration in respect of the original, disputed trade.

As indicated earlier, the buyer and the seller in a contract do not interact directly with each other, and the deals between the parties involved are executed through the Options Clearing Corporations. Thus, an OCC acts as an intermediary between the buyer and the seller of an option. Typically, when an investor wants to write (or buy) an option, he approaches his broker who in turn deals with the OCC. OCC regulates all trading in the options and guarantees the provisions specified in the options contracts. It ensures honouring of the contracts. Therefore, when an investor buys an option, he relies on the OCC to fulfil the obligations and not on the writer of the option. Similarly, the writer of an option has an obligation to the OCC. Thus, when the long option holder notifies his clearing firm of his intention to exercise it, the clearing firm informs the OCC. The OCC then randomly assigns the exercise to an outstanding short position in that particular option type and series. The client of the clearing firm gives shares (in case of short call or long put) or cash (in case of long call or short put) to the firm. The shares/cash are then sent to the OCC which transfers them to the appropriate clearing firm to be re-delivered to the customers.

An Indian case *The National Securities Clearing Corporation (NSCCL)* The NSCCL is a wholly owned subsidiary of NSE. Incorporated in 1995, it was the first clearing corporation to be established in the country to introduce settlement guarantee. It was set up with the following objectives:

1. To bring and sustain confidence in clearing and settlement of securities.
2. To promote and maintain, short and consistent settlement cycles.
3. To provide counter-party risk guarantee.
4. To operate a tight risk containment system.

The NSCCL carries out the clearing and settlement of the trades executed in the equities and derivatives segment of the NSE. It operates a well-defined settlement cycle and there are no deviations and deferments from this cycle. It aggregates trades over a trading period, nets the positions to determine the liabilities of members and ensures movement of funds and securities to meet respective liabilities.

The corporation assumes the counter-party risk of each member and guarantees settlement through a fine-tuned risk management system and employs an innovative method of on-line position monitoring. It maintains a Settlement Guarantee Fund for the Futures and Options segment, which has a corpus of Rs 655 crores as on April 30, 2002, in addition to a similar fund for the capital market segment. The Fund operates like a self-insurance mechanism where members contribute to it. In the event of failure of a trading member to meet settlement obligations or committing default, the Fund is utilised to the extent required for successful completion of the settlement. This eliminates counter-party risk of trading on the exchange. Thus, the market has full confidence that settlement shall take place in time and shall be completed irrespective of default by isolated trading members.

Recognising that a sound risk management system is integral to an efficient clearing and settlement system, NSCCL has put in place a comprehensive risk management system, which is constantly up-graded to pre-empt market failures. The Clearing Corporation ensures that trading member obligations are commensurate with their new worth. Risk containment measures include capital adequacy requirements of members, monitoring of member performance and track record, stringent margin requirements, position limits based on capital, on-line monitoring of member positions and automatic disablement from trading when limits are breached, etc.

Floor Traders and Types of Orders

A trader trading on the floor on a given day in a particular option series may be either a *broker*—a member of an exchange who executes orders for customers on the trading floor for a fee—or a *local* or *market maker*—trading on his own account. A market maker provides a continuous bid and offer on ten calls and ten puts in each of the option series that he chooses to trade in. His bid is the price at which he is prepared to buy and his offer is the price at which he sells an option contract immediately. A broker may also trade on his own account (although this is not permitted on the CBOE except in case of the Designated Primary Market Makers, DPM) wherever permitted, but his first responsibility is filling customers' orders. In the course of trading, all orders are treated equally and no distinction is made between an order for a customer or for a trader. However, it is usually ensured that if a broker has a customer's order and also wants to trade for himself, then the execution of the former shall always get precedence over the latter. This is done to prevent "leaning by the broker on a customer's order" that takes the up side away from the customer and leaves him with the down side.

A market maker trades on his own behalf only. There are several operating forms of such trading. For example, he might buy one call (or put or futures) series and sell another call (or put or futures) series, creating a spread. He is accordingly trading as a *spreader* in that case. Also, a market maker may simply take long or short positions in different options and keep them overnight. This type of trading would classify him as *position trader*. However, scalping is a dominating form of trading that the market makers engage in. The *scalpers* exist to provide liquidity to the market. When an investor from the investing public wishes to immediately execute a buy/sell trade and there is no public investor available to take the opposite position, then the scalper comes in to the picture and takes that position.

TYPES OF ORDERS

In the stock market, when prices of the well traded securities are quoted, full prices are seldom indicated. For instance, if the price of a share is currently quoted around Rs 270 and the price during a particular trading day is Rs 269 – 273, then, in the parlance of the operators on the stock exchange, the price shall be mentioned as 69 – 73, with the two hundred value being implied. Thus, when a buyer wants to buy 100 shares of this company, he may ask his broker to 'pay 72 for 100', implying thereby to pay (price not exceeding) Rs 272 for 100 (shares). The buyer (order giver) here has the onus to know the 'big figure' (two hundred here) with which he is dealing. In the context of options and futures also such big figures may be implied, especially if the quotation is on an index like NIFTY or SENSEX of a share like TISCO, State Bank of India or Reliance Industries Limited.

In contrast to the buying orders which take the form 'pay (the price) *for* (the quantity)', the correct form, when selling is involved, is to 'sell (the quantity) *at* (the price)'. A selling order in the context of the above quoted example of buying may be to 'sell 200 at 75', meaning thereby to make a sale of 200 shares at a price of Rs 275 (or above). In real life trading, the words 'pay' and 'sell' may not be spoken or heard so that the buy orders go like '72 for 100' and the sell orders as '200 at 75'—*for* and *at* being the key words distinguishing the two types of transactions.

Market Order Market Order is the most common type of order and simply involves an instruction to buy or sell at the prevailing price in the market. It represents the best price one can get at a point of time. Small orders can be conveniently executed at the market rate but if the size of the order is larger than the volume which is currently available in the dealing pit, then executions might not all be at the same price because the dealer would have to bid up or offer down until desired volumes are secured. Thus, large orders 'at market' have a tendency to move against those who give them. No wonder, then, that large orders may be placed by market participants who wish to move the market in a particular direction.

Limit Order A limit order is an order to buy or sell at a specified price, or a price better than that. Thus, a limit order is exemplified when a client may give a broker a price limit above which he should not buy or below which he should not sell. Also, there is a time limit for which it may be given. This kind of an order puts more responsibility on the dealer since he has to be aware of his limit orders once the limit is reached. An order to buy 200 for 12, stops the offer price in the trading pit from falling below 12 until the order is filled. In fact, a price greater than 12 puts the offer outside the current market quotation and forces the dealer to hold it until the market falls sufficiently or the client decides to alter the order. A limit order kind of an order is feasible when it is considered that there is sufficient market force in the opposite direction at current prices. This has the advantage that it is far less likely to push prices in an adverse direction.

Stop-Loss Order A stop-loss order is aimed at closing out positions when a particular price level is traded. It is this kind of an order when, for instance, a client orders his broker to sell a share or some other security, if its market price falls to a certain level below the current price. Thus, once the specified price is reached or penetrated, the order becomes the market order. Stop-loss orders are a good means of protecting ones' profits, or limiting ones' loss, while waiting for the market to recover. For instance, one may have bought a share for Rs 320. The price of the share rises to, say, Rs 470 and might rise even further. The investor might like to protect his profit already made while waiting for the further price rise. Accordingly, he may give his broker a stop loss order to sell the share at Rs 410 so that he does not lose the entire profit. Similarly, such orders provided a useful mechanism for investors intending to stop incurring more losses once a particular level of loss has been reached.

Stop-Limit Order A stop-limit order is said to be placed when, for example, a client can place a stop order at a particular level with a limit beyond which the market would cease to be chased. For the order, say, sell on stop 3188 limit 82, the broker/dealer to look to sell the position once the market declines and trades at 3188, but he would not sell below 3182.

Fill or Kill Order This is an order to a broker to buy or sell a security or derivative immediately. If the order is not executed at once, it is treated as withdrawn. This type of an order is often used by a party wishing to take out a large bid/offer but, in case of a failure, it does not wish to be viewed as a possible large counter party in the market.

Market If Touched (MIT) It is a limit order which automatically becomes a market order once a predetermined price is reached.

Good Till Cancelled (GTC) This is a client's order to buy or sell, usually at a specified price, which remains valid until its execution or cancellation.

Day Order or Good for the Day As the name implies, this means the limit or stop order would lapse at the end of the day (of dealing) if it has not been executed during the day.

RISKS IN DERIVATIVE TRADING

While it is true that derivatives are tools of managing risk for the hedgers; it is equally true that trading in such instruments, particularly for those taking speculative positions, may indeed prove to be very risky. Risk is involved in trading in such instruments because of the high degree of leverage associated with them. While taking positions in the cash market may need huge sums of money, the same can be done in the derivatives market with a fraction of it. For example, since entering into a futures contract requires only about 15% of its value to be deposited as margin, it enables one to accept contracts worth over six times the volume of money at the disposal of an investor. Similarly, a small percentage of the value of the underlying shares is all that is needed to take a position on such shares. This leverage provided by the futures and options is the basic source of potential dangers associated with trading in such instruments.

Accordingly, one should be aware of the risks inherent before venturing into options and futures market. In what follows, first an account is given on the risks associated with options contracts: both for the holders and writers. Then, the case of the fall of Barings Bank, in England, which was brought about by actions of a single individual in the futures market, is discussed.

Risks in Options Trading

The holder of an option runs the risk of losing his/her entire investment in buying the option in a relatively short period of time. This risk stems from the fact that an option is in the nature of a wasting asset—it becomes worthless when it expires. Thus, if the holder of an option does not sell a matching option in the secondary market or does not exercise it on or prior to its expiration, he/she is sure to lose the entire amount invested in buying the option. Accordingly, the holder runs the risk of losing the total money invested in a relatively short span of time, equal to the time to maturity of the option when it was bought. It is, therefore, imperative that an investor in options should be able to correctly predict the direction of price change of the underlying asset (which would be the price of the underlying share if the option is on the stock of a company). Not only that, the investor should be able to correctly visualize as to when is the change likely. If the price of the underlying asset does not change in the desired direction before the option expires (i.e., by such a magnitude as would be sufficient to cover the cost of the option), the investor may lose all or a substantial proportion of his/her investment. This is in direct contrast to a situation where an investor purchases the underlying interest instead of options and holds it notwithstanding the failure to change its price as anticipated, in the hope that the price would eventually change favourably leading to a profit.

The significance of this risk to an option holder depends in a large measure upon the extent to which the holder utilizes the leverage provided by the options to control a large quantity of the underlying interest than he could have bought by the same investment amount. For example, suppose an investor invests a certain sum in the shares of a company. After a given period, say six months, his return on the investment shall be equal to the change in the price of the share. Thus, if the price of the share increases by 20%, his return for the period would be 20% and if the price declines by 30% his return would be a negative 30%. On the other hand, if the investor invests the entire amount in buying, say, six-month options on the same shares, then he runs the risk of losing the entire amount—a cent per cent loss—if the price of the underlying share does not move or moves adversely at expiration. Of course, there is no limit on the potential gain that may be made with a favourable movement in the price. However, the price has to move at least as large as to recover the price paid for the option before a profit may be reaped. The investor dilutes the risk if he invests part of the money in buying options and the remaining amount in some risk-less securities like T-bills. However, whereas it has a cushioning effect in the case of adverse changes in price of the underlying shares, it would also dilute his profitability in the event of favourable price changes.

It can be easily visualized that the more an option is out-of-the-money and the shorter the time to its expiration, the greater would be the risk for the option holder. This is because an out-of-the-money option can be profitable only when an adequate price change occurs (and this change should occur before the expiration day). Obviously, then, the greater the pice movement desired (that is to say, the more the option is out-of-the-money when purchased, or the greater the price paid for buying the option) and the smaller the period of time in which it must happen, the greater would the chances be that the investor would lose his money. Of course, it does not necessarily imply that an option must be worthwhile to exercise to enable one to make profit. A profit can be make by selling the option in secondary market at a price, if available, greater than that paid for buying it. However, what is sought to emphasize here is that shorter the time to expiration, the less likely that it would be possible.

Further, we know that in contrast to American style options, which are exercisable at any time to the expiration day, European style options can be exercised only at the date of expiration. Should the holder of a European style option desire, he/she can derive value from it, prior to the date of expiration, only through selling (going short) it in the secondary market at the prevailing price for such an option. Obviously, if a secondary market for the option is not available during the time it is not exercisable, it would not be possible for its holder to realize any value from it. In any case, whether the option is American style or European, the holder of an option, who wishes to exercise, must ensure that a timely action is taken in this regard. Sometimes, the options have an automatic exercise feature wherein an option is automatically exercised if it is in-the-money by at least a specified amount. While the option holder faces no risk arising from inaction for exercising the option, the option holder runs the risk of the option being exercised at a price at which he/she would not voluntarily choose to exercise due to the involvement of transaction costs or some other factors.

In addition to the above, the various regulatory and legal authorities may impose trading or exercise restrictions in certain circumstances. Imposition of any such restrictions shall have the effect of restricting the exercise of an option. In such an event, an option cannot be exercised until the restriction is terminated. To that extent, it affects the liquidity associated with options.

The risks of option writers are manifold. To begin with, an American style option writer may be assigned with the exercise of an option at any time during the period that it is exercisable. Due to its very nature, an American style option may be exercised by its holder at any time until it expires, the writer of such an option is subject to being assigned the exercise at any time after he/she has written option until it expires or the investor has closed out his/her position by a closing transaction. Similarly, the writer of a European style option may be subject to assignment when the option is exercisable (at the expiration date). It is important to note that once an exercise has been assigned to a writer, the writer is not permitted to close out the assigned position in a closing purchase transaction. This is irrespective of whether the writer received or did not receive the notice of assignment by the OCC. The writer of an expirable option that is in-the-money may obviously expect that it would be exercised, particularly when the expiration approaches. Once assigned, an option writer must deliver (in a call option) the underlying interest (commodity, etc.) or pay the cash settlement amount when the option in cash-settled in nature.

Covered call option If the writer of a call option is *covered*, then he/she would have to forgo the opportunity of profit, if any, from the increased value of the underlying interest above the option price, but would continue to bear the risk of a decline in the value of the underlying interest. In case the writer is assigned the exercise, the net proceeds he/she would receive from the sale of the underlying interest might be substantially lower than the prevailing market price. For instance, suppose a call option is written on a share with an exercise price matching with its current selling price of Rs 70 and a premium of Rs 5 is received. Now, assume that the price of the share increases to Rs 82 as the expiration approaches and the writer is assigned the exercise. As a consequence, he would receive Rs 7000 for the shares in addition to a premium of Rs 500 (plus, of course, any dividend he might have received on the shares). This is lower by Rs 700 (or Rs 7 per share) than Rs 8200 he would have received if he had not written the option. On the other hand, if the price of the share becomes lower than Rs 70 towards expiration, then the call is not likely to be exercised. In such an event, the call writer would have unrealized loss on the underlying share, depending upon the price he had paid for acquiring the share. However, it would be adjusted by the amount of premium he receives.

Uncovered call option In case a call writer writes a naked call, he exposes himself to a very risky situation. Such a writer may incur huge losses should the value of the underlying interest increase substantially above the exercise price. Since the price of the underlying asset may rise to any level, at least theoretically, the potential loss of such a writer is unlimited. In case such a writer is assigned the exercise, he would have to buy the underlying interest (when the call involves a physical delivery) from the market to satisfy his obligation on the call, losing an amount equal to the excess of the purchase price over the exercise price of the call, reduced by the amount received as premium for call writing.

Uncovered call writing also involves larger margin requirements, which may rise substantially if the market moves in an adverse direction (from the writer's point of view).

As with uncovered call writing, there are substantial risks associated with writing put options. If the price of the underlying interest declines well below the exercise price, the writer would stand to lose. However, whereas the potential risk of an uncovered call writer is unlimited, it is not so for a put writer because the price of the underlying asset can fall to zero at best. Thus, the put writer of an option which requires physical delivery would have to take delivery at a higher price than the prevailing market price when the put is exercised, while in the case of cash-settled puts, the put writer shall have to pay the difference between the exercise price and the prevailing market price—which may be substantial, depending on the divergence between the two.

Writing of put options also requires keeping margins, like calls. The put writer's exposure to margin requirements can be eliminated if the writer elects to deposit cash equal to the option exercise price (which represents the maximum loss that the option writer can be required to take) with his broker. Under this cash-secured put writing, no additional margins would be called and the writer may get an interest on the amount deposited. However, the writer cannot escape the losses that may result from the declining price and the consequent exercise of the option.

Further, if trading in an option becomes unavailable and the option writers are unable to close their transactions, they obviously remain obligated until expiration (or exercise). Also, sudden developments may cause a sharp upward or downward spike in the value of the interest underlying an option. If the option happens to be a capped one, the spike may cause it to be exercised automatically making the writer liable to pay the cash settlement amount, even if the effect of the development which caused such a spike disappears soon thereafter.

Apart from risks associated with option writing, there are additional risks to which investors who engage in multiple transactions involving buying and writing multiple options in combinations or having positions in underlying interests and options are exposed to. For example, at times it may be impossible to execute transactions in all the options simultaneously or there may be a possibility of incurring a loss on both sides of a combination. Similarly, there are complexities which can emerge when options of different styles are mixed up—a writer of an American style option who is assigned to purchase/sell the underlying asset would not be able to cover himself by exercising a European style option. In addition, the possibility of insolvency of a brokerage firm provides an additional risk to traders in options. Likewise, the insolvency of an associate clearing house might present risks for the customers whose brokers have their accounts with such a clearing house. Not only this, although Option Clearing Corporations' rules and regulations are made so as to ensure prompt settlement of transactions and exercises, there is even a risk, albeit small, for the OCC to fail or for a failure of its backup. There may be other problems as well leading to a breakdown of the system. The failure of INSAT-2D in October, 1997, for example, led to the suspension of activities on the National Stock Exchange of India for about a week.

Futures Trading Risks

As indicated in Chapter 2, trading in forward contracts is fraught with the risk of non-performance by either of the parties involved. The futures contracts, on the other hand, have no such risk as the performance of the contracts is guaranteed by the exchange (the clearing corporation). However, since only a small percentage of the contract value is required to take a position, greed or fear may lead to reckless trading possibly with disastrous consequences, like in case of Barings Bank discussed later. Further, possibilities of manipulation, fraud and abuse also exist particularly when the futures contracts relate to individual stocks since individual scrips may be driven up or down to make a killing on the futures (and options) deals on them. Obviously, the index-based futures (and options) contracts would be expected to be better in this regard since an index is less amenable to manipulation since the resources needed to cause a change in an index are much greater than those needed to move an individual scrip.

The Barings Saga

The case of Nick Leeson was a landmark in the history of derivatives. It highlighted the risks associated with the trading of derivatives. It showed how a single individual, by his manipulative tactics, brought about the collapse of a 233-year old financial institution, the Barings Bank. Interestingly, the manipulation was done by an ordinary tool found in millions of homes—a desktop computer.

The Barings debacle exposed the vulnerability of global markets to manipulative actions of rogue traders. In this case, the maverick trader employed billions of dollars on unauthorized derivatives bets, wiping out the capital of the bank and bringing its collapse. The story begins when Nick Leeson, a young man of 28 years and the Singapore trader of Barings, purchased a large number of futures contracts on the Nikkie index in Tokyo. Nick Leeson's strategy was simple: he fooled the directors of Barings into believing that he was dealing on the behalf of clients, whereas he himself was dealing in the derivatives contracts. It is said that the Barings dealer bought between 15,000 and 20,000 derivatives contracts linked to the movement of the Japanese stock market and worth almost $20,000 each. It is estimated that Mr. Leeson might have built up a $7 billion futures position. For this, Barings borrowed a large sum of money going into hundreds of millions of dollars. Moreover, cash was also transferred from the London office of the firm to Singapore to cover margin payments.

The futures contracts were purchased on the assumption of rise in the index. Unfortunately, the index went down because of the Kobe earthquake. This resulted in mounting losses. Instead of booking losses, he kept on pouring more money in the Tokyo market, on the assumption that Kobe earthquake would be ignored and the market would rise. But that did not happen. Interestingly, the Barings officials knew nothing about the actions of its star dealer.

The worst came to fore on February 26, 1995 when the Barings, Britain's oldest investment bank, was officially declared broke. Subsequently, it was discovered that leading Japanese banks may have more than 390 million pounds in loans to Barings. It raised questions regarding effectiveness of Japan's financial supervision. The Barings Bank stood to lose around $650 million on deals made by the Singapore-based trader.

There was worldwide furore on the detection of the Barings scam. The crisis hit the Britain's banking world substantially. A rescue team headed by the Bank of England's Governor Mr. Eddie Goerge himself, was fighting to find a solution to avert a crisis of confidence in Britain's banking system. It was also apprehended that Japan's stock market would face a big drop after the Barings news. But actually, the Japanese stock market ignored the Barings demise and recovered.

Experts had diverse opinions on this even. On the extreme side, there was a demand to put a ban on derivatives trading. On the other, it was held by some that this fiasco had resulted because of failures of Barings to have in-built checks against malpractices by its own traders. It was even said that the debacle was welcome because it proved that neither size nor age can guarantee competence. Some experts argued that the fall in the market should be regarded as a normal event and not a crash. It was further opined that only those who traded stupidly lost money while the intelligent ones gained from this fiasco. Some experts were of the opinion that the event had shown that banks need to strengthen their internal checks. But there was no unanimity on the solution needed to avoid such type of fiascos in future.

For a while, the Barings episode put a question mark on the introduction of options and futures in the Indian markets. But the episode proved to be a blessing in disguise for India as it showed to the Indian authorities the overall framework under which option and futures could or should be introduced.

The loss by Barings in derivatives is not a solitary case. Other unfortunate cases have also been there. For example, the German industrial group Metallgesellscraft AG lost $1.5 billion in 1993 in oil derivatives deals.

Thus, it may be said that the Barings ordeal, though unfortunate, provided important lessons for the future. It showed how important it is for big institutions, especially those dealing with public money, to have tight internal checks to avoid such types of scams in the future.

REGULATION OF DERIVATIVE MARKETS

The futures and options markets, like the securities markets, are essential to economic growth and prosperity of an economy. These markets play a significant role in the efficient allocation of the resources of a country. No doubt, therefore, futures and options exchanges (and over-the-counter derivatives markets) are integral parts of virtually all economies which have reached an advanced stage of development. Also, it is likely to be so for the many countries whose economies are moving on the path of development. Due to the economic significance of the derivatives markets, their integrity is a matter of public interest. It is imperative, therefore, that such markets be properly regulated.

Market integrity and efficiency, financial safety and customer protection being vital to the success of any financial market, the regulators should strive to make securities and derivatives markets fair, transparent and orderly to instil investors' confidence into them. For this, it is necessary to regulate trading, devise controls to prohibit manipulative or fraudulent conduct, establish high standards for market intermediaries, and to vigorously enforce rules and regulations. A lack or inadequacy of measures against manipulation, fraud and improper activities is likely to lead to market abuse resulting in inefficient markets, higher transactional and systemic costs, losses to investors, and loss of investor confidence in the market. It is imperative, therefore, that such markets be properly regulated so that they can be viewed by investors, present and potential, to be fair and transparent.

As indicated in Chapter 1, the exchanges for derivatives serve the basic economic purpose of re-alignment of risks and price discovery. Also, they aim to increase efficiency by providing a focal point where buyers and sellers can meet conveniently. In fact, these purposes cannot be served properly if the prices on the exchange do not accurately reflect, or appear to reflect, the forces of demand and supply. Obviously, investors would not be drawn to a market whose integrity is in question. The most important threat to market integrity stems from the possibility of manipulation of prices. It is necessary, therefore, to provide adequate safeguards against price manipulations.

Further, as we know, trading in futures and options is unique in that an exchange/clearing house acts as a counter-party in each trade with the result that those who choose to use the exchange have not to worry about the credit-worthiness of the counter-parties in their trades. But, while the traders have not to worry, the exchange must equip itself, and establish a system which ensures that it has the funds required for the discharge of its responsibilities of performance of contracts. Thus, a derivatives exchange has to build a reputation such that investors have an absolute trust that the exchange shall meet its obligations. The financial integrity of the exchange is also important because a failure in one case can have a spill over effect on other exchanges. Thus, it is in the public interest to ensure that each derivatives exchange takes apposite steps to ensure its own financial integrity.

Another goal of having appropriate control measures is the need to have transparency in operations done on behalf of the investors. Since the customers' funds are usually handled by the firms through whom they conduct business, there exist possibilities of mishandling such funds. Similarly, handling of customer orders may not be orderly. It is possible, in the absence of adequate checks and controls, for the firms handling orders to give favours to some customers over others, or 'leaning' over customers' orders to credit advantageous positions to themselves and passing the unfavourable ones to the customers. To ensure fair and honest dealings, a regulatory framework is needed for imposing responsibility and accountability on market operators and market intermediaries.

It is apparent from the preceding discussion that regulatory framework is required to meet the needs of ensuring market integrity, financial integrity and customer protection. While there can be no general solution which may be applied universally to all countries, a few observations may, however, be made. In the first place, a country which intends to have derivatives markets would require legislation to the effect that derivatives are legal instruments. This would, in turn, necessitate the establishment of a governmental agency endowed with necessary regulatory powers—to establish, monitor and enforce the regulations. Thus, an effective regulatory framework calls for ensuring (a) a mechanism for imposing responsibility and accountability on market operators and intermediaries like exchanges, brokers, clearing and settlement agents; (b) a mechanism for monitoring compliance with the laws and rules governing the transactions; and (c) an effective system for enforcing laws and regulations of the exchanges and other market intermediaries governing operations in these markets.

However, whereas it is generally acceptable to have a governmental regulatory agency, opinions differ on the relationship between the governmental agency and the self-regulatory organizations like exchanges on the appropriate division of the regulatory responsibilities between them. Further, an important issue that requires consideration is whether there should be a single agency or multiple agencies to regulate all the derivatives markets and whether the same agency, which overlooks the securities market, should also regulate the derivatives markets. In fact, a single agency may be too large to be efficient and sufficiently flexible or it may be too small to be an efficient one. The existence of multiple agencies may be inconsistent, would mean duplication of regulation, and there could be some uncertainty about the jurisdiction of their governance. It is, therefore, better to have a single agency for overseeing the regulation.

Whatever the structure, any system which involved shared responsibility between various agencies for governance may be viewed as a pyramid. The bottom of this is comprised by the market intermediaries, including broking firms, which are members of the self-regulatory organisation like the derivatives exchanges. They must meet the established norms and standards devised for such an organisation. They should oversee the education and training of their employees about the laws and rules and regulations of trading. On the upper edge of the market intermediaries are the self-regulatory organisations including the exchanges and clearing corporations, etc. These organisations engage in overseeing of the daily trading activity and enforcement of standards of conduct by the market intermediaries. They are also obliged to cooperate with and assist the government authority in investigating and enforcing laws and regulations. On the top of the pyramid, of course, is the government regulatory body which is in the overall command and has the ultimate responsibility for the fair and effective operation of the regulatory system.

To meet the desired goals of regulation, it is necessary to ensure the following:

1. The derivatives products to be traded should be carefully designed to meet the requirements of customers. For example, while designing a contract on the stock index, consideration should be given to the method of calculation of the index, the number of stocks to be included in the index, the variation in stock prices, replacement of constituent stocks in the index and the 'multiplier' to determine the value of a futures contract.

2. The rules regarding fair and efficient execution of orders should be stated clearly and enforced consistently.

3. Constant scrutiny of trading should be done so as to identify any manipulative behaviour.

4. The exchanges should develop enough capacity in terms of manpower and technology to take on large trade volumes.

5. The exchanges should have enough powers to appropriately punish erring participants.

6. Appropriate capital adequacy norms should be set and implemented.

7. An adequate margining system should be in place, because it is the margins which underlie the safety provided by the clearing house. Margins should neither be too high (making entering into derivatives trading too costly) nor should they be too low (making the risk of default to be high). The marking-to-the-market of margins should be done to ensure financial integrity.

8. Although marking-to-market margins provide protection of the financial integrity of the system against price volatility, additional measures may sometimes be needed in the face of abnormal volatility or market disruption characterised by rapid market declines that threaten to create panic or disorderly market conditions. (A typical case in point is the famous stock market crash in USA in 1987, when on Monday, October 19 of that year, the value of the US stocks declined by about 1/5th of the pre-crash value. The decline had spill-over effects to other markets of the world including stock markets of Japan, Australia, and Great Britain). To meet such contingencies, adequate measures need to be taken. They include circuit breakers—trading halt in the cash market and a corresponding halt in the derivatives market—and setting of price limits.

9. The rules establishing the priorities by which orders may be executed should be clearly laid and properly enforced in order to ensure fairness and to prevent fraud.

10. Proper records must be kept for a sufficiently long period of time to enable checking, at any time, on whether the proper execution rules have been followed.

11. Appropriate fora should be provided for customers to settle disputes, if any, in trading.

While the points mentioned above can be taken care of in a number of ways, the bottom line is that it is necessary for all the market participants to appreciate the significance of rules and regulations and that such rules be applied uniformly to all.

TEST YOUR UNDERSTANDING

Mark the following statements as True or False.

1. _____ Options are tradeable only on exchanges.
2. _____ An open outcry market is one well organised market place where buyers and sellers meet for trading.
3. _____ At a given point in time, different classes and series of options may be traded.
4. _____ An exchange-traded option contract on stock may involve any number of shares of the stock.
5. _____ Pit observers are employed by the exchange to monitor trading and enforce rules and regulations.
6. _____ The clearing firm honours financial obligations including payment for, or delivery of, the underlying shares on the stock on an option which is exercised, in case the trader fails to do so.
7. _____ Out-trade is a trade entered into by the parties outside the exchange.
8. _____ OCC acts as the intermediary between the buyer and the seller of an option.
9. _____ Spread trader is one who buys one series of an options or futures contract and sells another.
10. _____ Scalpers provide liquidity to the market by taking a position opposite to the one taken by an investor who wishes to buy/sell but finds no investor.
11. _____ Large market orders may be placed by the market participants to move the market in a particular direction.
12. _____ A limit order is an order to buy or sell at a specified price only.
13. _____ A stop loss order is the same as a limit order.
14. _____ Day order is valid for the whole working day.
15. _____ Options are wasting assets—they are useless after they are exercised.
16. _____ The buyer of a call option enjoys unlimited gain potential.
17. _____ The more an option is out-of-the-money and the longer

the time to its expiration, the greater would be the risk faced by an option holder to lose money.

18. _____ An option writer has to deposit the same margin whether options written are covered or naked.
19. _____ Market integrity, financial integrity and customer protection are the key to success of a cash or derivatives market.
20. _____ Steep margins and marking-to-market continuously would ensure the development of a successful market.

EXERCISES

1. How are open electronic markets different from open outcry markets? Explain the mechanism of trading in an open outcry system.
2. Explain the different types of orders which may be placed in buying a security/derivative contract.
3. Who are scalpers? How are they useful?
4. Discuss the nature of risks facing option buyers and sellers.
5. Write a note on the failure of Barings Bank.
6. Describe the goals of regulation of security and derivatives markets. How can the goals be achieved?

CHAPTER

8

Indian Securities Market—An Overview

Having discussed about the nature, valuation and trading of derivatives including futures and options, we now look at the Indian capital market and the derivatives trading in it. In this chapter, an overview of the Indian capital market is presented. That includes the changes in its size and character which have taken place over the decades. The next chapter is devoted to futures and options in India including the products available, the trading volumes in these products, the participants in the market and so on.

A BRIEF HISTORY OF STOCK EXCHANGES

The history of stock exchanges in India dates back to the 1840s. There were 50–60 brokers led by the legendary Premchand Roychand. They formed the backbone of share floatation by the East India Company and a few commercial banks. In 1875, the Bombay stock exchange, the oldest in Asia, made its beginning under the name, Share and Stockbrokers Association. A voluntary non-profit association of persons, it mobilised funds for industrial growth and government securities, especially of Bombay Port Trust and Bombay Municipality. A similar organisation was set up in Ahmedabad in 1894. As a result of the *Swadeshi* movement and the coal boom of 1904–08, Calcutta became another major centre of share-trading and an exchange was set up in 1908. During interwar years, as the demand for industrial goods kept increasing, existing enterprises expanded and new ones were floated. Yet another stock exchange was started in Madras in 1920. Stock exchanges in Hyderabad and Delhi started operations in the years 1943 and 1947, respectively. At the time of independence, there were seven stock exchanges functioning in major cities of the country.

From seven stock exchanges in 1946, the country moved to form a total of 19 stock exchanges by 1990. There were 5,968 companies listed as against 1,125 in 1946. The paid-up capital of these companies multiplied many-fold from Rs 270 crore in 1946 to 27,761 crore in 1990. The market capitalisation of listed companies jumped from Rs 971 crore in 1946 to 70,521 crore in 1990.

From the nineties, started the current phase under which Indian stock exchanges are undergoing a rapid transition to be at par with stock exchanges in the developed world. Before 1990, the trading system was the open outcry system with scrips classified as specified (in which 'carry forward' or *badla* facility was available) and non-specified or cash scrips that were compulsorily settled with delivery at the end of the settlement . There were long and varying periods for specified and non-specified shares in the old clearing system because of the intricacies involved in the physical form of shares.

The membership of stock exchanges was initially open to individuals and partnership firms and was later opened to companies. While the Bombay Stock Exchange, Ahmedabad Stock Exchange and Madhya Pradesh (Indore) Stock Exchange were organised as voluntary non-profit associations of persons, the Calcutta Stock Exchange, Delhi Stock Exchange, Uttar Pradesh (Kanpur) Stock Exchange, and others including Ludhiana, Cochin, Gauhati, Jaipur and Kanara (Manglore) Stock Exchanges were organised as public limited companies. The governance of stock exchanges rests in a governing board comprising of members of the board and an Executive Director/President. Members of the governing board include brokers and non-brokers including government nominees.

Earlier, the investor service levels were low and the regulatory laws inadequate. In the mid-eighties, the G.S. Patel Committee on stock exchange reforms, and the Abid Hussain Committee on capital markets recommended the creation of a second tier stock market. In 1991, an expert study was instituted by the Department of Economic Affairs, Ministry of Finance, Government of India to:

(a) study the trading system, covering both specified and non-specified shares on major stock exchanges,

(b) review effectiveness of regulation and surveillance over trading operations,

(c) look into the working of *badla* and its impact on trading, and

(d) make recommendations for investor confidence.

The expert group suggested for a uniform one-week settlement, replacing the old margining system with 'marking-to-market', to do away with the carry forward system, introduction of formal market making, more investor representation on governing boards, and the introduction of MIS. In 1991, another high-powered study group on establishment of new stock exchanges, popularly known as the *Pherwani Committee* recommended the promotion of a new stock exchange at New Bombay as a model exchange and to act as National Stock Exchange (NSE). Accordingly, Over-the-Counter-Exchange of India, OTCEI, was established in 1992, on the model of NASDAQ of USA. It was promoted by UTI, IDBI, IFCI, LIC, GIC, SBI Capital Markets and CanBank Financial Services as a non-profit company under section 25 of Companies Act, 1956. Also, The National Stock Exchange of India (NSE) was set up and its capital market segment became operational in 1994. With the coming of OTCEI and NSE, screen-based trading took off in India.

FORMATION OF SEBI AND AFTERMATH

The stock exchanges are meant to facilitate mobilisation of resources by companies. Their effective regulation is required for protecting interests of investors and safeguarding their developmental role. The Securities Contracts (Regulation) Act 1956, along with Securities Contracts (Regulation) rules of 1957 have been the main laws to regulate the securities market in India. A look at the powers given to stock exchanges in India to make and enforce bylaws under these reveals that Indian Stock Exchanges have been envisaged as self-regulatory organisations. But legislative regulation has its own importance, like the UK has the Securities and Investment Board (SIB) and the US has the Securities Exchange Commission (SEC). Thus, when the Indian securities market saw huge expansion in the late eighties, the government decided to set up a separate Board for the regulation and orderly functioning of stock exchanges and the securities market, stop trade malpractices, and to protect the investors.

Securities and Exchange Board of India (SEBI) was constituted as an interim administrative body by a notification issued on 12th April, 1988, functioning under the overall administrative control of the Ministry of Finance, Central Government. It was given statutory status on 30th January 1992 by an ordinance to provide for establishment of SEBI. Later a bill was passed and it became an Act on 4th April 1992 and by section (3) the Act it deemed to have come into force on 30th January 1992. The general provisions of Section 11 of SEBI Act provide for regulating business of stock exchanges and other securities markets; registering and regulating the working of stock brokers, sub-brokers, share transfer agents, bankers to an issue, trustees of trust deeds, registrars to an issue, merchant bankers, underwriters, portfolio managers, investment advisers and other intermediaries associated with the securities market. Also, they provide for registering and regulating the work of collective investment schemes including mutual funds, promoting and regulating self regulatory organisations, prohibiting fraudulent and unfair trade practices relating to the securities market, prohibiting insider-trading in securities, regulating substantial acquisition of shares and take-over of companies, calling for information, undertaking inspection, conducting inquiries and audit of stock exchanges, intermediaries and self regulatory organisations in the securities market, performing such functions and exercising powers under the provisions of the Capital Issues (Control) Act 1947, and the Securities Contracts Act 1956 (42 of 1956) as may be delegated by the Central Government levying of fees and other charges for carrying out the purpose, conducting research for the above purpose and performing such functions as may be prescribed.

With the launch of screen-based trading, the trading interest of investors started to expand. These exchanges adopted modern technology and through Satellite VSATs, it was possible to cover the entire length and breadth of the country. Initially, only NSE was allowed to extend its operations all over India. In 1999, SEBI allowed other exchanges also to expand in the whole country and abroad. This resulted in fierce competition between leading exchanges and in the process, smaller exchanges got completely marginalised. Even Delhi Stock Exchange felt the pinch and its turnover declined substantially. Although Calcutta Stock Exchange registered rise in absolute turnover levels, its relative share declined under the continuous onslaught of the BSE and NSE. In 1998, these marginalised exchanges got together and floated another national exchange by the name of *Inter-Connected Stock Exchange.* The various regional exchanges are members of this exchange and have facility to trade at national level, in addition to trading at regional stock exchanges. It was granted recognition on November 18, 1998 and commenced trading operations on February 26, 1999. The exchange has not been able to attract significant trading volumes. At the end of 1999, the bullish sentiment in the market was raging and major exchanges like BSE, NSE and CSE were posting record volumes. All these developments called for an effective regulation of the market.

However, things started changing rapidly in the last quarter of the year 2000. By the beginning of 2001, the ongoing bull-run was heading for a halt with the bears gathering strength with every passing day. Initially, analysts and market men took this change for a reflection of the gathering gloom in the US economy. Also, this downturn in prices was largely limited to technology stocks. But in March 2001, immediately after the central union budget was announced, the bears started a severe onslaught on the market in the shape of a seemingly never-ending selling spree. As a result, several players who had been going long, selected technology sector stocks without having taken their delivery, or not having enough funds to do so even if they wished, got trapped. As a result, several brokers defaulted on the exchanges. In less than a week, the whole market scene had become messy. All the stock exchanges were alarmed as the number of defaulters kept on rising. Exchanges such as Calcutta Stock Exchange were on the brink of collapse, with the trading guarantee funds falling short to meet the requirement. SEBI started a probe into the market and banned naked short sales in a bid to stop the sliding prices from any further decline. However, all such preventive steps on the part of the regulator had probably arrived late and could not prevent the market from further deterioration.

What followed in the next few months was perhaps a very dark chapter in the history of the Indian capital market. The whole episode was termed as a major stock market scam coupled with a bank scam. A good number of major stockbrokers who were supposed to be a part of either the "Bull Cartel" or the "Bear Cartel" lost their brokerage licenses. Trading volumes took a deep plunge as the trading in all the exchanges got reduced to very low levels as compared to what they used to be a few months back. On July 2, 2001 SEBI removed the age-old *badla* from the Indian capital market and introduced *Compulsory Rolling Settlement.* The market did not recover fully even by the end of the year, with trading volumes on NSE being less than one-half of what they used to be in the beginning of the year. The various derivative products launched have met with not-so-significant success so far. Although the future belongs to derivatives, these products still have a long way to go.

Since its formation in 1992, SEBI has introduced many regulations for a healthy and vibrant securities market, which include Merchant Bankers Regulations (1992), Insider Trading Regulations (1992), Stock Brokers and Sub-Brokers Regulations (1992), Registrars to the Issue (1993), Portfolio Managers (1993), Debenture Deed Trustees (1993), Underwriter Regulations (1993), Appeal to the Central Government (1993), Bankers to the Issue (1994), FII Regulation (1995), Unfair Trade Practices (1995), Appellate Tribunal (procedure) Rules (1995), Depositories Act (1996), D and P Regulations (1996), Custodian Regulations (1996), Mutual Fund Regulations (1996), Venture Capital Regulations (1996), Collective Investment Schemes Regulations (1996), Credit Rating Agencies Regulation (1996), Substantial Acquisition of Shares and Take-overs Regulations (1997), Buy-back of Securities Regulations (1998), Employee Stock Option Scheme (1999) and Internet Trading Guidelines (2000), abolishment of minimum lot and par value of shares, continuing disclosure norms, securities lending scheme and so on. Here are some of the milestones that have been achieved in regulation, investor protection and bringing the Indian securities market at par with markets in developed nations.

The Modern Stock Exchanges: Computerised Screen-based Trading

The open outcry system has been completely replaced by computerised trading. OTCEI, which was set up in 1992, was the first computerised exchange of India. NSE started operations in 1994. Till 1996–97, 16 exchanges had switched over to electronic trading. By March 31, 1994, all the 23 exchanges had computerised on-line screen based trading. All these exchanges had a weekly settlement cycle. The Calcutta Stock Exchange, one of the large stock exchanges, shifted to a weekly cycle in 1998–99. In October 1997, the Modified Carry Forward System (MCFS) recommended by the J.R. Verma committee was approved by SEBI and exchanges desirous of implementing it were advised to apply to SEBI for prior approval. All the major stock exchanges worked on the basis of this system for all the shares traded until the time *badla* was banned and all A-group shares got transferred to the category of compulsory rolling settlement since July 2, 2001.

Capital Adequacy and Margins, Surveillance, Clearing Corporations, Investor Protection

As the trading rings graduated from the open outcry system to a screen-based one, the reach, size and efficiency of the market increased many-fold. The same got reflected in greater number of players, their size, and daily turnover on exchanges. To illustrate, the BSE average daily turnover climbed from 135 crores in 1989–90 to 3,594 crores by December 1999.

Base Minimum and Additional Capital All active members of the exchanges are required to maintain a base capital with the exchange. This capital can be in the form of cash, fixed deposit receipts, approved shares and bank guarantees. The members are allowed to do daily business upto only 33.33 times of the base minimum and additional capital deposited. Daily valuations are done for the securities deposited as margin. Members have to deposit additional capital in the form of cash, FDR receipts, shares, bank guarantees to avail higher turnover limits. A member's gross exposure (i.e. scrip-wise outstanding cumulative Net purchases *plus* Net sales in the current settlement and deliverable and receivable obligation of the previous settlement) is restricted to 20 times of base minimum capital and additional capital deposited with the exchange. The trading software delivers on-line messages of the 70%, 80%, and 90% limits, and when the member violates the 100% limit, the trading workstation automatically gets de-activated.

Margins The exchanges collect various kinds of margins from the members as a part of its risk management system. To illustrate, The Stock Exchange, Mumbai collects the following margins:

1. Daily margin
2. Mark-to-market margin
3. Additional volatility margin
4. Special margin
5. Special Ad-hoc margin
6. Ad-hoc margin

SEBI in 1995 directed all exchanges to have a separate '*surveillance department.*' This department aims to keep a close watch on price movement of scrips, detect price manipulation like rigging, monitor abnormal prices and volumes which are not consistent with normal trading patterns and monitor the members' positions, so that defaults may not occur. Surveillance goes along with the imposition of margins and their collection. Prices of the scrips are monitored and circuit filters are applied in case of high volatility in the same day. The cumulative volatility is also kept under check. The punitive action includes suspension of trading for one or more days and imposition of special margins. For companies with high turnover, specific deals of brokers, monitoring of newly listed stocks, warning to members and disciplinary actions are initiated on the basis of surveillance. Concentrated purchases and sales are monitored on a daily basis, scrips having thin trading volumes are kept under close scrutiny. Care is taken to ensure that the limits are not violated, all notional losses are recovered on daily basis without adjusting for notional profits. The volatility of the scrips is kept under close scrutiny. The volatility is computed on a rolling basis for six weeks. Graded margins are imposed on scrips having high volatility. The matching of net positions of 100 top net buyers and sellers is done with their financial strength. Irregularities are also detected with the help of market intelligence. The exchanges have also brought in an on-line surveillance system that monitors prices, volumes, members' positions and generates necessary alerts.

Clearing Corporations and Trade Guarantee Funds All transactions done on exchanges are guaranteed by clearing corporations. A clearing corporation is a counter-party to each trade executed on the exchange. If any of the members default, the clearing corporation steps in. A clearing corporation also facilitates smooth completion of securities/funds pay-in and pay-out. To illustrate, the National Securities Clearing Corporation Limited (NSCCL) operates for the NSE and performs all functions of a clearing corporation.

To eliminate the counter-party risk, exchanges are required to set up trade guarantee funds. This facilitates market regulation, improves investor confidence and enhances investor protection. By February 1999, there were 10 exchanges in the country having trade guarantee funds.

Trade Guarantee Funds (BSE: A Case Study) The Stock Exchange, Mumbai (BSE), established Trade Guarantee Fund in 1997. The exchange guarantees the settlement of all transactions of the members that form part of its settlement system and are settled through the clearing house of the exchange. This instils confidence in the minds of various market participants, protects interests of investors, and helps in regulating the secondary market. The initial corpus of the fund was Rs 4,995.1 million and was composed of initial contribution from members, exchange contribution, interest accertion, continuous contribution, members' base minimum capital contribution, bank guarantees provided by members and additional capital. The fund is managed by a defaulter's committee, comprising 60% public representatives, and is constituted as a statutory committee under the by-laws of the exchange. The exchange ensures that the fund size does not go below Rs 600 million. If it does, the exchange is obliged to inform SEBI and its members and it can call further contribution within two weeks. If a member is declared a defaulter, the defaulter's committee pays the unpaid settlement dues of the defaulter to the clearing house before the pay-out.

Investor Protection Funds (IPF's) In pursuance of the guidelines issued in this regard in 1986 by the Ministry of Finance, the exchanges are required to set up investor protection funds to meet the claims of the investors against defaulting members. The amount of compensation available against a single claim of an investor arising out of default by a member broker of a stock exchange, is Rs 1 lakh in case of major stock exchanges (it is Rs 3 lakh for BSE) and Rs 50,000 for medium stock exchanges and Rs 25,000 in case of small stock exchanges. Another fund maintained by exchanges is the Investor Services Fund, whose purpose is to provide investor-related services.

Investor Grievances Investors' grievances against corporates are required to be settled within a set time frame. Various exchanges have started investor grievances redressal cells. If a company does not oblige, the governing board of the exchange can recommend disciplinary action against it. These cells also settle investor grievances against the members. The exchanges can initiate disciplinary action if a member does not oblige.

Investor Education All exchanges are required to make efforts to educate the investor about his rights and obligations. This is done through free distribution of information brochures on items like exchange by-laws, margins, settlement of trades and market reforms etc. Investors are also educated through organisation of seminars and workshops etc.

FII Participation in the Secondary Market

Foreign institutional investors have been permitted to invest in the Indian securities market since September 1992, when the Government of India issued guidelines for foreign institutional investment. In November 1995, the SEBI (Foreign Institutional Investors) regulations were notified. These regulations require foreign investors to register with SEBI and to obtain approval from the Reserve Bank of India to enable them to buy and sell securities, to open foreign currency and rupee bank accounts and to remit and repatriate funds.

Investment in the securities market is also possible through the purchase of Global Depository Receipts (GDR's), foreign currency convertible bonds, and foreign currency bonds issued by Indian issuers. These are listed, traded and settled overseas and are mainly denominated in US dollars. Foreign investors, whether registered as foreign institutional investors (FIIs) or not, may also invest in Indian securities outside the FII route. Such investment requires case-by-case approval from the Ministry of Industry and Reserve Bank of India, or only Reserve Bank of India depending upon the size of investment and the industry in which the investment is to be made.

Foreign financial services institutions have also been allowed to set up joint ventures in stock-broking, asset management companies, merchant banking and other financial services firms along with Indian partners.

Mutual Funds

Mutual funds seek to represent millions of investors who do not have analytical skills to invest in the markets. These investors with a variety of risk-taking capacities invest in securities markets through these mutual funds. The mutual funds create tailor-made schemes for them to subscribe. The mutual funds have been in the market for long (US64 was the first scheme launched by UTI), but the real growth started only with UTI launching its Mastershare Scheme, which was a huge success. Till 1985, the money raised by mutual funds was a paltry Rs 2200 crores. In 1987, the monopoly of UTI was brought to end and public sector banks and insurance companies were also permitted to set up mutual funds. After that, mutual funds have undergone sustained growth. By 1992, the public sector mutual funds had collectively raised more than Rs 40,000 crores, with the UTI having 75% of this. The private sector mutual funds were given permission to participate in the market since 1992. With this, the dominance of public sector mutual funds is fast eroding. SEBI issued Mutual Funds Regulations in 1996.

The net assets of all mutual funds aggregated at Rs 68,193.08 crores as on March 31, 1999. Despite large outflows from UTI, it still stood on top with 77.93 percent of total assets of all mutual funds, followed by public sector mutual funds.

Dematerialization

Dematerialization of securities is a major step for improving and modernizing our markets and enhancing the level of investor protection. A dematerialized security does not carry the risk of bad deliveries, loss in transit, theft, mutilation etc. The Depositories Act was passed in 1995 but the first steps in this direction came from SEBI only in 1998 when it decided to introduce dematerialized trading in a phased manner. To begin with, institutional investors were directed to settle trades only in a dematerialized form in respect of eight scrips, beginning January 1998. The list increased to 360 by May 31, 1999. Upon review of progress, the delivery of demat shares was permitted in the physical segment. On January 4, 1999, the retail investor was also brought into its ambit by making settlement of all trades in respect of a total of 12 securities compulsorily in demat form by all investors. The list increased to 104 by May 31, 1999 and further to 200 by January 17, 2000. Procedures have been simplified for dematerialization of securities, the concept of market lot has been abolished, the no-delivery period has been reduced to check volatility. Investors with small holdings of shares are temporarily provided exit route but demat delivery is compulsory, if the obligation is for more than 5,000 shares in respect of 24 select scrips, from January 4, 1999. The RBI was approached by SEBI to allow banks to become depository participants because of their wider reach. The same was allowed.

To speed up the process of dematerialization, SEBI has decided that the shares of any company coming with public issue will automatically be traded in the compulsory demat segment for all offer documents approved after February 9, 2000.

Besides this, various other schemes like transfer-cum-demat facility, one-time payment scheme for companies (thereby benefiting investors with reduced transaction costs), certification program, investor awareness programs are also organised.

At present, there are two depositories functional in the country. National Securities Depository Limited (NSDL) which is mainly promoted by NSE, and Central Depository Services Limited (CDSL) promoted by BSE.

On-line Initial Public Offers

Initial public offers in India have typically been fixed price offers. A major problem with such fixed price offerings has been the information asymmetries between the issuers and the investors. A computerised network of exchanges has provided effective means to resolve this problem.

The network of exchanges is now used for conducting primary issues for initial public offers (IPO's), subsequent issues by companies, private placements as well as book building. The trading software adopts the principle of order driven market. So this facility meets the requirements of the user, investor, and trading member. It can be used either for issues made through a book building process or for the traditional issues that are made at pre-determined fixed price. The system can also be used for issues that have various combinations or components of book building and fixed price issues. The main highlights of this network are that it:

1. Provides facility to the issuers for on-line issue of securities.
2. Provides an efficient retail distribution network.
3. Reduces the cost of the issue of securities.
4. Permits early trading in issues to help the investors liquidate their investment should they so wish.
5. Allows real-time market response for the issue.
6. Reduces the time period involved in the allotment process.
7. Reduces the load of the banking sector.

Efforts are in progress to design software through which an exchange can provide flexibility for making issues of any security whether equity, debt or any other hybrid instrument.

Rolling Settlements

The L.C. Gupta Committee appointed by SEBI for the introduction of derivatives suggested the move towards shorter settlement cycles—rolling settlements of one day. Earlier all the stock exchanges had a five-day trading cycle. The rolling settlements are supposed to reduce transaction cost and prevent cash markets from being manipulated as unregulated futures market. For the first time in the country, rolling settlements was introduced by SEBI by making it optional for dematerialized shares. The stock exchanges, where trading in dematerialized securities takes place, have commenced T + 5 rolling settlement cycles from January 15, 1998 for the dematerialized segment on an optional basis. As a part of phased introduction, SEBI introduced rolling settlement on compulsory basis from 10th January 2000. This has been introduced by shifting 10 selected stocks to the compulsory rolling settlement segment. All investors in these securities are to trade only on rolling basis. In the T + 5 rolling settlement system, the funds/securities pay in/out is completed on 5th working day excluding the transaction date. Probably, the biggest turning point in this series of continuous changes arrived when all the 'A' group shares (BSE) were transferred to the Compulsory Rolling Settlement System on July 2, 2001.

Futures and Options

Futures and options have gained popularity in world financial markets since the 1980's as they perform vital economic functions. They are used for hedging, risk management and price discovery. SEBI appointed a committee headed by Dr. L.C Gupta to make recommendations for introduction of derivatives trading in India. While derivatives are of various types, the committee focussed its working to equity derivatives. The committee recommended introduction of derivatives in a phased manner beginning with stock index futures, which found favour with market participants. This was followed by the introduction of options on stock indices and then options on selected securities. To enable the same, Securities Contract Act was amended by Parliament to include stock index and options as securities. This was earlier not legal.

Another committee headed by Prof. J.R. Varma was appointed by SEBI to recommend risk containment measures in the stock index futures market of India. The report provided the methodology for fixing of initial margin on index futures contracts, prescribe liquid net-worth requirement for clearing members, transparency, disclosure norms for clearing corporation, trading member position limit etc.

A more detailed account of futures and options in India may be found in Chapter 9.

Other Measures

(a) The Securities Lending Scheme 1997 The Securities Lending Scheme was introduced by SEBI in 1997. The scheme provided for lending of securities through an approved intermediary to the borrower under an agreement for a specified period. The scheme facilitated the timely delivery of securities that improves the efficiency of the settlement system and corrects the temporary imbalances between demand and supply. It also provided for the mobilisation of idle stocks in the hands of FIs, FIIs, mutual funds and other large investors, leading to additional income to the holder of securities by resorting to lending of securities. It was felt that this would also make transition to rolling settlements easier. SEBI gave permission to four intermediaries to act as stock lenders. This activity continuously picked up as reflected, for example, in the volumes of trading in ALBM (Automated Lending and Borrowing Mechanism) sessions of NSE. However, the securities lending scheme came to an end when SEBI banned *badla* and its modified forms such as ALBM, BLESS etc.

(b) Trading Terminals Abroad To enhance the reach of the market and its depth, SEBI has formulated guidelines for allowing trading terminals of the broking community to be located outside India also. The Gulf, USA, and Europe are likely to be covered under the scheme.

(c) Abolishing the Fixed Par Value of Shares Following economic reforms and free pricing of shares, companies are free to access the capital markets and price their shares freely. These issues are subject to the regulatory framework put in place by SEBI for the purpose, like the disclosure and investor protection guidelines for issuers of securities. The markets have grown in terms of size, depth, number of issuers, number and variety of institutions and players and, above all, in terms of investor population. Given the wide spectrum of changes in the market, the informal group on primary market recommended the abolition of the par value. This provides companies the freedom to issue shares at a fixed amount to be determined by them in accordance with section 13 (4) of the Companies Act, 1956. The companies whose shares are dematerialized would be eligible to alter the "fixed" amount indicated in the Memorandum and Articles of Association under the same section. The existing companies that have issued shares at Rs 10 and Rs 100 could also avail of this by splitting/consolidating the existing shares. In fact several listed companies have started to split their shares to improve their market capitalization.

(d) Shift from Market Lot The concept of market lot has also been abolished in case of dematerialized shares. The investors can now trade in any number of shares, instead of only 50 or 100 earlier in case of physical shares. This has boosted retail participation in the market.

(e) Continuing Disclosure Standards The SEBI had appointed a committee to suggest measures for further improving the continuing disclosure standards by corporates and timely dissemination of price sensitive information to the public. All companies are now required to furnish to the stock exchanges and also publish un-audited financial results on quarterly basis, from June 1998. For better accountability, the listing agreement has also been amended to provide for details of deployment of funds mobilised on a half-yearly basis instead of on a yearly basis. The disclosure of material events that would have a bearing on the performance/operations of the company are now required to be made available to the public immediately.

(f) Short Sales The SEBI appointed a committee to suggest measures for regulating short sales. Accordingly, on April 26, 2000, SEBI banned payment of carry forward charges to the shot sellers or on naked sales to bring the Indian market at par with developed markets. After the stock market scam in March, 2001, SEBI banned all naked short sales by all investors. This ban however, was lifted when compulsory rolling settlements were brought in and *badla* made its exit from the Indian capital market on July 2, 2001.

INDIAN CAPITAL MARKET: CURRENT STATUS

The Indian Capital Market in the past few months has undergone a significant change from the viewpoint of regulatory environment and market participation.

Successive stock market scams, including the Ketan Parekh scam, the UTI debacle and Home trade scam that came to light in 2001 stirred the Capital Markets. It in fact hurt all segments of the market including the fixed income market and the banking system. The banker-broker nexus that earlier was responsible for an unwarranted inflow of bank funds in the capital market resurfaced. It even led to stringent steps being taken by the RBI to restrict the bank funds from entering the capital market. For long, the market appeared in firm grip of bears.

The steps taken by SEBI did not do much to alter the market sentiments. The rolling settlement introduced to replace the age-old *badla* system took quite some time for the market participants, especially speculators and arbitrageurs, to adjust to. Even the Foreign Institutional Investors, the Financial Institutions and Mutual Funds who were supposed to benefit from the measures such as this were not able to do their best due to lack of liquidity. In a bid to lend greater liquidity and make possible wider market participation, SEBI allowed the introduction of new derivatives products. The encouraging fact about the introduction of more derivatives products is that they are capable of providing more business opportunities to various market players. Further, two way fungibility of shares has been permitted recently whereby the depository receipts (DRs), which are either Global Depository Receipts (GDRs) or American Depository Receipts (ADR's), can be converted into underlying (domestic shares) and local shares can be re-converted into DRs. This has thrown open doors for FDI's, FII's and trans-continental arbitrageurs.

It remains to be seen, however, how these measures prove to be effective in course of time. The success of derivatives segment depends on the degree of understanding on part of the various market players and the much needed flexibility in market operations as and when provided by SEBI. The SEBI seems to be considering changes in the derivatives segment, like increasing the number of underlying scrips on which options and futures may be written, resizing the contracts etc. The coming few months only will give a clearer picture of the outcome of all these changes taking place in the market.

TEST YOUR UNDERSTANDING

Mark the following statements as T (True) or F (False).

1. _______ Ahmedabad Stock Exchange was the first exchange to be established in Asia.

2. _______ At the time of independence, there were a total of seven stock exchanges in India.
3. _______ Before 1990, the trading system was open outcry system in which scrips were classified as *specified* and *non-specified.*
4. _______ Specified scrips are those where settlement is compulsorily done with delivery and no carry forward facility is available.
5. _______ The NSE was established on the recommendations of the Pherwani committee.
6. _______ SEBI was established in 1988 after the passing of Securities and Exchange Board of India Act.
7. _______ Inter-Connected Stock Exchange was established as a national exchange in 1998 by various regional stock exchanges.
8. _______ *Badla* was removed from the Indian market and compulsory rolling settlement introduced in July 2001.
9. _______ The NSE is the first computerized exchange of India.
10. _______ All the 23 exchanges in India now use screen-based trading.
11. _______ The minimum base capital of the members of an exchange has to be provided in cash only.
12. _______ Members are allowed to do daily business up to one hundred times of the base minimum and additional cash deposited.
13. _______ A clearing corporation is counter-party to each trade executed on the exchange.
14. _______ The trade guarantee fund is used to give loans to the members if they do not have sufficient funds to meet their obligations.
15. _______ The investor protection fund is used to meet the claims of the investors against defaulting members.
16. _______ The foreign institutional investors have been permitted to invest in India since 1995.
17. _______ Mutual Fund Regulations were issued by SEBI in 1996.
18. _______ The commercial banks are not allowed to act as depository participants.
19. _______ The network of exchanges is now also used for making initial public offers.
20. _______ In the T + 5 rolling system, the funds/securities pay in/out is completed on fifth working day after the transaction day.
21. _______ ALBM stands for automatic borrowing and lending market.
22. _______ ALBM and BLESS, the securities lending schemes, are no longer available.
23. _______ The current market lot size is a single share.

24. _______ The companies are now allowed to price their shares freely.
25. _______ Futures on individual stocks were introduced in India on November 9, 2001.

EXERCISES

1. Give an account of the evolution of stock exchanges in India. At present, how many exchanges does India have?
2. Briefly discuss the role of SEBI in the Indian Capital Market.
3. List the major changes that have taken place in the last decade in the capital market of India.
4. What is rolling settlement? How is it different from weekly/fortnightly settlement prevalent earlier?

CHAPTER

9

Futures and Options in India

As discussed in Chapter 8, the Indian capital market has witnessed impressive growth and qualitative changes, especially over the last two decades. In the fifties, sixties and most of the seventies, it was in a dormant stage when the investors were generally not familiar with, or inclined towards, the corporate securities. During this time, only few companies accessed the capital market. As a consequence, trading volumes were low during these years. However, gradual dilution of the Foreign Exchange and Regulation Act (FERA) towards the close of seventies provided a stimulus to investor interest in the capital market. Particularly since the mid-eighties, the capital market saw an influx of millions of investors, a multiplication of new issues, and a manifold increase in the trading volumes. The process of liberalisation of the Indian economy since the early nineties has further contributed to the changes in the capital market scenario. The entry of foreign investors in the market has resulted in a substantial change in the scale of operations. Now, introduction of trading in derivatives including futures and options has also been made.

In this chapter, we discuss about the introduction and trading of futures and options on the Indian bourses. However, we will first consider analytically the *Badla* system, which has been an integral part of the Indian markets for long, and how does it compare with futures and options. Along with it, we review the form in which options trading has been prevalent in the Indian capital market, prior to the formal introduction of derivatives trading.

THE *BADLA* SYSTEM

The system of forward trading was prevalent in the Indian capital market for decades. It originated as fortnightly clearings, the clearings being meant as "contracts for clearance and settlement through clearing house", under the bye-laws and regulations of the stock exchanges. Such contracts for "clearings" were prohibited in June 1969 by the Government of India vide a notification under Section 16(1) of the Securities Contracts (Regulation) Act, 1956. This led to a dampening of the market sentiments and brought about a sharp reduction in the stock market activities.

In June 1972, the trading for hand delivery contracts (where delivery and payment needed to be made within fourteen days following the date of contract) was divided into two categories. These were called *A Group* and *B Group*. While the contracts in the B Group shares provided for payment and delivery of shares on the specified date, the type of trading evolved in A Group shares was such that it conformed only apparently to the definition of hand delivery contracts. In reality, it was carried forward from one cycle of fourteen days to another, by means of closing the transaction outstanding at the end of the settlement cycle by an opposite transaction, and re-opening the same at the beginning of the next settlement, after suitably adjusting the opening price. This system did help in reviving somewhat activities in the markets but problems relating to orderly settlement of transactions were witnessed due to the lack of adequate checks and balances.

As a result of continuing demands of the market operators, observations and recommendations of the Anjaria Committee (which was set up soon after the ban on forward trading was imposed) and on recommendations of an expert committee, a forward trading system was introduced by the Government of India in July, 1983 in the Bombay, Calcutta, Delhi and Ahmedabad stock exchanges. Under the system, the listed shares were divided into two categories: *specified* and *non-specified*. The system permitted the *carry-forward*, or *badla* trading in specified shares. The underlying principle of the system was simply this that although, strictly, forward trading could not be undertaken, transactions were done on a spot basis, but the settlement was carried forward.

The system was stuffed with a strict schedule of regulatory measures like daily margins, carry-over margins, automatic margins, limits on holdings of individuals, limits on price fluctuations—daily and fortnightly, etc. The system induced liquidity in the stock market, which was largely due to the participation of the retail investor who otherwise had no access to fund the purchases. The *badla* system of trading worked well and led to a stupendous growth of the market in terms of various parameters like the number of investors, number of new issues, market capitalization and turnover.

In 1991, the Ministry of Finance asked the *Society for Capital Market Research and Development* to undertake an expert study of the trading in shares in stock exchanges, one of the terms of reference being to look into the working of the *badla* system in shares and its effect on trading. In terms of the findings of the study, it was observed that typically, only about one-fourth of the outstanding positions at the end of a settlement got settled by actual delivery, while the remaining bulk got carried forward to next settlement. The committee did not seem to be in agreement with the brokers' defence of the system as a provider of liquidity. It felt the carry forward system to be a totally unjustifiable and unhealthy practice in economic terms. The system of *badla* helps speculators, who have neither money to pay nor shares to deliver. In its view, the liquidity provided by speculators, who are not interested in paying and taking delivery on the settlement date, can not be considered as a genuine liquidity. Accordingly, it recommended to do away with the carry forward system.

The *badla* system was banned in December 1993 by the market regulator SEBI, presumably because it led to excessive speculation and/or its misuse. Based on the recommendations of the G.S. Patel committee that SEBI had set up, a new carry forward trading system was introduced in January 1996. However, the system did not find much favour with the broking and investing community because it entailed a number of restrictions.

This carry forward system

(a) put limits on carry forward transactions (i) as a percentage of the total transactions in respect of a broker on any day, (ii) as the amount of such business to be carried forward from one settlement to another, on an overall as well as on each side of the trade (i.e. sales and purchases) basis, and (iii) in terms of the capital adequacy norms.

(b) stipulated stiff margins system incorporating daily margins, and carry forward margins. The carry forward margins were marked-to-market daily, in which gains were withheld and losses collected by the exchange.

(c) prohibited carry forward of transactions beyond 90 days.

(d) required comprehensive reporting of all trades.

Calls were made from time to time for relaxation in the stringent conditions revised carry forward scheme and even a demand was made for reviving the old *badla* system. The re-introduction of the *badla* trading was suggested in some quarters to be the key to the revival of the capital market, having deep faith in the ingenuity of the system which simultaneously facilitates share financing, share lending and carry forward.

Pursuant to the Varma committee appointed by it, SEBI announced in October 1997 some modifications in the carry forward system. While daily margins were reduced on carry forward trades and were done away with, on transactions marked for delivery for members doing carry forward business; sub-limit on scrip-wise carry forward business were dropped; and the limit of such business for brokers was raised. SEBI decided to continue with the twin-track system of reporting transactions and the 90-day limit on the conclusion of all deals, disregarding the recommendations of the committee to scrap these. However, the interest of market participants remained lukewarm in the modified carry forward system. Beginning with early 1998, SEBI introduced rolling settlement on an optional basis. Eventually, the *badla* system was banned in the year 2000 when all shares in the Group A of The Stock Exchange, Mumbai were transferred to *Compulsory Rolling Settlement*.

Badla: Operation and Rationale

We may look in to the *modus operandi* of *badla*. Under the bye-laws of the stock exchanges as they existed when *badla* was in force, a contract in specified shares could be for

(a) spot delivery (where the delivery and payment are effected on the same, or the next, day as the date of contract); or

(b) for hand delivery (in which the delivery and payment are effected up to or on the date stipulated while entering in the contract, or within fourteen days, whichever is shorter); or

(c) for special delivery (wherein, subject to the approval of the exchange, the delivery and payment may be effected within any time exceeding fourteen days following the date of the contract as may be agreed upon when entering into the contract); or

(d) for the settlement.

Unless otherwise stipulated when entering into the contract, a contract is deemed to be for the current settlement.

A contract entered into for the current settlement may be performed by way of delivery; offsetting or by carrying forward.

Delivery Delivery against a sale contract may be given (and delivery against a purchase contract received), and the payment made at the rate contracted upon.

Offsetting A purchase contract may be offset by a sale contract, and *vice versa*, during the settlement period and the difference in prices settled.

Carry Forward A contract, in respect of which neither the delivery is given (or taken) and nor is it off-set by an opposite transaction during a settlement period, may be carried forward to the next settlement period at the making-up price (which is usually the closing price on the last trading day) and the difference between the contract rate and the making-up price be settled.

At the end of a settlement, all the transactions for each broker are clubbed together and each broker's net position is worked out for that settlement. The broker then decides in consultation with his clients whether they would accept/give delivery of the shares and pay/receive money in full for the same, would carry forward the sale/purchase. Thus, outstanding positions at the end of a settlement may be categorised as (i) the sellers who want, and those who do not want, to give deliveries, and (ii) the buyers who want, and those who do not want, to take deliveries.

Now, if a buyer does not want to take delivery and desires to carry forward a transaction from current settlement to the next settlement period, he usually has to pay the contango charge or the *badla* to the seller. It is a consideration for acquiring, by the buyer, of the rights (like dividends etc.) and obligations in the shares. A buyer is not obliged to carry forward, and if he does so, he does it out of his own willingness and desire. Thus, as some of the buyers do not want to take delivery, in case the quantum of delivery sales exceeds the quantum of delivery purchases, the financiers known as *vyaj badla wala* emerge. They take delivery in the current settlement from the seller giving the delivery and give the delivery in the next settlement to the buyers carrying forward the transaction, receiving the difference between the settlement rate and the sale rates for the next settlement as interest charges. This is termed as *seedha badla* and the transaction is known as *vyaj badla* or *mandi badla*.

However, the reverse can also happen. If the quantum of purchases by buyers wanting to take delivery exceeds the quantum of sales of sellers desiring to deliver, that is to say when there is excessive short selling, share financiers known as *teji badla wala* come on the scene. They give delivery in the current settlement to the buyers at the settlement rate and take back delivery in the next settlement from the seller at lower sale rates, receiving the difference between the two rates as charges for lending such shares. This is known as backwardation or *ulta* or *undha badla* and the transaction is known as *mal badla* or *teji badla*.

The badla charges for carrying forward the transactions are determined by the inter-play of the market forces in a half-hour session at the end of the current settlement period and at the beginning of next settlement, known as *badla session*. These charges, which vary in the half-hour *badla* session between scrips and also for the same scrip, depend upon various factors like prevailing interest rates, technical position of the market, etc.

It may be reiterated that buyers/sellers are not obliged to engage in the carry forward operation and if they do so, they do it on their own volition. If a buyer insists on delivery and the seller does not have the shares, the stock exchange authorities automatically move in and effect the auction at the cost and risk of the defaulting seller. The defaulting seller would then be called upon to pay the difference between the contracted price and the price at which the shares are bought in the auction.

Similarly, if a seller insists on delivery, and the buyer shows no desire for the delivery of shares, the stock exchange authorities auction the shares at the cost and risk of the defaulting buyer. Such a buyer is then required to pay the difference between the contract price and the price at which the shares are sold in the auction.

The rationale for providing the *badla* facility to carry forward transactions from one settlement period of two weeks to another is that it imparts liquidity and breadth to the market. This allows the absorption of large purchases and sales in relatively narrow fluctuations in prices, leading to stability in the market. The carry forward system provides the investor an opportunity to enhance his position significantly as it is only a fraction of total amount which is needed for the carrying forward of the position. Thus, *badla* is seen to contribute substantially towards liquidity, forecasting of the future market behaviour and reasonable level of speculation, which are essential ingredients for an efficient functioning of the secondary capital market.

In the absence of such a facility, all purchases would be required to be taken delivery of, with the payments being in respect of the same and, similarly, all sales outstanding at the end of the settlement have to result in delivery with respect to the consideration amount. Such a situation would lead to an illiquid and narrow market characterized by sharp oscillations in prices. This is reflected in the fact that the movement of prices in the specified group is relatively more orderly than in case of the non-specified shares.

Badla versus Options and Futures

From our discussion about *badla*, and the futures and options, it may be observed that:

1. In *badla*, all net positions at the end of the settlement period can be carried forward and members pay or receive *badla* charges. On the other hand, in futures and options, various combinations are available which enable the operator to close or re-close the open position till the maturity period, and carrying forward the open position to the next maturity period is neither necessary nor possible.

2. *Badla* is basically a financing mechanism. *Badla* financiers provide finance to the members with net bought positions. Usually, bulls pay the *badla* charges to short sellers. On the other hand, no such financing mechanism exists in futures and options. In case of options, the right to perform the contract lies with the holder, while in the futures contracts, both the parties are to perform.

3. *Badla* system encourages short sellers as they generally get *badla* charges. However, both bulls and bears have an equal opportunity to trade in case of options and futures. Buying or selling is directly controlled, which keeps the market healthy.

Now, a comparison of *badla* on the one hand, and options and futures on the other, may be made by assessing their relative utility as a hedging instrument and as a contributor to the generation of liquidity.

A good hedging instrument is one that provides the hedger a full or nearly full protection against the risk of adverse price fluctuations. The efficacy of futures contracts has already been discussed in Chapters 2 and 3. It may be recalled that futures contracts are available on the stock indices and on individual stocks (though only in some markets in the world). The effectiveness of the stock index futures as a hedging device is dependent upon the relationship between the prices of the stocks in the portfolio held, or proposed to be held, and the stock index. For a perfect hedge, it is required that the two move in tandem with each other. Since this does not usually happen, futures do not provide a perfect hedge. In an attempt to devise appropriate hedging policies, beta factors of the concerned shares, by relating variations in their returns to the variations in the stock index values are calculated. However, the values of beta factors obtained from historical data may not be valid for future hedging. Similarly, other factors, like transaction costs, margin deposits, price limits etc. also serve as deterrents to allow futures to act as a perfect hedge. Futures on individual stocks, on the other hand, provide a convenient and effective means of hedging.

On the other hand, the options route to hedging is an effective one since it allows the hedger take advantage of the favourable price changes and ignore the unfavourable ones. However, hedging using options contracts is a costly affair. Besides transaction costs, it also involves a premium to be paid. As seen previously, other things remaining the same, the premium is higher for higher exercise price and lower for lower exercise price in respect of put options, and higher for lower exercise price and lower for higher exercise price in case of call options.

As a hedging instrument, *badla* ranks very high on the scale. While the effectiveness of futures contracts to act as a suitable hedging instrument hinges upon the degree of correlation between the spot and futures prices, there is nothing of this sort in case of *badla* as the quotation for all types of transactions—delivery, offsetting and carry forward—is the same. Also, *badla* does not require payment of any premium. The payment of *badla* charges by the buyer to the seller is virtually by way of interest for the shares bought by him, but he has chosen not to pay the amount and to carry forward the transaction to the next settlement.

With regard to liquidity, it may be observed that all the three of them add liquidity to the market. Futures do contribute to the liquidity but the opinion is not uniform on the impact it has on the volatility.

On the impact of options on trading in shares, studies reveal that generally, the turnover of those shares on which options are written, increases. Again, it is not established whether the increase in turnover leads to a decline in the volatility. However, it is widely accepted that options do stimulate undesirable speculation.

The degree of liquidity in a share with *badla* facility is much higher than that in a share which does not have this facility. The system of *badla* has the merit of providing liquidity with narrow spreads between *buy* and *sell* quotes. The increase in liquidity is also accompanied by a lower volatility.

In this context, it may be observed that the *badla* system is not free from weaknesses, especially as it leads to speculation, many a time. Unhealthy speculation has led to payment problems that were many a times followed by the closure of the markets.

Also, *badla* makes questionable the integrity of contracts made on the floor of the exchange when both the parties are not in a position to fulfil their part of the contract.

However, the weaknesses of the *badla* system should not be viewed in isolation, but instead, should be considered in the overall context, since not all speculation is bad. In a broad sense, human activities are accompanied by speculation of one kind or another and as such, speculation *per se* is neither avoidable nor undesirable. But unfortunately, the term speculation has usually come to acquire a derogatory connotation in the Indian Capital Market. What needs to be emphasised in this context is that all speculation should not be viewed the same way and *normal* (or *healthy* or *desirable*) speculation should be distinguished from *unhealthy* or *undesirable* speculation.

Speculation is positively correlated with risk. Thus, greater speculation increases risk but their relationship is not linear or proportionate. To some extent, greater speculation leads to higher risk but the increase is only marginal. Beyond this level, an increase in speculation is accompanied by a disproportionately higher increase in risk. Similarly, speculation has the positive effect of providing liquidity, though not always. In fact, within desirable limits, an increase in speculation leads to more liquidity but once this level is exceeded, greater degrees of speculation produce certain undesirable effects and causes liquidity levels to drop to low levels.

OPTIONS IN INDIA IN THE PAST: *TEJI* AND *MANDI*

The concept of derivatives and their trading in India is not entirely new to the capital market. However, the trading has been of a limited type and on a limited scale, since it was not enforceable by law. There were two legal hurdles: one, the Securities and Contracts Regulations Act did not recognise "index" as a security (thus preventing any type of contracts with an index as the underlying), and two, the Indian Contract Act which prohibits settling of a contract in the form of differentials (being a wagering contract).

Before looking into the introduction of the derivatives trading in the Indian market, after having cleared the legal barriers, we examine the nature of trading which has been prevalent in the past. In fact, according to market sources, options trading has been in vogue in places like Ahmedabad, Mumbai, Kolkata and Delhi for long. However, the nature and extent of operations have been, expectedly, rather limited since it has had no legal sanction and is exposed to the risks associated with an illegal business. Also, there is no question of a regulated market for such products and there is a lack of guarantee of performance of the contracts. The limited mutual faith among the parties involved in such contracts also has the effect that the time period for squaring the transactions is very short in comparison to the normal life span of the options in the legalized, regulated markets.

The operations in the Indian market have been confined to call options (known as *teji*), put options (known as *mandi*), their combination in the form of straddles (known as *jhota* or *du-ranga*) and *bhav-bhav* on stocks only. While in options trading markets in the world, options with exercise prices less than, equal to, or greater than the stock price are available (so that the call options are accordingly labelled as *in-the-money*, *at-the-money*, or *out-of-money*), in the Indian markets only out-of-the-money call options, i.e., options with an exercise price higher than the current stock price, are traded. Hence the name *teji*. The seller or the writer of such an option is called *teji khaii-wal* as he/she agrees to sell the share in case of '*teji*' (the price rising above the exercise price) for a value, the option premium. The buyer of the option is called *teji lagaii-wal*.

Similarly, the put options traded are also those which are out-of-the-money options, i.e., options with an exercise price lower than the current stock price. The writers of such options agree to buy a share in the event of its price falling below the exercise price, i.e., *mandi*, in consideration for a premium. The writer of an option of this type is called the *mandi khaii-wal* while the buyer is a *mandi lagaii-wal*.

Both *teji* and *mandi* usually have the expiry time at the stroke of 15 minutes before the closing time of trading of the next business day. However, sometimes they are *event-based*, so that while they can originate any day but the exercise date is fixed, like the day following the budget day or the day following the annual general meeting of the company whose share underlies the *teji/mandi* contract. The premium on *teji/mandi* options is fixed customarily, usually at 25 paise per share, and is not negotiable, although the strike price may be negotiated. On event-based options, the premium payable is double than that on the ordinary options.

The greater part of the derivative trading in India is in the form of jhota or fatak, which involves the buyer, known variously as *lagaii-wal* or *lagane-wala* or *punter*, the writer, known by various names like *khaii-wall*, *khane-wala* or *bookie*, and a broker, the mediator. A *fatak* involves a call option and a put option available to the *punter* at exercise prices higher and lower than a certain value, which is generally the closing pice of a share on a given day. The size of *fatak*, that is to say, the gap between the exercise prices of call and put options is generally higher before and after the market trading hours and it is smaller during these hours.

To understand *fatak*, suppose a share closes at Rs 66 on a given day. A bookie on such a share would agree to give a punter the right to buy from him (the bookie) the share at, say, Rs 69, or sell to him (the bookie) the share at a rate of Rs 63. Thus, with the share price of Rs 66, the bookie creates a *fatak* (a gate) for his safety between the prices of Rs 63 and Rs 69, and makes himself liable only when the share price plummets below Rs 63 or rises beyond Rs 69. The writer of a *fatak* obviously perceives that the market shall move within the two limits, between Rs 63 and Rs 69 in our example. Due to a two-sided risk, the premium on a *fatak* is typically double the premium on *teji* or *mandi* options.

It may be noted that most of the traders trading in such market are intra-day of intra-settlement players and not long-duration investors. They tend to move 'with the market' and their prime strategy is to remain with the market. Accordingly, most of the traders take positions in keeping with the market prices with an allowance for some variations. It accounts for the fact that between 50 and 60 per cent of the trades in derivatives in the market are in the form of *fatak* trades while about 30–40 per cent are accounted for by *teji* and *mandi* transactions.

Another derivative traded in the market is known as *bhav-bhav* or *nazrana*. In this case, the closing price of the day is taken as the exercise price and the holder of *nazrana* can exercise a call or put option depending on the price of the stock. For instance, if the closing price of a stock is Rs 66 on a given day, then the holder shall hold both options with him: buy the share from the bookie at a price of Rs 66 or sell to him the share at the same price (Rs 66) at the time of exercise. It will obviously pay the option buyer to buy at Rs 66 if the share price goes beyond this level and sell it to the writer at Rs 66 if the share price decreases below Rs 66.

In *nazrana*, then, the exercise price is fixed and so is the date of expiry. However, the premium is negotiable. The premium is roughly one-half of the amount of gap in *fatak*. Thus, with the share price of Rs 66 and a *fatak* with exercise prices of Rs 63 and Rs 69, the gap (on either side) is equal to Rs 3. In such a case, the premium payable by a buyer shall be around Rs 1.50 per share.

The *nazrana* apparently exposes the writer to a greater risk by providing call and put options to the buyer at the same exercise price, in contrast to a fatak where the same options are given but with a gap in the exercise prices. However, a closer look at the two reveals that for a given amount of premium, one has to write options on a larger number of shares in case of a *fatak* than in case of *nazrana*. Accordingly, when there are significant fluctuations in the price of the underlying share, a *fatak* involves a far greater degree of risk than a *nazrana*. To illustrate, consider the following information:

Closing price of the *XYZ* share = Rs 66

Fatak exercise prices:

Put option (*mandi*) = Rs 63

Call option (*teji*) = Rs 69

Nazrana, or *bhav-bhav* exercise price = Rs 66

Premium per share:

Fatak	Re 0.50
Nazrana	Rs 1.50

Premium desired by the bookie = Rs 600

Accordingly,

$$\text{Number of shares involved in a } \textit{fatak} \text{ contract} = \frac{600}{0.50} = 1200$$

$$\text{Number of shares involved in a } \textit{nazrana} \text{ contract} = \frac{600}{1.50} = 400$$

The profit/loss profile for the bookie for some selected share prices is contained in Table 9.1.

Table 9.1

Profit/Loss for Some Selected Share Values

Share Price	*Profit/Loss to Writer*	
	Fatak	*Nazrana*
60	– 3000	– 1800
61	– 1800	– 1400
62	– 600	– 1000
63	600	– 600
64	600	– 200
65	600	200
66	600	600
67	600	200
68	600	– 200
69	600	– 600
70	– 600	– 1000
71	– 1800	– 1400
72	– 3000	– 1800

The calculation of profit/loss for each of the two contracts is done on the following basis. Let,

E_0 = exercise price of *nazrana*

E_1 = exercise price for put option in *fatak*

E_2 = exercise price for call option in *fatak*

P = premium desired

S = share price on expiry of option

N = number of shares

Accordingly, E_0 = Rs 66, E_1 = Rs 63, E_2 = Rs 69, P = Rs 600, $N = 400$ for *nazrana* and $N = 1200$ for *fatak*.

1. For Fatak The profit/loss may be obtained as follows:

$$\text{Profit/Loss} = P + (S - E_1)N \quad \text{for } S < E_1$$

$$\text{Profit/Loss} = P \quad \text{for } E_2 \geq S \geq E_1$$

$$\text{Profit/Loss} = P + (E_2 - S)N \quad \text{for } S > S_2$$

For example, when $S = 60$, we have

$$\text{Profit/Loss} = 600 + (60 - 63) \times 1200 = -3000$$

Similarly, for $S = 62.5$,

$$\text{Profit/Loss} = 600 + (62.5 - 63) \times 1200 = 00, \text{ and}$$

for $S = 70$, we get

$$\text{Profit/Loss} = 600 + (69 - 70) \times 1200 = -600.$$

2. Nazrana The profit function for the writer is:

$$\text{Profit/Loss} = P + (S - E_0)N \text{ for } S < E_0$$

$$\text{Profit/Loss} = P \quad \text{for } S = E_0$$

$$\text{Profit/Loss} = P + (E_0 - S)N \text{ for } S > E_0$$

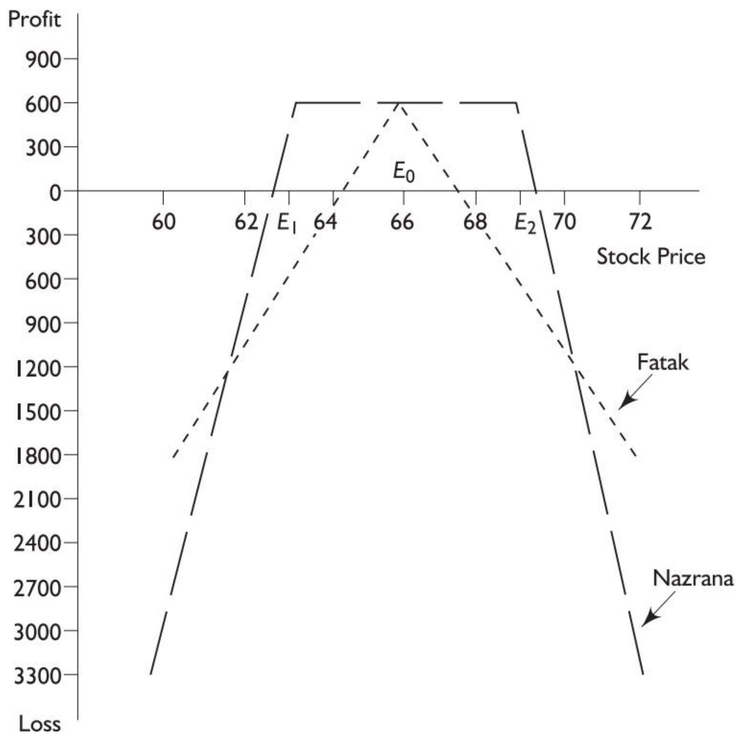
Thus, when $S = 61$, we have

$$\text{Profit/Loss} = 600 + (61 - 66) \times 400 = -1400, \text{ and}$$

when $S = 68$,

$$\text{Profit/Loss} = 600 + (66 - 68) \times 400 = -200.$$

The profit/loss functions for both contracts are shown in Fig. 9.1. From the figure, it is evident that the *fatak* is better than *nazrana* in the price range of Rs 61.5 to Rs 70.5. Beyond these limits on either side, fatak results in greater losses for a given change in the share price. In fact, for every rupee decline in price below Rs 61.50 (or for each rupee increase in price above Rs 71.50), *fatak* involves a greater loss of Rs 800. For instance, when stock price is Rs 60, the loss in *fatak* shall be $(61.50 - 60) \times 800$ = Rs 1200 more than the loss in the *nazrana* contract. This is clear from the figure as the amount of losses in *fatak* and *Nazrana* are Rs 3000 and Rs 1800 respectively when the share price is Rs 60.



➢ **Fig. 9.1** *Fatak vs Nazrana*

One-sided Nazrana As mentioned earlier, a *nazrana* gives both a call and a put option to the buyer, and hence is two-sided in nature. However, in some cases, the buyer is given only a call option or a put option, thus making it only one-sided in nature.

In the context of the Indian market, the various derivatives are very attractive due to the involvement of cash settlements and that too virtually on the daily basis. However, if these derivatives, particularly *fatak* and *nazrana* (one-sided or the common two-sided), are written without having positions in the underlying stock, they may eventually prove very dear. It is a common saying in the market circles that these transactions (in derivatives) make 'pockets full and vaults empty'.

INTRODUCTION OF FUTURES AND OPTIONS IN INDIA

India is one of the many emerging markets of the world where derivatives have been introduced in the recent past. For long, exchanges like The Stock Exchange, Mumbai and Vadodara Stock Exchange showed their willingness in introducing trading in futures and options. However, a concerted effort in this direction was made by the National Stock Exchange (NSE) in July, 1995 when it considered the modalities of introducing derivatives trading, mainly futures and options. Within a few months, NSE developed a system of options and futures trading aiming at modifying the carry forward system to include options and futures in its scope. By January 1996, the NSE started work on the scheme of such trading. In March 1996, it made a presentation to SEBI on its plans to commence trading in futures and options. The exchange proposed to start with index based futures and index based options, which are seen as comparatively safer forms of derivatives.

While the exchanges were willing for derivatives trading, opinions differed widely about the advisability of their introduction. It was largely felt that derivatives are important for an emerging country like India essentially for the same reasons as they are for all securities markets. They work as instruments of risk management and tools for market development and serve to enhance market efficiency basically in areas of risk transfer and price discovery. The derivatives allow shifting of risk from one who does not want it to one who wants to take it and in the absence of them, people have to suffer risk without much choice. The lack of derivatives leaves much to be desired for the hedging purpose i.e. transfer of risk. Further, international experience suggests that introduction of a successful index derivative and options on equity are accompanied by a substantial improvement in the market quality of the underlying equity market. The improved market efficiency implies that the market prices of securities become more informative. Besides, options also allow one to guage the market's perception of volatility of the underlying security. Knowledge about volatility and its forecast is helpful in investment and other decisions. Also, as discussed earlier, derivatives markets permit price discovery particularly where the underlying product has a decentralized cash market. In fact, once futures markets come into existence, a certain de-linking of the roles in cash and futures markets is witnessed. Whereas the relatively non-speculative orders come to the cash market, the futures market absorbs the effects of any news first and enables price discovery, which in turn is transmitted to the cash market through arbitrageurs. Further, availability of tradable index futures enables one to take positions on indices at a low transaction cost which, in the absence of such markets, is possible only at relatively very high cost because positions are required to be taken on the securities which underlie such indices.

Those who were positive about the introduction of such trading in India were confident that the investors could learn the complexities and intricacies of the derivatives fast. It was felt that the knowledge of the market players of *teji* and *mandi* would enable them to grasp the concepts of futures and options. Some others observed that although the concepts of *badla*, and futures and options are not strictly comparable, they both serve the basic function of trading on margins based upon the price movements of the underlying securities and that of adding to the market liquidity. With the market operators well-versed with the *badla* concept, they believed that the Indian market can have all the three instruments concurrently.

On the other hand, many people felt otherwise. According to them, there are a number of problems and issues which hamper the development of exchange-traded derivatives markets, including market failures, scandals, inadequate infrastructure, lack of properly designed derivative products, shortage of domestic technical expertise and so on. Also, there was a fear that in India, like in other emerging markets, that the foreign firms might be more sophisticated and hence dominate the market at the cost of local participants, or that some unscrupulous foreign players may take undue advantages. Apprehensions were expressed in some quarters over the presence of an adequate number of players who could bear with ease the unlimited risk that option writers are exposed to, and the feeling that the derivative products were probably too sophisticated for the Indian market. The Nick Leeson episode seemed to be hovering in the minds of some others who labelled the derivative products to be even 'dangerous'. Further, infrastructural and other requirements for developing such markets for setting up of futures and options trading outlined below were believed not in place.

(i) Creation of an Options Clearing Corporation (OCC) as the single guarantor of every exchange-traded option. In case of a default by a party to a contract, the clearinghouse has to bear the costs necessary to carry out the contract.

(ii) Creation of strong cash market (secondary market). This is because after the exercise of an options contract, the investors move to the secondary market to book profits.

(iii) Creation of paper-less trading and a book-entry transfer system.

(iv) Careful selection of the securities to be traded on the options exchange. These securities may be listed on a national securities exchange, have a wider capital base, be actively traded and so on.

(v) Uniformity of rules and regulations in all the stock exchanges.

(vi) Standardization of the terms governing the options contracts. This would decrease the transaction costs.

For a given underlying security, all contracts on the Options exchange should have an expiry date, a strike price, and a contract price, only the premium should be negotiated on the floor of the exchange.

(vii) Large, financially sound institutions, members and a number of market makers, who can write the options contracts. Strict capital adequacy norms to be laid, and followed.

Besides, a study undertaken in 1996, titled *The Feasibility of the Establishment of a Derivatives Exchange in India*, by Dr. William J. Barclay, Director International Business Development of Chicago Board of Options Exchange (CBOE), pointed out that India had to go a long way before derivatives trading could be introduced. According to him, at a consertative estimate, the minimum time period before the derivatives trading could be introduced in India a year-and-a-half hence, by the close of 1997.

Indeed, concerted efforts are required for developing derivatives markets. The exchanges, the regulators and other participants in developing countries face a common problem as to how to develop a derivatives market that fulfils the useful market functions but where the risks of abuse and scandals are minimised. Setting up of such markets is not an easy proposition. There are usually conflicting viewpoints. This is because while on the one hand the exchanges and market participants usually seek new business opportunities and are keen to develop new products, the governments and regulators, on the other, normally do not let the things happen too fast for the fear of introducing new risks into the market without adequate controls.

Efforts began in the direction of exploring the possibility of developing a derivatives market in India. A number of steps were taken including the setting up of the National Securities Clearing Corporation Limited (NSCCL) and the National Securities Depositories Limited (NSDL) etc. The Securities and Exchange Board of India, in the mean time, set up a committee under the chairmanship of Prof L.C. Gupta, to go into the question of derivatives trading and suggest the vartious policy and regulatory measures that need to be undertaken before such trading is formally allowed. In the meantime, it set up a special derivatives regulatory department that would coordinate and ensure the sharing of accounting information between stock exchanges.

L. C. Gupta Committee on Derivatives

The committee was set up in November 1996 in order to develop appropriate regulatory framework for derivatives trading in India. The committee's concern was with financial derivatives in general and equity derivatives in particular.

The main recommendations of the committee are given below:

1. The committee strongly favoured the introduction of financial derivatives trading in order to provide the much-needed facility of hedging to the general as well as institutional investors in the most cost-efficient way. It also recognised the importance of speculators in the market to act as counter parties to hedgers. Thus, it was recognised that in order to have a sound market, both hedgers and speculators should be present in good numbers.

2. Since there are inter-connections among various types of financial derivatives, the committee recognised the need for equity derivatives, interest rate derivatives and currency derivatives. In the case of equity derivatives, the committee felt the need to introduce both futures and options contracts in accordance with the needs of market forces. Any of such contracts, the committee laid, should be launched as per the market needs and under the general oversight of SEBI. The committee held that it would be best to make a beginning with the introduction of stock index futures.

3. The committee favaoured a phased introduction of equity derivatives so as to make sure that the market first gets to understand the use of simpler variants of equity derivatives before the more complex forms of contracts are introduced in the market. This was to avoid all unnecessary confusion over the use of the equity-derivatives

contracts and to increase the acceptability of all the contracts to be used. It was considered desirable from the regulatory angle as well.

4. The committee recommended a two-level regulatory framework for derivatives trading in the form of *exchange level* and *SEBI level* regulatory framework. The committee's main emphasis was on ensuring an effective exchange level regulation framework by ensuring that all the exchanges providing derivatives contracts should be functioning as self-regulatory organisations under constant supervision of SEBI.

5. As per the committee's recommendations, SEBI should take care of the overall governance and guidance by playing the part of the overall supervisor of all the exchanges providing trading facilities in the derivatives segment. It is thus, essential for SEBI to continuously review the overall working of the various concerned exchanges and strengthen their working as and when needed. The committee held that the overall governance system of the exchanges as well as SEBI should be much stricter than the one prevailing in the capital market segment. This means that the committee has asked for steps such as better surveillance facilities on the regulator's end, better margin emphasising and collection systems on the exchange's end, better net worth requirements for the participating brokers etc.

6. The committee provided very clear and specific entry requirements in the derivatives segment for all brokers/dealers stating that the existing members of the stock exchanges (capital market segment) will not be made members of the derivatives segment automatically. The preconditions of taking membership in the derivatives segment have both capital adequacy and knowledge requirements. As per these requirements, every broker/dealer needs to have a net worth of at least Rs. 300 Lac and a minimum deposit of Rs. 50 Lac has to be maintained with the exchange at all times. On the knowledge requirements part, it is essential for all the brokers/dealers and their authorized sales persons to pass a SEBI recognized certification requirement.

7. In the committee's view, many of SEBI's important requirements relating to exchanges, brokers/dealers, prevention of fraud, investor protection etc. are of general and over riding nature and hence, these should be reviewed in detail in order to be applicable to the derivative exchanges and their members.

8. The committee also recommended removing the existing regulatory prohibition on the use of derivatives by mutual funds, as

they are one of the major providers of liquidity to the market. However, the committee made it clear that any such use of derivatives contract by the MFs should be only for hedging and portfolio balancing and not for speculation. The responsibility for proper control in this regard should be of the Trustees of the Mutual Funds. In this respect, the committee did favour the idea of framing of detailed SEBI regulations for controlling the involvement of the MFs in derivatives as it may come in the way of the desired flexibility and development of ideas. Thus, the committee advised that the involvement of MFs should be kept under minimum possible checks so as to allow them to play their part (hedger) freely. This would help in increasing the liquidity of the derivatives contracts tremendously.

9. The committee felt that the introduction of equity derivatives is going to increase the responsibility of SEBI many folds as these derivative contracts have the equity cash market as their underlying which themselves are in need of constant regulation and improvement. The equity cash market and the equity derivatives market are both parts of the same mechanism and their development can only be mutual. The committee has advised SEBI to take all possible care to introduce derivatives, which can have a competitive and healthy cash market for an underlying.

10. It further recommended that SEBI create a Derivatives Cell, a Derivatives Advisory Committee and Economic Research Wing. It would need to develop competence among its personnel in order to be able to guide this new development along sound lines. The committee has proposed a SEBI-RBI coordination mechanism in order to keep the problems related to overlapping jurisdictions (say between Money markets and Equity markets) at bay. The idea here is to help in controlling the various related financial derivatives markets.

11. The committee recommended the Govt. of India to take the required legal action in order to enable the use of stock index derivatives by expanding the definition of 'securities' under section 2 (h) (iia) of the Securities Contract Regulation Act, 1956, by declaring derivatives contracts based on index prices and other derivatives securities to be securities. The committee also recommended that the notification issued by the Central Govt. in June 1969, under Section 16 of the Securities Contract Regulation Act, be amended so as to enable trading in futures and options contracts.

BEGINNING OF DERIVATIVES TRADING AND THEREAFTER

Pursuant to the L.C. Gupta committee report, the exchange-traded derivatives were introduced in the Indian capital market in June 2000, beginning with stock index futures contracts. Both NSE and BSE started the trading in NIFTY futures and SENSEX futures contracts respectively, almost simultaneously. As expected, market interest in these contracts was very limited initially. No previous trading experience in derivative instruments, lack of knowledge and awareness about derivatives amongst most of the market participants and the relatively tough rules framed by the market regulator kept most of the market traders away from the derivatives market, resulting in very low volumes of trading. SEBI's thinking about introducing index futures as the first exchange-traded derivative instrument in India was that perhaps this instrument was easier to understand and regulate. Also, index futures were viewed as useful instruments of hedging and something that the small investors could also use to safeguard their interests. Internationally as well, index futures are among the most popular derivative instruments.

In India, however, relatively tight regulations such as minimum trade lot size limit of Rs. 2 lakh per contract and lack of sufficient understanding kept most of the market players uninterested in these dynamic instruments of trading. SEBI's intended segment of small retail investors was not in a position to participate in such expensive contracts. Another factor that kept the initial growth of derivatives a low-key affair was the booming stock market. The ever-increasing prices of shares kept the attention of big market players focused on the cash market only. Also, the market players were used to the then prevalent weekly settlement cycles and use of official deferral products such as ALBM and BLESS (which themselves were modified forms of the age old *Badla*). They were not keen to adapt to the more modern and dynamic instruments and systems like derivatives and rolling settlements, of which they had no understanding.

Following a global meltdown in the technology-sector shares, the bull-run in the Indian stock markets that started in 1999, met its end in March 2001. As a result, the Indian Capital market moved into a very depressed state. In less than a year, the face of the market changed beyond recognition as *badla* finally met its dead end and weekly settlements gave way to rolling settlements. A positive result of all these developments was that derivatives finally started growing rapidly. SEBI also started putting emphasis on introducing more exchange traded derivative instruments.

The stock market scam that came to light in the month of March 2001 was a significant contributing factor for several significant changes such as end of the *badla* system and the introduction of rolling settlement on July 2, 2001. Also, the broker-banker nexus which earlier also had been responsible for unwarranted inflows of bank funds into the capital market resurfaced. In fact, it hurt both the capital market as well as the banking system so badly that RBI was forced to take stringent steps to restrict and channelise the bank funds from entering the stock market.

With the exit of *badla* and the introduction of rolling settlement, initially the markets were practically dried of funds and liquidity as speculators and arbitrageurs were finding it difficult to sustain in the market without a proper deferral product. Also, the Foreign Institutional Investors, the Financial Institutions and Mutual Funds who were supposed to benefit from measures such as the introduction of rolling settlement were initially not able to do their best due to severe lack of liquidity in the market.

Many market players accused SEBI of not regulating the markets in the most efficient manner and taking many harsh decisions, such as banning the *badla* and cancellation of several brokers' trading licenses etc, that were affecting the market's health adversely. It was felt that if things kept going the way they had been, the Indian capital market would no longer remain as 'healthy'. Fortunately, SEBI took the decision of introducing more derivative instruments in the market: stock index options and options on individual stocks. Such options were introduced in July, 2001 on a total of 31 stocks to provide more instruments for market players and attempt to increase overall liquidity in the capital market. However, these derivative instruments have shown only limited growth due to limited participation of market players owing to their own lack of understanding as well as due to the rigid rules framed by the market regulator in this regard.

However, trading got a fillip once SEBI introduced, in November 2001, futures on the same 31 individual stocks in which stock options were being traded. As stock futures possess shades of *badla*, *market* participants welcomed their introduction with open arms. Their trading opened gates for new business opportunities. In fact, within days of their inception, they surpassed trading in other derivative products available. They have done well not only in the context of Indian derivatives market but also in terms of global trading of such contracts. To illustrate, since its inception on November 9, 2001, the average daily volume of stock futures on individual stock futures on NSE (which dominates this type of trading in India) witnessed more than 11 thousand contracts during November, 2001 and was on a continuous rise. This works out to be second only to Spain, having surpassed London International Financial Futures and Options Exchange (LIFFE). To illustrate, the average daily number of contracts traded in November 2001 on exchanges where futures on individual stocks are available is given in Table 9.2.

Table 9.2

Average Number of Contracts Traded per Day in Nov 2001

Exchange	*No. of Contracts*
Spain (MEFF)	56,430
India (NSE)	11,135(*)
London (LIFFE)	10,370
Sweden (OMM)	6,970
Hong Kong (HKFE)	81
Sydney (SFE)	45
Amsterdam (AEX)	30
South Africa (SAFEX)	25
Canada (MONTREAL)	None

(*) Average daily volume till date since start on Nov 9, 2001.

Source: *Economic Times*, December 17, 2001

The trading in stock options and futures on the NSE since their inception is given in Table 9.3.

The data given in Table 9.3 are presented in Figs. 9.2, 9.3 and 9.4. The data on stock options are presented in Figs. 9.2 and 9.3. The average daily volumes of stock options are nearly Rs. 250 crore. Similarly, the growth of individual stock futures on NSE is indicated in Fig. 9.4.

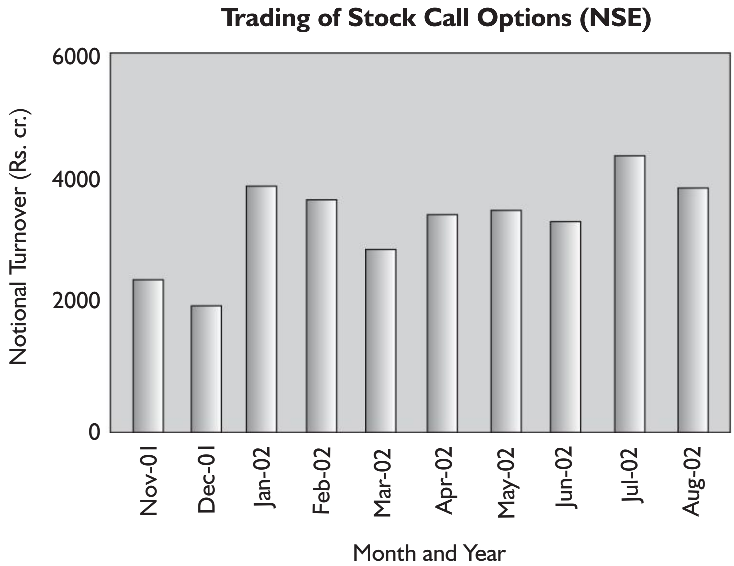
It may be noted that the average daily sales volume of stock futures works out to be above Rs 800 crore per day. This means it is the largest traded derivative product in the Indian capital market and, in that sense, the most successful derivative instrument.

Table 9.3

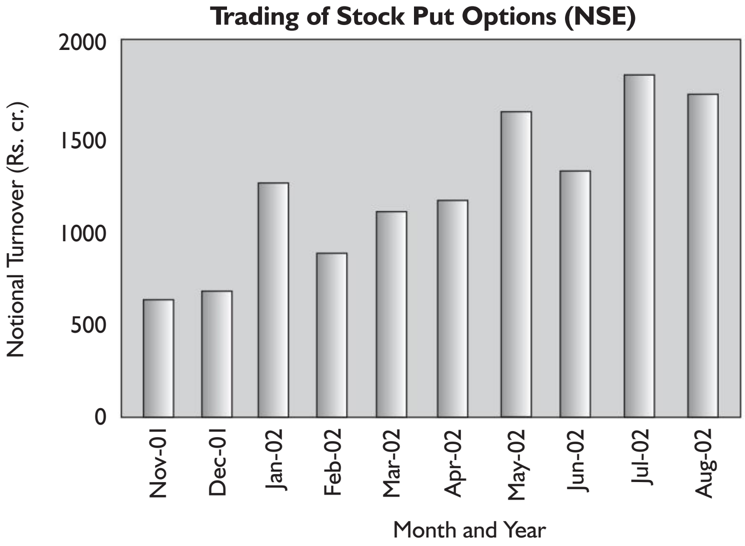
Growth of Stock Options and Futures Trading (NSE)

Month and Year	*Stock Futures*		*Stock Call Options*		*Stock Put Options*	
	No. of Contracts	*Turnover (Rs. Cr.)*	*No. of Contracts*	*Notional Turnover (Rs. Cr.)**	*No. of Contracts*	*Notional Turnover (Rs. Cr.)**
Jul-01			13082	290	4746	106
Aug-01			38971	844	12508	263
Sep-01			64344	1322	33480	690
Oct-01			85844	1632	43787	801
Nov-01	125946	2811	112499	2372	31484	638
Dec-01	309755	7515	84134	1986	28425	674
Jan-02	489793	13261	133947	3836	44498	1253
Feb-02	528947	13939	133630	3635	33055	864
Mar-02	503415	13989	101708	2863	37387	1094
Apr-02	552727	15065	121225	3400	40443	1107
May-02	605284	15981	126867	3490	57984	1643
Jun-02	616461	16178	123493	3325	48919	1317
Jul-02	789290	21205	154089	4341	65530	1837
Aug-02	726310	17881	147646	3837	65630	1725

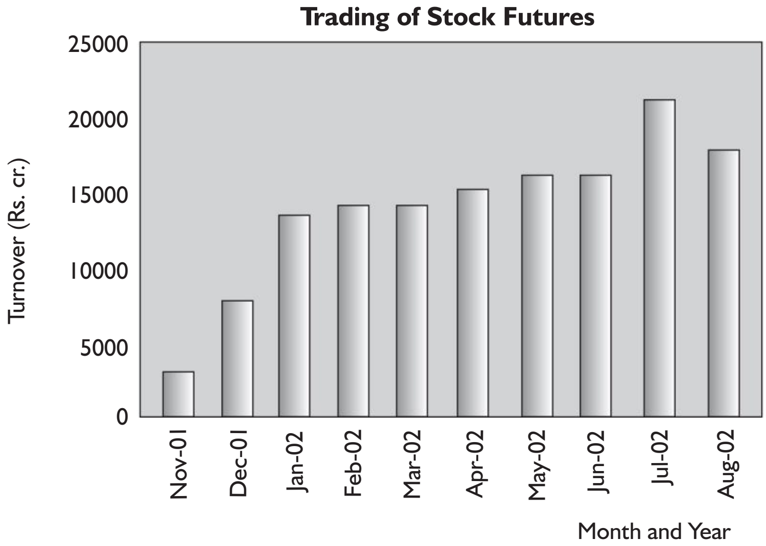
* Notional Turnover: (Exercise price + Premium) × Quantity



➢ **Fig. 9.2** *Growth of Stock Call Options Trading at NSE*



➢ **Fig. 9.3** *Growth of Stock Put Options Trading in NSE*



➢ **Fig. 9.4** *Growth of Stock Futures Trading at NSE*

Some concluding observations on derivatives trading in India follow.

(i) As of now, there are two exchanges on which derivatives trading is done, viz, The National Stock Exchange of India (NSE) and The Stock Exchange, Mumbai. Even of these, the NSE shares the trading bulk.

(ii) Futures on individual stocks is the most traded derivative product in India.

(iii) Generally, contracts on individual stocks involve 100 shares of the underlying. However, in India, it is not so. This is because when the derivatives were introduced here, it was stipulated that at initiation, the minimum value of a contract should be Rs 2 lakhs. Accordingly, based on the prices prevailing at the time of introducing stock options contracts, the number of shares of the underlying securities for each of the 31 stocks were determined (when the futures on these stocks were introduced, the same contract sizes were taken). However, with passage of time, the prices have undergone significant changes. With contract sizes in terms of the number of shares involved remaining unchanged, this has resulted in wide variations in the options and futures contract values for different securities. To illustrate, based on the closing prices on 15 May, 2002, the values of single contracts were found to be ranging between Rs 77,220 for Sterlite Optical Technology Ltd (contract size 600 shares and share price Rs 128.70) and Rs 4,66,125 for TELCO (contract size 3,300 shares and share price Rs 141.25).

(iv) At present, all options and futures contracts traded in India are settled in cash. While the contracts involving indices can be settled in cash only, the contracts on stocks may be settled in cash or in delivery of the underlying. The futures and options contracts on individual stocks, which are settled in cash as of now, are under consideration of SEBI for settlement through physical delivery.

(v) Clearances have been given to the mutual funds (MFs) and the foreign institutional investors (FIIs) to trade freely in the derivatives. It is likely to provide greater and better business opportunities to the market players and a boon to further development of the derivatives market in India.

TEST YOUR UNDERSTANDING

Mark the following statements as T (True) or F (False).

1. ______ Forward trading was banned in India in 1969.
2. ______ *Badla* trading was started in India in 1972 when shares traded on stock exchanges were divided in to two categories: specified and non-specified.

3. ______ Introduction of *badla* helped the market to grow in terms of number of new issues, market capitalisation, turnover etc.
4. ______ A study in 1991 by the *Society for Capital Market Research and Development* revealed that bulk of the transactions in a settlement got settled in that settlement only, while the remaining were carried forward to the next.
5. ______ *Vyaj badla* is also called *teji badla.*
6. ______ The open positions in futures and options can be taken to the next maturity period just as *badla* allows taking open positions to the next settlement cycle.
7. ______ Basically, *badla* was a financing mechanism.
8. ______ The shares in which badla/carry forward facility was available, were generally much more liquid than the shares on which such facility was not available.
9. ______ All speculation is bad and, therefore, undesirable.
10. ______ A limited trading in options, known as *teji* and *mandi* was prevalent in India for quite a long time.
11. ______ Only out-of-the-money options have been traded in Indian *teji-mandi* dealings.
12. ______ A *fatak* involves a call option and a put option.
13. ______ In the type of trading prevalent in India before derivatives were formally introduced, the premium on an option was fixed while the exercise price was negotiable, but in the legalised options trading, the premium on an option with a given exercise price is negotiated.
14. ______ The derivatives markets in developing countries are as useful and important as they are for the developed countries.
15. ______ Derivatives markets exert positive influence on the efficiency of the markets of the underlying.
16. ______ To make stock index futures trading possible, the L.C. Gupta committee changed the definition of securities under section 2 (h) (iia) of the Securities Contract Regulation Act, 1956, by declaring derivatives contracts based on index of prices and other derivatives securities to be securities.
17. ______ The derivatives trading began in India in June, 2001 with the first product open to trading being the futures on stock indices.
18. ______ Presently, futures and options contracts both on stock indices and individual stocks are traded in India.
19. ______ Of all the products, futures on stock indices are the most-traded in terms of the trading volumes.

20. ______ Futures on individual stocks met with immediate success in the Indian market.
21. ______ Options and futures on individual stocks were introduced simultaneously in November, 2001.
22. ______ As of now, options contracts are available on a total of 31 securities.
23. ______ Each of the contracts on individual stocks involves a total of 100 shares of the underlying.
24. ______ Presently, the derivatives contracts on individual stocks are settled through physical delivery and they are likely to be allowed to be cash-settled shortly.
25. ______ In India, one can trade in derivatives only for hedging or arbitrage and not for speculation.

EXERCISES

1. When and why was *badla* banned in India? Do you agree with the view that the decision to ban *badla* was correct?
2. Compare *badla* with futures and options in regard to (i) their hedging ability, and (ii) their ability to provide liquidity.
3. Discuss the nature of options trading as practised in India prior to their formal introduction.
4. List the infrastructural requirements for setting up options and futures trading.
5. When and why was L.C. Gupta committee set up? List the main recommendations of the committee.
6. Write a note on derivatives trading in India.

APPENDIX

A

Review Illustrations

1. Share X is currently available at Rs 100. The risk free rate of interest is 8% per annum compounded continuously. What should be the ideal contract price of one-month futures contract?

   Solution: We know,

   $$F = S_0 \, e^{rt}$$

   Here, $S_0 = 100$, $r = 0.08$, and $t = 1/12$ or 0.083.

   Thus,

   $$F = 100e^{(0.08)\ (0.083)}$$
   $$= (100)\ (1.0067)$$
   $$= \text{Rs } 100.67$$

2. Share Y is currently selling at Rs 75. The risk-free rate of interest is 9% per annum. What should be the fair contract price of a two-month futures contract?

   Solution: First we calculate the continuously compounded risk-free rate of return. With an interest rate of 9% p.a.,

   $$r = \ln(1 + 0.09) = 0.0862$$

   Now,

   $$F = S_0 \, e^{rt}$$
   $$= (75)\ e^{(0.0862)(2/12)}$$
   $$= (75)\ (1.0145)$$
   $$= \text{Rs } 76.09$$

3. A share Z is currently available at Rs 100. The risk-free rate of interest is 8.5% compounded continuously. The share is expected to yield a dividend of Rs 2.50 in 1 month from now.

Determine the value of a 3-months futures contract if one contract involves 2000 shares.

Solution: Total dividend receivable $= 2000 \times 2.5$
$= \text{Rs } 5{,}000$

Present value of the dividend, $I = 5{,}000\ e^{-(1/12)\ (0.085)}$
$= 5{,}000 \times 0.993$
$= \text{Rs } 4{,}965$

Value of the 3-months futures contract, $F = (S_0 - I)e^{rt}$
$= (2{,}00{,}000 - 4{,}965)e^{(0.085)\ (0.25)}$
$= (1{,}95{,}035)\ (1.02145)$
$= \text{Rs } 1{,}99{,}223.80$

4. A forward contract on 200 shares, currently trading at Rs 112 per share, is due in 45 days. If the annual risk-free rate of interest is 9%, calculate the value of the contract price.
How would the value be changed if a dividend of Rs 4 per share is expected to be paid in 25 days before the due date?

Solution: Here $N = 200$, $S_0 = 112$, $t = 45/365$,
$r = \ln(1 + 0.09) = 0.0862$. With these inputs, value of a futures contract is given here:

$$F = NS_0e^{rt}$$
$$= 200 \times 112 \times e^{(0.0862)\ (45/365)}$$
$$= \text{Rs } 22{,}639.32$$

When dividend is receivable:
Dividend receivable after 20 days (or 25 days prior to due date) $= 200 \times 4 = \text{Rs } 800$

Present value of the dividend, $I = 800\ e^{-(20/365)\ (0.0862)}$
$= \text{Rs } 796.23$

Thus, value of a forward contract
$= (200 \times 112 - 796.23)\ e^{(0.0862)\ (45/365)}$
$= \text{Rs } 2{,}11{,}834.59$

5. A certain share index provides a dividend yield of 3.5% per annum. The current value of the index is 1003. The continuously compounded risk-free rate of return is 8%.
(i) Find the value of a one-month futures contract on the given index per unit.
(ii) Find the value of a one-month futures contract on the given index assuming that each contract has 200 units.

Solution: Here, $S_0 = 1003$, $r = 0.08$, $y = 0.035$, and $t = 0.083$

Now, $F = S_0 e^{(r-y)t}$

$= 1003\ e^{(0.08 - 0.035)\ (0.083)}$

$= (1003)\ (1.004)$

$=$ Rs 1,007.01

Thus, value of a one-month futures contract is Rs 1007.01 per unit. Now, if the contract involves 200 units, the contract value would be equal to $200 \times 1007.01 =$ Rs 2,01,402.

6. A share is currently available at Rs 100. The risk-free rate of interest is 9% per annum compounded quarterly. What should be the fair price of a 45-days futures contract?

Solution: First we shall calculate the continuously compounded risk-free rate of return, r.

Here $r = \ln\ (1 + r_1/4)^4$

{Compounding being on quarterly basis}

$= \ln\ (1 + .09/4)^4$

$= \ln\ (1.093)$

$= 0.0893$

Now,

$F_0 = S_0\ e^{rt}$

$= (100)\ e^{(0.0893)\ (45/365)}$

$= (100)\ (1.011)$

$=$ Rs 101.10

7. On January 1, 2003 an investor has a portfolio of 5 shares as given here:

Security	*Price*	*No. of Shares*	*Beta*
A	59.50	5,000	1.05
B	81.85	8,000	0.35
C	101.10	10,000	0.80
D	125.15	15,000	0.85
E	140.50	1,500	0.75

The cost of capital to the investor is 12.5% per annum.

You are required to:

(a) Calculate the beta of his portfolio.

(b) Calculate the theoretical value of the NIFTY futures for February.

(c) If its current value is 1005 and NIFTY futures have a minimum trade lot requirement of 200 units, obtain the number of contracts of NIFTY he needs to sell in order to get a full hedge until

February for his portfolio. Assume that the futures are trading at their fair value.

(d) Calculate the number of futures contracts the investor should trade if he desires to reduce the beta of his portfolio to 0.7.

Solution: (a) The portfolio of the investor has a beta value equal to 0.8123 as shown here:

Calculation of Portfolio Beta

Shares	*Price*	*No. of Shares*	*Value*	*Weightage* W_i	*Beta* β_i	$W_i\beta_i$
A	59.50	5000	29750	0.073	1.05	0.0767
B	81.85	8000	65480	0.162	0.35	0.0567
C	101.10	10000	101100	0.250	0.80	0.2000
D	125.15	15000	187725	0.463	0.95	0.4399
E	140.50	1500	21075	0.052	0.75	0.0390
		Total	4051300			0.8123

(b) Calculation of theoretical value of NIFTY:
Given, cost of capital = 12.5% p.a.
Thus, continuously compounded rate of interest

$$= \ln(1 + 0.125)$$
$$= 0.1178$$

For February contracts, $t = 58/365 = 0.1589$ years

Now, $F = 1005e^{(0.1178)(0.1589)}$

$$= (1005)\ (1.019) = 1024.10$$

(c) Value of a February contract = 1005 × 200 = Rs 2,01,000
Number of contracts required to get a hedge:

$$\frac{\text{Value of spot position requiring hedging}}{\text{Value of a futures contract}} \times \text{Portfolio beta}$$

$$\frac{\text{Rs. }40{,}51{,}300}{\text{Rs. }2{,}01{,}000} \times 0.8123 = 16.37 \text{ or } 17 \text{ contracts.}$$

Note: Due to compulsions of contract size, the investor's position stands over-hedged with shorting of 17 contracts.

(d) For calculating the number of futures contracts required to be sold to lower the beta to 0.7, we have

Value of portfolio = Rs 40,51,300
Current Beta of the portfolio = 0.8122
Desired beta value β'_p = 0.7 and
Value of a futures contract = 1005 × 200 = Rs 2,01,000

Now, No. of contracts of sell $= \dfrac{P(\beta_p - \beta'_p)}{F}$

$$= \frac{40{,}51{,}300\,(0.8122 - 0.7)}{2{,}01{,}000} = 2.26 \text{ or } 2 \text{ contracts}$$

Note: Due to rounding off, the portfolio beta would not be reduced to exactly 0.7.

8. Consider the following data about calls on share X:

Option	*Exercise Price (Rs)*	*Stock Price (Rs)*	*Call Option Price (Rs)*
1	70	72.50	7.75
2	75	72.50	2.50

Classify each of the above options and show their intrinsic values and time values.

Solution: On the basis of given data, we have:

Option	S_0	*E*	*Premium*	*Intrinsic Value*	*Time value*	*Classification*
1	72.50	70.00	7.75	2.50	7.75 – 2.50 = 5.25	In-the-money
2	72.50	75.00	2.50	0	2.50 – 0 = 2.50	Out-of-the-money

9. Consider the following data about puts on a share:

Option	*Exercise Price (Rs)*	*Stock Price (Rs)*	*Put Option Price (Rs)*
1	80	83.50	2.50
2	85	83.50	6.75

Classify each of the above options and state their intrinsic and time values.

Solution: The required analysis is done here:

Option	S_0	*E*	*Premium*	*Intrinsic Value*	*Time Value*	*Classification*
1	83.50	80.00	2.50	0	2.50 – 0 = 2.50	Out-of-the-money
2	83.50	85.00	6.75	85.0 – 83.50 = 1.50	6.75 – 1.50 = 5.25	In-the-money

10. Consider the following data about April 2002 NIFTY options, (all values taken are the opening values for the day):

Exercise Price	*Call Premium*	*Put Premium*
1060		1.10
1080		1.30
1100	50.00	2.60
1120	31.05	6.00
1140	17.45	12.25
1160	8.00	23.40
1180	4.95	
1200	2.75	
1220	1.00	

The index opened at 1146.05.

(**Source:** *The Financial Express*, April 06, 2002)

Based on these, classify the options on the basis of their "moneyness" and segregate the intrinsic and time values.

Solution: The given information is reproduced below and the desired values are obtained.

E	S_0	*Call*				*Put*			
		Cat.	*Prem.*	*IV*	*TV*	*Cat.*	*Prem.*	*IV*	*TV*
1060	1146.05					OTM	1.10	0	1.10
1080	1146.05					OTM	1.30	0	1.30
1100	1146.05	ITM	50.00	46.05	3.95	OTM	2.60	0	2.60
1120	1146.05	ITM	31.05	26.05	5.00	OTM	6.00	0	6.00
1140	1146.05	ITM	17.45	6.05	11.40	OTM	12.25	0	12.25
1160	1146.05	OTM	8.00	0	8.00	ITM	23.40	13.95	9.45
1180	1146.05	OTM	4.95	0	4.95				
1200	1146.05	OTM	2.75	0	2.75				
1220	1146.05	OTM	1.00	0	1.00				

ITM: *In-the-Money*, OTM: *Out-of-the-Money*, IV: *Intrinsic Value*, TV: *Time Value*

11. A call option with an exercise price of Rs 72 due to expire in 10 days' time is selling at Rs 2.25. The underlying share is selling in the market at Rs 76. How can an arbitrageur benefit in this scenario, assuming that contract settlement would be through physical delivery?

    Solution: In this case the call is in-the-money and priced lower than its intrinsic value. It is possible to buy call option from the options market by paying the premium of Rs 2.25 per share, exercise the option and sell shares in the cash market at Rs 76. The profit per share works out to be Rs 1.75 {= 76 – (72 + 2.25)}, excluding the transaction costs.

12. Given:

    Exercise price = Rs 220
    Expiration month = Dec., 2002
    Size of contract = 1000 Shares
    Price of underlying share = Rs 224.50
    Price of a call option = Rs 10

    Investor A writes a contract and receives a premium of Rs 10,000 while investor B takes a long call and pays a premium of Rs 10,000. How much does each of these investors stand to gain or lose in case of positive and negative price movements?

    Solution: Since investor A has written the option and received the premium, his gain of Rs 10,000 is assured if the option is not exercised. If the price of underlying share is Rs 220 or less, the call option would not be exercised. However, the option would be exercised when the share price exceeds Rs 220. In that case, investor A would lose or gain an amount depending on the share price. To illustrate, if the price is Rs 228, he would net a gain of Rs 2000 (loss of: 1000 (228 – 200) = 8000 and a premium of Rs 10000) while if the price is Rs 245, he would lose Rs 15000 (1000 (245 – 220) = 25000 and a premium of Rs 10000). Since the share price can increase to any level, his potential loss has no limit.

On the other hand, investor B can suffer a maximum loss of Rs 10000, the premium paid. His gain potential is unlimited. His pay-off profile is the mirror image of the same for investor A. The break-even share value for both the investors is Rs 230 (exercise price plus premium).

13. A put option on share PQR has the following details.

Exercise Price	= Rs 110
Expiration Month	= March 2003
Size of contract	= 2000 Shares
Underlying share's price	= Rs 112
Price of put option on the date of contract	= Rs 7.50

Investor A writes a put option contract and receives a premium of Rs 15,000 on it from B who buys the option. How much does each of these investors stand to gain/lose in case of price movements?

Solution: Since investor A has written an options contract, his maximum gain by way of the premium received of Rs 15,000 is assured. However, the extent of losses in case of adverse price movements can be very large. In the worst possible situation of the share price falling to zero, A would lose $2000 \times 110 - 15{,}000 =$ Rs 205,000.

On the other hand, since investor B is a buyer of an options contract, his maximum loss limit is up to the amount of the premium he has paid. He stands to gain if the share price falls below Rs 110 – 7.50 = Rs 102.50. Since the minimum price of a share can be zero, the maximum gain possible is $2000 \times 102.50 =$ Rs 205,000. For share prices between Rs 102.50 and Rs 110, his gain from option exercise would be more than offset by the cost (the premium paid) and he would stand to lose.

14. P has a long position in 1000 shares in a certain company. He fears a fall in the market, thus affecting his interest adversely. What help can he get from options?

Solution: If P is not interested in diluting his long position and wants to hedge the risk of falling prices, he should buy an appropriate number of put option contracts on shares held by him. In case the price increases, he would not exercise his options and enjoy the gains. If the price falls, he can exercise his option and protect himself against the loss incurred. The price of this cover is the option premium payable by him. In this way, his losses made on the shares will be more or less equalized by his gains in the put options.

This strategy is especially useful in the current cash settlement system of derivatives market where settlement by delivery is not essential. The difference between the exercise price and stock price is paid/received by the clearing-house on exercise or settlement of contract.

15. An investor holds a long position in 1000 shares of a certain company. He bought these shares at Rs 210 each. Fearing a fall in the market, he has bought a put option contract involving 1000 shares with exercise price of Rs 212 at a premium of Rs 7.80 per share. Explain how this position will perform in different price scenarios on expiration.

Solution: The profit/loss profile is presented below where calculations are done in respect of a few prices of the underlying share.

Share Price S_0	*Exercise Price, E* (A)	*Profit/Loss on option $N(E - S_0)$,* (B)	*Option Premium* (C)	*Profit/Loss on Shares*	*Net Profit/ Loss* (A – B + C)
190	212	22,000	7,800	– 20,000	– 5,800
195	212	17,000	7,800	– 15,000	– 5,800
200	212	12,000	7,800	– 10,000	– 5,800
205	212	7,000	7,800	– 5,000	– 5,800
210	212	2,000	7,800	0	– 5,800
215*			7,800	5,000	– 2,800
220			7,800	10,000	2,200
225			7,800	15,000	7,200

* For share price greater than Rs 212, the option is out-of-the-money, and hence not exercised. It is evident that if the price of the share does fall, the investor is protected because he can exercise the option profitably. However, the put option becomes out-of-the-money for prices above Rs 212 and would not be exercised. In that event, he makes a profit from the shares held. The investor would break-even at a share price of Rs 219.80. Evidently, then, the put option allows him to mitigate his losses should his fears become a reality.

16. Mr Shukla holds 1000 shares of company 'R', which he acquired at an average rate of Rs 210 each. Anticipating a fall in

the market, he decides to sell call options on R at the level of Rs 210 for a premium of Re. 1. Each contract consists of 1000 shares so he decides to short one call option contract. Explain how this position will perform in various price scenarios.

Solution: When an investor holds a long position in stock, he can protect himself either by buying a put option (the right to sell the shares) or by writing a call option (giving the opposite party the right to purchase) and known as *covered call writing*. In buying a put option, the down side risk is eliminated and the investor can keep any profits resulting from upward movement of prices—all this for a price. On the other hand, writing a call option brings in money but in the process the investor forgoes any profit resulting from increase in the price. This income does reduce losses from the downward movement of prices by an amount equal to the total premium received.

For the given data, the pay-off profile of the investor under given price values is presented below:

Share Price (S_0)	*Exercise Price* (*E*)	*Profit/Loss on Option* $N(E-S_0)$ (*A*)	*Option Premium* (*B*)	*Profit/ Loss on Shares* (*C*)	*Net Profit* (*A + B + C*)
190			1,000	– 20,000	– 19,000
195			1,000	– 15,000	– 14,000
200			1,000	– 10,000	– 9,000
205			1,000	– 5,000	– 4,000
210	210		1,000	0	1,000
215	210	– 5,000	1,000	5,000	1,000
220	210	– 10,000	1,000	10,000	1,000
225	210	– 15,000	1,000	15,000	1,000

The option is at-the-money at share price of Rs 210 and out-of-the-money for share prices lower than Rs 210 and hence would not be exercised.

Notice here that the strategy of writing call options, as a hedging tool is effective only to the extent of premium received on the calls written. The other strategy of buying put options provides a much greater and effective cover.

17. An investor has a short position of 500 shares at Rs 412 each. Expecting a rise in the market, he decides to hedge his position by way of buying call option contracts at Rs 410 by the way of paying Rs 5 premium. Each contract consists of 250 shares.

How will this position perform in case of different share prices?

Solution: Hedging a short position of 500 shares with call options will require buying two contracts since each contract involves 250 shares. The total premium payable would be $2 \times 250 \times 5 =$ Rs 2500. The 410 calls would be exercised if the price of the underlying share goes beyond Rs 410. The pay-off profile of the investor at some selected prices in such a case in as given here:

Share Price S_1	*Exercise Price* E	*Gain from Option (A)*	*Option Premium (B)*	*Gain/Loss on Shares (C)*	*Net Gain/Loss (A – B + C)*
390	410	–	2,500	11,000	8,500
395	410	–	2,500	8,500	6,000
400	410	–	2,500	6,000	3,500
405	410	–	2,500	3,500	1,000
410	410	–	2,500	1,000	– 1,500
415	410	2,500	2,500	– 1,500	– 1,500
420	410	5,000	2,500	– 4,000	– 3,500
425	410	7,500	2,500	– 6,500	– 3,500
430	410	10,000	2,500	– 9,000	– 3,500

Thus if the shares price falls, the investor can keep the gain which would be reduced by the amount of premium paid. On the other hand, he would lose a maximum of Rs 3500 in case the share changes adversely for him. The breakeven price is Rs 407—the investor stands to gain if the share price below this price and lose if it is greater than this.

18. An investor feels that the price of share 'Z' is going to rise in the next few days. How can he use the existing options market to benefit from any such movement?

Solution: When an investor feels that the price of a share is expected to increase, he may:

(i) Buy call options on share 'Z' at the current rates. He will be able to realize a gain from this position once the prices start rising.

(ii) Sell/write put options on share 'Z' at the present rates. This way he will be getting an income by way of the premium he receives on the puts written/sold by him. In case prices do rise, he can keep all premium money. Of course, if price declines, he would lose money.

The investor can use any of (i) and (ii) of these strategies to gain from any favourable movement in the share 'Z'.

19. A bought a Rs 360.50 call option contract involving 1000 shares of a company. He paid a premium of Rs 5.50 per share on this. On the expiry of the contract, the settlement rate was Rs 365.50. What was A's profit/loss on this contract?

    Solution: Since the effective rate of purchase is Rs 360.50 + Rs 5.50 = Rs 366.00 and the settlement rate is Rs 365.50, A's loss = 366 – 365.50 = Re 0.50 per share or 1000 × 0.50 = Rs 500.00 on the contract.

20. B bought a put option contract of 1200 shares of 'S' with exercise price of Rs 266.25 and paid a premium of Rs 2.30 per share. Three days later he decided to exercise the contract when the market price of 'S' was Rs 260.55 per share. Calculate the profit/loss of B.

    Solution: The effective exercise rate for the put option is Rs 266.25 – 2.30 = Rs 263.95.

    B's profit = Rs 263.95 – Rs 260.55
    = Rs 3.40 per share

    or Rs 3.40 × 1200 = Rs 4080 per contract

21. P decides to create a 'Bull Spread' by way of buying a February 2003 call option on a stock, with an exercise price of Rs 100 for Rs 5 and selling a call option on it involving an exercise price of Rs 110 for Rs 2. Find out how much profit/loss he makes in each of the following conditions:
    (i) On settlement day, the price of the underlying stock is Rs 95 per share.
    (ii) On settlement day, the price of the underlying stock is Rs 106 per share.
    (iii) On settlement day, the price of the underlying stock is Rs 113 per share.

    Solution: (i) Since the settlement rate of Rs 95 is below both the exercise prices, none of the options would be exercised. Thus, P would bear a loss of Rs 3 per share (equal to the excess of premium paid over premium received).

    (ii) Since the settlement rate of Rs 106 is higher than Rs 100 and lower than Rs 110, only in-the-money call of Rs 100 will be exercised by P and the out of-the-money call of Rs 110 will not be exercised. He stands to gain Rs 6 (= Rs 106 – Rs 100) on the Rs 100 call. The net profit for P = 6 – 5 + 2 = Rs 3 per share.

(iii) Since the settlement rate of Rs 113 is higher than both Rs 100 and Rs 110, both the call options are in-the-money and shall be exercised. In this event, Gain to the investor from Rs 100 call = 113 – 110 = Rs 13 per share.
Loss to the investor from Rs 110 call = 113 – 110 = Rs 3 per share.
Cost of the spread = Rs 3 per share.
Therefore, the net profit = Rs 13 – 3 – 3 = Rs 7 per share.
Note that for all prices above Rs 110, both the calls would be exercised and the investor would gain a net Rs 7 per share.

22. K decides to create a Bull Spread by way of buying a put option on share 'J' at an exercise price of Rs 90 for Rs 5 and sell/write an identical put option at an exercise price of Rs 100 for Rs 8. Find out how much profit/loss he will make in each of the following conditions.
    (i) On the settlement day, the price of the underlying 'J' is Rs 85.
    (ii) On the settlement day, the price of the underlying 'J' is Rs 96.
    (iii) On the settlement day, the price of the underlying 'J' is Rs 110.

Solution: (i) Since in this case, both the options are in-the-money, K is obliged to buy at Rs 100 and is free to sell Rs 90. Also, he has an initial credit of the earnings on the two premia equal to Rs 3 (Rs 8 *minus* Rs 5). Accordingly,
Loss on Rs 100 put = Rs 100 – Rs 85 = Rs 15 per share.
Gain on Rs 90 put = Rs 90 – Rs 85 = Rs 5 per share.
Initial credit = Rs 3 per share.
Thus, net loss = 15 – 5 – 3 = Rs 7 per share.
(ii) Since the put option sold is in-the-money, it would be exercised and the net pay off would be, = Rs 100 – Rs 96 = Rs 4
Thus, net loss to the investor would be = Rs 4 – Rs 3 = Re. 1 per share.
(iii) Since both the options are out-of-money, none of them would be exercised and K will make a net profit of Rs 3 per share (the initial credit).

23. S wants to create a Bear spread. He buys a call option on a share 'K' of Rs 110 for a premium of Rs 5. Also, he sells an identical call option at the exercise price of Rs 100 for a premium of Rs 9. Find out the net profit/loss that S will make in each of the following conditions:
    (i) If the settlement rate is Rs 90.
    (ii) If the settlement rate is Rs 108.
    (iii) If the settlement rate is Rs 119.

    Solution: (i) Since both the call options are out-of-the-money, none of them would be exercised. S will get to keep the difference between the premia he receives and pays.

    This is equal to Rs 9 – Rs 5 = Rs 4 per share.

    (ii) The call option sold by S is in-the-money at this price while the one bought is out-of-the-money so that only the former of these can be executed. The pay off would be,
    Rs 108 – Rs 100 = Rs 8 per share.
    His net loss would be,
    Rs 8 – Rs 4 = Rs 4 per share.

    (iii) At the given settlement price of Rs 119, both the calls are in-the-money.

    The profit on the call bought is equal to Rs 9 (Rs 119 – Rs 110), while the loss made on the call sold is equal to Rs 19 (Rs 119 – Rs 110).

    Accordingly the net loss to S work out to be Rs 6 per share, which is obtained as Rs 9 – Rs 19 + Rs 4.

24. A butterfly spread is created when large price changes are not expected but instead small changes are anticipated. Consider the following data about call options on BHEL (prices taken from *The Economic Times*, April 9, 2002) for which one contract involves 1100 shares.

Strike price	*Premium*
Rs 170	Rs 21.10
Rs 180	Rs 14.00
Rs 190	Rs 8.00

Help an investor to build a butterfly spread. Find the pay-off for him at various ranges of stock prices. Illustrate by taking stock price as Rs 168, Rs 176, Rs 185, Rs 189 and Rs 198.

Solution: To create a butterfly spread, the investor should buy a call option each with exercise prices of Rs 170 and Rs 190, called E_1 and E_3 respectively and pay a sum of Rs 29.10

(= 21.10 + 8.00). With this, he should sell two options with strike price of Rs 180, called E_2, and pay Rs 28. Thus, the position will require him to pay a net amount of Rs 1.10 per share. Now, we can determine the pay-off at various stock prices as follows:

Stock Price	*Pay-off from* First Long Call (E_1)	Second Long Call (E_3)	Short Calls (E_2)	*Total*	*Profit/Loss*
$S_1 < 170$	0	0	0	0	– 1.10
$170 \leq S_1 < 180$	$S_1 - 170$	0	0	$S_1 - 170$	$S_1 - 171.10$
$180 \leq S_1 < 190$	$S_1 - 170$	0	$2(180 - S_1)$	$190 - S_1$	$188.9 - S_1$
$190 < S_1$	$S_1 - 170$	$S_1 - 190$	$2(180 - S_1)$	0	– 1.10

With reference to the above pay-off schedule, the following conclusions may be drawn:

(i) For a price of Rs 168 per share, the investor would lose Rs 1.10 per share or $1100 \times 1.10 =$ Rs 1210 per contract.

(ii) When the price is Rs 176 per share, the net profit would be $1100 \times (176 - 171.10) =$ Rs 5390.

(iii) For the share price equal to Rs 185, the investor would gain $1100 \times (188.9 - 185) =$ Rs 4290.

(iv) For a price equal to Rs 189 per share, the loss to the investor would be $1100 \times (188.9–189) =$ Rs 110.

(v) When the share is selling at Rs 198, the investor would stand to lose Rs 1.10 per share or Rs 1210 per contract.

The break-even share prices for the investor are: Rs 171.10 and Rs 188.9.

25. The Rs 660 call and put November options on a security are available at Rs 23.25 and Rs 9.80 respectively. Each contract involves 300 shares.

Using this information, help an investor to create a (i) Bottom Straddle (ii) Strip, and (iii) Strap.

Also, discuss under what conditions each of these is appropriate.

Solution: (i) *Bottom Straddle:* Buy a call and buy a put for a total of Rs 33.05 in this case to create a straddle. The put would be exercised if the price falls below Rs 660 and the call if the price goes beyond Rs 660. Considering the information given, it may be observed that the break-even prices are Rs 660 ± Rs 33.05 or Rs 626.95 and Rs 693.05. Thus, straddle will be profitable if the price of the underlying share falls below Rs 626.95 or rises above Rs 693.05. If the price of the underlying share happens to be more than Rs 626.95 but less than Rs 693.05, a loss would be incurred. The loss would be the maximum if the share price settles at Rs 660. To illustrate, if the share price at expiration stands at Rs 630, then the put option will be exercised for a profit of Rs 660 – 630 = Rs 30 and the net loss would be Rs 3.05 per share or Rs 915 in all. Similarly, if the share price at expiration is Rs 700, than the call would be exercised for a profit of Rs 40 per share while the net profit would work out to be Rs 6.95 per share or Rs 2,085 in total.

(ii) *Strip*: Formation of a strip involves a long position in one call and two put options. In the given problem, the investor would pay Rs 23.25 + 2 × 9.80 = Rs 42.85. Now if the price of the underlying share settles at lower than Rs 660, both the put options would be exercised. The resulting profit/loss in such a case is 2 × (660 – S_1) – 42.5. Thus, if the share price settles at Rs 615 per share, the investor would gain Rs 47.15 on the options, or Rs 14,145 in the aggregate. On the other hand, if the price of the share on settlement were greater than Rs 660, the profit/loss would be (S_1 – 660) – 42.85. To illustrate, a price of Rs 705 per share on settlement would yield at profit of Rs 21.5 per share or Rs 645 in all. The break-even prices are Rs 638.58 and Rs 702.85. Notice that an equal movement in prices (from 660 to 615, and to 705) results in unequal gain—the decline gives greater profit while the increase yields lower profit).

(iii) *Strap:* A strap is formulated by taking a long position in two call and one put options. This involves a total cost of Rs 23.25 × 2 + 9.8 = Rs 56.30. At settlement, if the price of the share is Rs 615, the loss to the investor would be (660 – 615) – 56.30 = Rs 11.30 per share or Rs 3390 in all. Similarly, a price of 705 would translate into a profit of 2 × (705 – 660) – 56.30 = Rs 33.7 or Rs 10,110 in all. The break-even prices here are Rs 603.7 and Rs 688.15.

Suitability: All of the above three strategies are suitable when an investor believes that the price of the underlying is expected to change, but is not clear as to the direction in which the change would take place. A straddle is suitable when the investor believes that the price increase and price decrease are equally probable; a strip is appropriate when the investor believes that price decrease is more likely than the price increase, while a strap is preferable if, in the opinion of the investor, the price increase is more probable than the price decrease.

26. Using the following data, help an investor to create a bottom strangle. Obtain the break-even prices also.

Option	*Expiry*	*Exercise Price*	*Premium*
Nifty Call	25th April 2002	1140	14
Nifty Put	25th April 2002	1120	4

Solution: A bottom strangle is created with a put and a call option purchase by the investor. The expiration dates of the two options are same but the put option has an exercise price lower than that of the call option. In terms of the given data, the investor would buy Nifty 1120 put option for Rs 4 and Nifty 1140 call option for Rs 14. Now, for values of Nifty in the range of 1120 to 1140, none of the options would be exercised. For Nifty values below 1120, the investor would exercise his put option, whereas for values above 1140, the call would be exercised. However, the investor can make a profit only when the index fall below 1106 (= 1120 – 14) or above 1154(= 1140 + 14). The two break-even points are, accordingly, 1106 and 1154.

27. Given the following data about four put options expiring in the month of May:

Exercise Price	*Premium*
Rs 1120	Rs 2.15
Rs 1140	Rs 8.95
Rs 1160	Rs 28.00
Rs 1180	Rs 51.90

Help an investor to create a long condor. Calculate the break-even prices.

Solution: To create a long condor with the put options given here, the investor would buy one put each with exercise prices of Rs 1120 and Rs 1180 and short one each with exercise prices of Rs 1140 and Rs 1160. The deal will result in a cost of (2.15 + 51.90) – (8.95 + 28.00) = Rs 17.1. Now, if the price at expiration is more than 1180, none of the options would be exercised and the investor would lose Rs 17.1. Similarly, if the price at expiration is less than Rs 1120, then all options would be exercised and the investor would lose Rs 17.1. The investor would have to buy the shares at Rs 1140 and Rs 1160, totalling Rs 2300 and similarly, he would sell at Rs 1120 and Rs 1180, also aggregating to Rs 2300. He loses in all the premium money.

For share price from Rs 1120 onwards and up to Rs 1140, three options will be exercised. The profit/loss to the investor would be S_1 – 1137.1. Similarly, if the price exceeds Rs 1140 but not Rs 1160, his profit from the two in-the-money options would be Rs 20 and the net profit equal to Rs 20 – 17.1 = Rs 2.90. Finally if the price exceeds Rs 1160 but not Rs 1180, he would gain Rs 1180 – S_1 from the option and his net gain/loss would be 1180 – S_1 – 17.1 or 1162.9 – S_1.

From the above calculations, it is evident that the break-even prices are Rs 1137.1 and Rs 1162.9.

28. From the following data, calculate the values of call and put options using Black and Scholes model:

Current price of the share	= Rs 486
Exercise price	= Rs 500
Time to expiration	= 65 days
Standard deviation	= 0.54
Continuously compounded rate of interest	= 9% p.a.
Dividend expected	= Nil

Solution: Here, S_0 = 486, E = 500, r = 0.09, σ = 0.54 and t = 65/365. With these inputs we have

$$d_1 = \frac{\ln(S_0/E)\quad \left(r \quad 0.5 \quad ^2\right)t}{\sqrt{t}}$$

$$= \frac{\ln(486/500)\quad \left(0.09 \quad 0.5 \quad 0.54^2\right)65/365}{0.54\sqrt{65/365}}$$

$$= 0.0596 \sim 0.06$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= 0.0596 - 0.54\sqrt{65/365}$$

$$= -0.1683 \sim -0.17$$

For the d_1 and d_2 values, the various $N(d)$ values are given below as obtained from Table A2:

$$N(d_1) = N(0.06) = 0.5239$$

$$N(d_2) = N(-0.17) = 0.4325$$

$$N(-d_1) = N(-0.06) = 0.4761$$

$$N(-d_2) = N(0.17) = 0.5675$$

Now, call option value,

$$C = S_0\, N(d_1) - Ee^{-rt}\, N(d_2)$$

$$= 486 \times 0.5239 - 500 \times e^{-0.09(65/365)} \times 0.4325$$
$$= 254.6154 - 212.8117$$
$$\sim \text{Rs } 41.80$$

Similarly, put option value,

$$P = Ee^{-rt} N(-d_2) - S_0 N(-d_1)$$
$$= 500 \times e^{-0.09(65/365)} \times 0.5675 - 486 \times 0.4761$$
$$= 279.238 - 231.3846$$
$$\sim \text{Rs } 47.85$$

29. Using information given in Example 28, calculate the derivatives for the call and put options values and provide a brief interpretation of each of these.

Solution: From the information included in the example in consideration we have

$$N(d_1) = 0.5239,$$
$$N(d_2) = 0.4325,$$
$$\sigma\sqrt{t} = 0.54 \times \sqrt{65/365}$$
$$= 0.22788$$
$$N(-d_2) = 0.5675$$
$$Z(d_1) = \frac{e^{-d_1^2/2}}{\sqrt{2\pi}}$$
$$= \frac{e^{-0.0596^2/2}}{\sqrt{2\pi}}$$
$$= 0.3982$$
$$S_0 = 486$$
$$E = 500$$

The calculation and interpretation of the derivatives is given here.

Delta

For call option, Delta = $N(d_1) = 0.5239$

For put option, Delta = $N(d_1) - 1 = 0.5239 - 1 = -0.4761$

If the price of the underlying share increases by Re 1, the price of call option would rise by approximately 52 paise while the put option price would fall by about 48 paise.

Gamma

For call and put options both, $\text{Gamma} = \dfrac{z(d_1)}{S_0 \sigma \sqrt{t}}$

$$= \frac{0.3982}{486 \quad 0.22788}$$

$$= 0.0036$$

Thus, if the stock price increases by Re 1, the call delta would change from 0.5239 to 0.5239 + 0.0036 = 0.5275 approximately and the put option delta would change to – 0.4761 + 0.0036 = 0.4625 approximately.

Theta

For call option, $\text{Theta} = -\dfrac{S_0\, z(d_1)}{2\sqrt{t}} - Ee^{-rt}\, r\, N(d_2)$

$$= \frac{486 \quad 0.3982 \quad 0.54}{2\sqrt{65/365}} - 500e^{-0.09(65/365)} \times 0.09 \times 0.4325$$

$$= -142.97$$

For put option, $\text{Theta} = \dfrac{S_0\, z(d_1)}{2\sqrt{t}} + Ee^{-rt}\, r\, N(-d_2)$

$$= \frac{486 \quad 0.3982 \quad 0.54}{2\sqrt{65/365}} + 500 \times e^{-0.09(65/365)} \times 0.09 \times 0.5675$$

$$= -98.69$$

Theta indicates changes in the option value for small changes of time. For call option, the time decay is 142.97/365 = 0.39 or 39 paise per day. Similarly, for the put option, it is equal to 98.69/365 = 0.27 or 27 paise per day. Thus, a day nearer to expiry would cause a fall of about 39 paise for the call option and about 27 paise for the put option.

Rho

For call option, $\text{Rho} = Ete^{-rt}\, N(d_2)$

$$= 500 \times \frac{65}{365} \times e^{-0.09(65/365)} \times 0.4325$$

$$= 37.89$$

For put option, Rho $= -\,Ete^{-rt}\,N(-\,d_2)$

$$= -\,500 \times \frac{65}{365} \times e^{-0.09(65/365)} \times 0.5675$$

$$= -\,49.73$$

From the rho values, it is evident that an increase of one percent in the risk-free rate of interest shall increase the value of the call option by 0.3879 or 38 paise while the put option value would reduce by 0.4973 or 50 paise. A decrease of one percent would have the effect of reducing the call premium and increasing the put premium by these amounts respectively.

Vega

For call and put options both, Vega $= S_0\sqrt{t}\;z(d_1)$

$$= 500 \times \sqrt{65/365} \times 0.3982$$

$$= 81.67$$

It implies that a 0.1 change in σ would cause a change of Rs 8.17 approximately (= 81.67/10) in the values of call and put options alike. Greater σ would increase and smaller σ would reduce these values.

30. Reconsider Example 28. Trace the effect on the call and put option values if it is known that a dividend of Rs 12 per share is expected in 27 days from now.

Solution: The various inputs given are:
$S_0 = 486$, $E = 500$, $r = 0.09$, $\sigma = 0.54$, $t = 65/365$ and a dividend (D) of Rs 12 obtainable 27 days hence.

Present value of dividend, $D_0 = De^{-rt_1}$

$$= 12e^{-0.09 \times 27/365}$$

$$= 11.92$$

The present value of S_0, adjusted for the dividend, equals

$$S_0^* = S_0 - D_0$$

$$= 486 - 11.92 = 474.08$$

Now, we can obtain different inputs as follows:

$$d_1 = \frac{\ln\left(S_0^*/E\right) \quad \left(r \quad 0.5\,\sigma^2\right)t}{\sigma\sqrt{t}}$$

$$= \frac{\ln\,(474.08/500) \quad \left(0.09 \quad 0.5 \quad 0.54^2\right)\ 65/365}{0.54\sqrt{65/365}}$$

$$= -\,0.04932 \sim -\,0.05$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= -\,0.04932 - 0.54\sqrt{65/365}$$

$$= -\,0.2772 \sim -\,0.28$$

Using Table A2, we have

$$N(d_1) = N(-\,0.05) = 0.4801$$

$$N(d_2) = N(-\,0.28) = 0.3897$$

$$N(-\,d_1) = N(0.05) = 0.5199$$

$$N(-\,d_2) = N(0.28) = 0.6103$$

Accordingly,
call option value,

$$C = S_0^* N(d_1) - Ee^{-rt} N(d_2)$$

$$= 474.08 \times 0.4801 - 500 \times e^{-0.09(65/365)} \times 0.3897$$

$$= 227.60 - 191.75 = \text{Rs } 35.85$$

Also, put option value,

$$P = Ee^{-rt} N(-\,d_2) - S_0^* N(-\,d_1)$$

$$= 500 \times e^{-0.0(65/365)} \times 0.6103 - 474.08 \times 0.5199$$

$$= 300.30 - 246.48 = \text{Rs } 53.82$$

31. Estimate the time to expiration of the call and put options on a stock about which the pertinent information is given here:

$$\left.\begin{array}{l}\text{Call option : Rs 10.30}\\ \text{Put option : Rs 6.44}\end{array}\right\}\text{(B.S. model)}$$

Exercise price : Rs 100
Stock price : Rs 100
Risk-free rate of interest : 0.08

Solution: From the put-call parity, we have

$$P = C + Ee^{-rt} - S_0$$

Simplifying for t, we get

$$t = \ln\left[\frac{E}{P \quad C \quad S_0}\right] \Big/ r$$

Substituting the known values,

$$t = \ln\left[\frac{100}{6.44 \quad 10.30 \quad 100}\right] \Big/ 0.08$$

$$= 0.49 \text{ year or 180 days}$$

32. Using the information given below, estimate the implied volatility in the call option values:

(a) Spot price of the share = Rs 256
Time to maturity = 54 days
Exercise price = Rs 248
Risk-free rate p.a. = 8%
Call premium = Rs 14.30

(b) Exercise price = Rs 256
Call premium = Rs 12.40
Other inputs as in (a) above.

Solution: (a) Here $C = 14.30$, $S_0 = 256$, $E = 248$, $r = 0.08$, $t = 54/365$.
Now,

$$\sigma = \frac{1}{\sqrt{t}}\left[\frac{2\pi}{S_0 + Ee^{-rt}}\left(C - \frac{S_0 - Ee^{-rt}}{2} + \sqrt{\left(C - \frac{S_0 - Ee^{-rt}}{2}\right)^2 - \frac{(S_0 - Ee^{-rt})^2}{\pi}}\right)\right]$$

From the given values,

$$S_0 + Ee^{-rt} = 256 + 248\ e^{-0.08(54/365)}$$
$$= 501.082$$
$$S_0 - Ee^{-rt} = 256 - 248\ e^{-0.08(54/365)}$$
$$= 10.918$$

With these and other inputs, we have

$$\sigma = \frac{1}{\sqrt{54/365}}\left[\frac{2\pi}{501.082}\left(14.30 - \frac{10.918}{2} + \sqrt{\left(14.30 - \frac{10.918}{2}\right)^2 - \frac{(10.918)^2}{\pi}}\right)\right]$$

$$= 0.19746$$

This is the implied volatility.

(b) With $E = 256$, the call is at-the-money. Accordingly,

$$\sigma = \frac{0.5(C \quad P)\sqrt{(2\pi/t)}}{E/(1 \quad r)^t}$$

Here $P = C + Ee^{-rt} - S_0$ (from put-call parity)

$$= 12.40 + 256\ e^{-0.08(54/365)} - 256$$
$$= 9.39$$

With these values,

$$\sigma = \frac{0.5\,(12.40 \quad 9.39)\sqrt{2 \quad /(54/365)}}{256/(1.08)^{54/365}}$$

$$= 0.2774$$

33. Using the following data, calculate the values of (i) call and (ii) put options on an index:

Spot value of the index	= 1238
Exercise price	= 1230
Risk-free rate of return	= 8% p.a.
Standard deviation of the continuously compounded rate of return	= 0.42
Time to expiration	= 45 days
Continuous dividend rate on the index	= 1.8%

Also state whether each of the options is in-the-money or out-of-the-money, and split the options premia into intrinsic and time values.

Solution: From the given data, we have, $S_0 = 1238$, $E = 1230$, $r = 0.08$, $\sigma = 0.42$ and $t = 45/365$ and dividend rate $\delta = 0.018$. We first obtain various $N(d)$ values.

$$d_1 = \frac{\ln(S_0/E) \quad (r \quad \delta \quad \sigma^2/2)\,t}{\sigma\sqrt{t}}$$

$$= \frac{\ln(1238/1230) \quad (0.08 \quad 0.018 \quad 0.42^2/2)(45/365)}{0.42\sqrt{45/365}}$$

$$= 0.1695 \text{ or } 0.17$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$= 0.1695 - 0.42\sqrt{45/365}$$

$$= 0.0220 \text{ or } 0.02$$

Taking d_1 and d_2 to two decimal places, we evaluate $N(d)$.

$$N(d_1) = N(0.17) = 0.5 + 0.0676 = 0.5675$$

$$N(-d_1) = N(-0.17) = 0.5 - 0.0675 = 0.4325$$

$$N(d_2) = N(0.02) = 0.5 + 0.0080 = 0.5080$$

$$N(-d_2) = N(-0.02) = 0.5 - 0.0080 = 0.4920$$

With these values, call and put option values are obtained here:

$$C = S_0\, e^{-\delta t} N(d_1) - E e^{-rt} N(d_2)$$

$$= 1238 \times e^{-0.018 \times 45/365} \times 0.5675 - 1230 \times e^{-0.08 \times 45/365} \times 0.5080$$

$$= \text{Rs } 82.30$$

Similarly,

$$P = E e^{-rt} N(-d_2) - S_0 e^{-\delta t} N(-d_1)$$

$= 1230 \times e^{-0.08 \times 45/365} \times 0.4920 - 1238 \times e^{-0.018 \times 45/365} \times 0.4325$

$=$ Rs 64.97

Here, the call option is in-the-money while the put option is out-of-the-money. The call option is in-the-money by Rs 1238 – Rs 1230 = Rs 8. For this option, the intrinsic value = Rs 8 and time value = Rs 82.30 – Rs 8.00 = Rs 74.30. For the put option, however, the entire amount is time value. It has no intrinsic value.

34. Calculate the total premium required to buy put option contracts for hedging a portfolio valued at Rs 20,28,720 and having a beta value of 0.92, using the following data:

Exercise value	=	1240
Price of an option	=	Rs 48.40
Lot size	=	100
Put delta	=	– 0.428

Solution: For hedging with put option contracts, we have Number of options contracts to buy

$$= \frac{\text{Value of portfolio}}{\text{Contract value}} \quad \text{Portfolio Beta} \quad \frac{1}{|\text{Delta}|}$$

Using the given data, we have

$$\text{Number of contracts} = \frac{20,28,720}{1240 \quad 100} \quad 0.92 \quad \frac{1}{0.428}$$

$$= 35.17 \text{ or } 35$$

Thus, total premium required for hedging = 35 × 48.40 × 100
= Rs 1,69,400

35. Using the data given below, calculate the theoretical values of (i) call and (ii) put options on futures:

Futures contract price	= 1725
Exercise price of the option	= 1730
Time to expiration of the option	= 56 days
Risk-free interest rate	= 8%
Volatility, σ	= 28%

Solution: *Calculation of call option price*

As a first step, we calculate the values of the inputs d_1 and d_2 as follows:

$$d_1 = \frac{\ln(1725/1730) \quad 0.5 \quad 0.28^2 \quad (56/365)}{0.28 \quad \sqrt{(56/365)}}$$

$$= -0.0764 \text{ or } -0.08$$

$$d_2 = -0.0764 - 0.28 \times \sqrt{(56/365)}$$

$$= -0.1860 \text{ or } -0.19$$

Accordingly,

$$N(d_1) = N(-0.08) = 0.4681, \text{ and}$$

$$N(d_2) = N(-0.19) = 0.4247.$$

Using the given and calculated values, we have

$$FC = e^{-0.08(56/365)}\,[1725 \times 0.4681 - 1850 \times 0.4247]$$

$$= \text{Rs } 21.51$$

Calculation of put option value

$$FP = 21.51 - e^{-0.08(56/365)}\,[1725 - 1750]$$

$$= \text{Rs } 46.21$$

Answers

TEST YOUR UNDERSTANDING

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19. T	20. T	21. T	22. F	23. T	24. T
25. T	26. T	27. T	28. T	29. T	30. F

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7. T	8. T	9. T	10. T	11. F	12. T
13. T	14. F	15. F	16. T	17. F	18. F
19. T	20. F	21. T	22. T	23. F	24. T
25. T	26. F	27. F	28. T	29. T	30. T
31. F	32. T	33. T	34. T	35. T	36. T
37. T	38. T	39. T	40. F	41. T	42. F
43. T	44. T	45. T	46. F	47. T	48. T
49. F	50. T	51. F	52. T	53. T	54. F
55. T	56. T	57. F	58. F	59. T	60. T
61. T	62. T	63. F	64. T	65. T	66. F
67. T	68. F	69. T	70. T		

Chapter 3

1. F	2. T	3. F	4. T	5. F	6. F
7. F	8. T	9. T	10. T	11. T	12. T
13. F	14. T	15. T	16. F	17. F	18. F
19. F	20. T	21. T	22. F	23. F	24. F
25. T	26. T	27. T	28. F	29. T	30. T
31. T	32. F	33. T	34. F	35. F	36. F
37. F	38. T	39. F	40. F		

Chapter 4

1. T	2. T	3. T	4. T	5. T	6. F
7. F	8. T	9. F	10. F	11. T	12. T
13. F	14. F	15. T	16. T	17. T	18. T
19. F	20. T	21. F	22. F	23. T	24. F
25. T	26. T	27. F	28. T	29. T	30. T
31. T	32. T	33. T	34. T	35. T	36. F
37. F	38. F	39. T	40. F	41. T	42. F
43. T	44. T	45. F	46. T	47. T	48. T
49. T	50. T				

Chapter 5

1. F	2. F	3. F	4. F	5. T	6. F
7. T	8. F	9. F	10. T	11. T	12. T
13. F	14. F	15. T	16. F	17. F	18. T
19. T	20. T	21. F	22. F	23. T	24. T
25. F	26. T	27. T	28. F	29. F	30. F
31. T	32. T	33. T	34. F	35. T	36. F
37. F	38. T	39. F	40. T	41. F	42. F
43. F	44. F	45. T	46. T	47. F	48. T
49. T	50. T	51. F	52. F	53. T	54. T
55. T					

Chapter 6

1. T	2. F	3. T	4. T	5. T	6. F
7. F	8. F	9. T	10. T	11. F	12. T
13. T	14. F	15. F	16. F	17. F	18. T
19. T	20. F				

Chapter 7

1. F	2. T	3. T	4. F	5. T	6. T
7. F	8. T	9. T	10. T	11. T	12. F
13. F	14. F	15. F	16. T	17. F	18. F
19. T	20. F				

Chapter 8

1. F	2. T	3. T	4. F	5. T	6. F
7. T	8. T	9. F	10. T	11. F	12. F
13. T	14. F	15. T	16. F	17. T	18. F
19. T	20. T	21. F	22. T	23. T	24. T
25. T					

Chapter 9

1. T	2. T	3. T	4. F	5. F	6. F
7. T	8. T	9. F	10. T	11. T	12. T
13. T	14. T	15. T	16. F	17. F	18. T
19. F	20. T	21. F	22. T	23. F	24. F
25. F					

EXERCISES

Chapter 2

15. (i) 15.563% (ii) 14.464%
16. 18.23%
17. (i) 14.87% (ii) 13.86%
18. (a) 20% (b) 19.09% (c) 18.37% (d) 18.23%
19. Margin Account Balance:
    June 4 Rs 9360
    June 5 Rs 6160 Margin Call Rs 4400
    June 6 Rs 11360
    June 7 Rs 10960
    June 10 Rs 10360
    June 11 Rs 11560
    June 12 Rs 11160
20. Rs 7493.84 for a 100-share contract
21. Rs 78.07 for a 1-share contract
22. 19.10%

23. Rs 7975.03 for a 100-share contract
24. 1.25
25. $Y = -1.3562 + 1.03125X$, 1.03125

Chapter 3

10. Rs 2,49,871.70
11. 832.39
12. Rs 2,88,422.98
13. 7.74% p.a.
14. 6.9244
15. 1.0018
16. Rs 76,965.17; Rs 74,939.98
17. (i) 1.434373 (ii) 74 contracts

Chapter 4

20.

S.No.	*Status*
1.	In-the-money
2.	At-the-money
3.	Out-of-the-money
4.	In-the-money
5.	In-the-money
6.	In-the-money

21.

S.No.	*Intrinsic Value*	*Time Value*
1	nil	Rs 5.30
2	nil	Rs 4.10
3	Rs 2.50	Rs 5.90
4	Rs 4.00	Rs 5.70

22. Maximum loss: Rs 9300, Maximum profit: No limit
    BEP = Rs 87.75 per share
23. Maximum loss: Rs 2850, Maximum profit: Rs 51,150,
    BEP = Rs 170.5 per share
24. (a) Butterfly spread (b) Long condor

25. Buy one Call 1, Buy one Call 3, Write two Call 2.

Stock Price	*Profit (Loss)*
46	(800)
50	(800)
54	2400
55	3200
58	800
60	(800)
67	(800)

26. Loss shall be made if share price is less than Rs 72 or more than Rs 78
27. Profit function for strangle sold:
    Profit $= S_1 - 46$ for $S_1 <= 60$
    $= 14$ for $60 < S_1 < 70$
    $= 54 - S_1$ for $S_1 > 54$
28. Strategy: Strip

Chapter 5

15. Rs 6.92
16. Rs 17.71
17. Rs 13.23 per share
18. (a) Rs 10.58 per share (b) Rs 15.70 per share
19. (i) Rs 9.54 (ii) buy the call option
    (iii) Rs 6.26
20. Call: Rs 13.83 Out-of-the-money, IV = 0, TV = Rs 13.83
    Put: Rs 14.73 In-the-money, IV = Rs 6.00, TV = Rs 8.73
21.

	Call	*Put*
Premium	Rs 12.19	Rs 4.14
Delta	0.682	– 0.318
Gamma	0.019	0.019
Theta	– 36.877	– 21.041
Vega	26.357	26.357
Rho	16.527	– 8.962

22. Call : Rs 5.48; Put Rs 9.40
23.

	Call	*Put*
(a)	Rs 18.20	Rs 2.15
(b)	Rs 13.31	Rs 5.26
(c)	Rs 11.86	Rs 4.33

24. 0.2964; 0.1413

Chapter 6

6. (a) Call : Rs 46.15, Put : Rs 54.76
   (b) Call : Rs 44.87, Put Rs 56.32
7. 28 contracts
8. Call : Rs 36.00, Put : 63.73

Annexure

Table A1

Natural logs, e^x and e^{-x} Values

x	$\ln x$	e^x	e^{-x}	x	$\ln x$	e^x	e^{-x}
0.01	– 4.60517	1.01005	0.99005	0.24	– 1.42712	1.27125	0.78663
0.02	– 3.91202	1.02020	0.98020	0.25	– 1.38629	1.28403	0.77880
0.03	– 3.50656	1.03045	0.97045	0.26	– 1.34707	1.29603	0.77105
0.04	– 3.21888	1.04081	0.96079	0.27	– 1.30933	1.30996	0.76338
0.05	– 2.99573	1.05127	0.95123	0.28	– 1.27297	1.32313	0.75578
0.06	– 2.81341	1.06184	0.94176	0.29	– 1.23787	1.33643	0.74826
0.07	– 2.65926	1.07251	0.93239	0.30	– 1.20397	1.34986	0.74082
0.08	– 2.52573	1.08329	0.92312	0.31	– 1.17118	1.36343	0.73345
0.09	– 2.40795	1.09417	0.91393	0.32	– 1.13943	1.37713	0.72615
0.10	– 2.30259	1.10517	0.90484	0.33	– 1.10866	1.39097	0.71892
0.11	– 2.20728	1.11628	0.89583	0.34	– 1.07881	1.40495	0.71177
0.12	– 2.12026	1.12750	0.88692	0.35	– 1.04982	1.41907	0.70469
0.13	– 2.04022	1.13883	0.87810	0.36	– 1.02165	1.43333	0.69768
0.14	– 1.96611	1.15027	0.86936	0.37	– 0.99425	1.44773	0.69073
0.15	– 1.89712	1.16183	0.86071	0.38	– 0.96758	1.46228	0.68386
0.16	– 1.83258	1.17351	0.85214	0.39	– 0.94161	1.47698	0.67706
0.17	– 1.77196	1.18530	0.84366	0.40	– 0.91629	1.49182	0.67032
0.18	– 1.71480	1.19722	0.83527	0.41	– 0.89160	1.50682	0.66365
0.19	– 1.66073	1.20925	0.82696	0.42	– 0.86750	1.52196	0.65705
0.20	– 1.60944	1.22140	0.81873	0.43	– 0.84397	1.53726	0.65051
0.21	– 1.56065	1.23368	0.81058	0.44	– 0.82098	1.55271	0.64404
0.22	– 1.51413	1.24608	0.80252	0.45	– 0.79851	1.56831	0.63763
0.23	– 1.46968	1.25860	0.79453	0.46	– 0.77653	1.58407	0.63128

(*Contd.*)

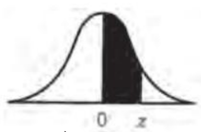
x	$ln\ x$	e^x	e^{-x}	x	$ln\ x$	e^x	e^{-x}
0.47	– 0.75502	1.59999	0.62500	0.90	– 0.10536	2.45960	0.40657
0.48	– 0.73397	1.61607	0.61878	0.91	– 0.09431	2.48432	0.40252
0.49	– 0.71335	1.63232	0.61263	0.92	– 0.08338	2.50929	0.39852
0.50	– 0.69315	1.64872	0.60653	0.93	– 0.07257	2.53451	0.39455
0.51	– 0.67334	1.66529	0.60050	0.94	– 0.06188	2.55998	0.39063
0.52	– 0.65393	1.68203	0.59452	0.95	– 0.05129	2.58571	0.38674
0.53	– 0.63488	1.69893	0.58861	0.96	– 0.04082	2.61170	0.38289
0.54	– 0.61619	1.71601	0.58275	0.97	– 0.03046	2.63794	0.37908
0.55	– 0.59784	1.73325	0.57695	0.98	– 0.02020	2.66446	0.37531
0.56	– 0.57982	1.75067	0.57121	0.99	– 0.01005	2.69123	0.37158
0.57	– 0.56212	1.76827	0.56553	1.00	– 0.00000	2.71828	0.36788
0.58	– 0.54473	1.78604	0.55990	1.01	0.00995	2.74560	0.36422
0.59	– 0.52763	1.80399	0.55433	1.02	0.01980	2.77319	0.36059
0.60	– 0.51083	1.82212	0.54881	1.03	0.02956	2.80107	0.35701
0.61	– 0.49430	1.84043	0.54335	1.04	0.03922	2.82922	0.35345
0.62	– 0.47804	1.85893	0.53794	1.05	0.04879	2.85765	0.34994
0.63	– 0.46204	1.87761	0.53259	1.06	0.05827	2.88637	0.34646
0.64	– 0.44629	1.89648	0.52729	1.07	0.06766	2.91538	0.34301
0.65	– 0.43078	1.91554	0.52205	1.08	0.07696	2.94468	0.33960
0.66	– 0.41552	1.93479	0.51685	1.09	0.08618	2.97427	0.33622
0.67	– 0.40048	1.95424	0.51171	1.10	0.09531	3.00417	0.33287
0.68	– 0.38566	1.97388	0.50662	1.11	0.10436	3.03436	0.32956
0.69	– 0.37106	1.99372	0.50158	1.12	0.11333	3.06485	0.32628
0.70	– 0.35667	2.01375	0.49659	1.13	0.12222	3.09566	0.32303
0.71	– 0.34249	2.03399	0.49164	1.14	0.13103	3.12677	0.31982
0.72	– 0.32850	2.05443	0.48675	1.15	0.13976	3.15819	0.31664
0.73	– 0.31471	2.07508	0.48191	1.16	0.14842	3.18993	0.31349
0.74	– 0.30111	2.09594	0.47711	1.17	0.15700	3.22199	0.31037
0.75	– 0.28768	2.11700	0.47237	1.18	0.16551	3.25437	0.30728
0.76	– 0.27444	2.13828	0.46767	1.19	0.17395	3.28708	0.30422
0.77	– 0.26136	2.15977	0.46301	1.20	0.18232	3.32012	0.30119
0.78	– 0.24846	2.18147	0.45841	1.21	0.19062	3.35348	0.29820
0.79	– 0.23572	2.20340	0.45384	1.22	0.19885	3.38719	0.29523
0.80	– 0.22314	2.22554	0.44933	1.23	0.20701	3.42123	0.29229
0.81	– 0.21072	2.24791	0.44486	1.24	0.21511	3.45561	0.28938
0.82	– 0.19845	2.27050	0.44043	1.25	0.22314	3.49034	0.28650
0.83	– 0.18633	2.29332	0.43605	1.26	0.23111	3.52542	0.28365
0.84	– 0.17435	2.31637	0.43171	1.27	0.23902	3.56085	0.28083
0.85	– 0.16252	2.33965	0.42742	1.28	0.24686	3.59664	0.27804
0.86	– 0.15082	2.36316	0.42316	1.29	0.25464	3.63279	0.27527
0.87	– 0.13926	2.38691	0.41895	1.30	0.26236	3.66930	0.27253
0.88	– 0.12783	2.41090	0.41478	1.31	0.27003	3.70617	0.26982
0.89	– 0.11653	2.43513	0.41066	1.32	0.27763	3.74342	0.26714

(*Contd.*)

x	$ln\ x$	e^x	e^{-x}	x	$ln\ x$	e^x	e^{-x}
1.33	0.28518	3.78104	0.26448	1.80	0.58779	6.04965	0.16530
1.34	0.29267	3.81904	0.26185	1.90	0.64185	6.68589	0.14957
1.35	0.30010	3.85742	0.25924	2.00	0.69315	7.38906	0.13534
1.36	0.30748	3.89619	0.25666	2.10	0.74194	8.16617	0.12246
1.37	0.31481	3.93535	0.25411	2.20	0.78846	9.02501	0.11080
1.38	0.32208	3.97490	0.25158	2.30	0.83291	9.97418	0.10026
1.39	0.32930	4.01485	0.24908	2.40	0.87547	11.02317	0.09072
1.40	0.33647	4.05520	0.24660	2.50	0.91629	12.18249	0.08209
1.41	0.34359	4.09595	0.24414	2.60	0.95551	13.46373	0.07427
1.42	0.35066	4.13712	0.24171	2.70	0.99325	14.87972	0.06721
1.43	0.35667	4.17870	0.23931	2.80	1.02962	16.44464	0.06081
1.44	0.36464	4.22069	0.23693	2.90	1.06471	18.17413	0.05502
1.45	0.37156	4.26311	0.23457	3.00	1.09861	20.08551	0.04979
1.46	0.37844	4.30596	0.23224	4.00	1.38629		0.01832
1.47	0.38526	4.34923	0.22993	5.00	1.60944		0.00674
1.48	0.39204	4.39294	0.22764	6.00	1.79176		0.00248
1.49	0.39878	4.43709	0.22537	7.00	1.94591		0.00091
1.50	0.40546	4.48169	0.22313	8.00	2.07944		0.00034
1.60	0.47000	4.95303	0.20190	9.00	2.19722		0.00012
1.70	0.53063	5.47395	0.18268	10.00	2.30259		0.00005

Table A2

Area Under Normal Curve



(The values in this Table give areas between mean μ and z)

z	*00*	*01*	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830

(*Contd.*)

z	*00*	*01*	*02*	*03*	*04*	*05*	*06*	*07*	*08*	*09*
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998
3.6	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.7	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.8	.4999	.4999	.4999	.4999	.4999	.4999	.4999	4.999	.4999	.4999
3.9	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000

Glossary

American-style option An option contract that can be exercised at any time between the dates of purchase and expiration.

Arbitrage The purchase of a commodity or financial instrument in one market and the simultaneous sale of an equivalent instrument in a different market in order to benefit from price differentials.

Assignment A formal notification received by an option seller (writer) whereby the seller is obliged to sell (in case of a call) or purchase (in case of a put) the underlying security at the specified strike/exercise price.

At-the-money An option is at-the-money if the strike price of the option is equal to the current market price of the underlying security.

Backwardation When the price of nearby futures is at a premium to futures whose expiration is more distant.

Basis The difference between the prices of futures contract and its underlying cash instrument.

Bear One who believes that (share) prices would go down.

Bear strategy A spread strategy reflecting bearish sentiments.

Beta Statistical measure of the sensitivity of the movement of an equity price to the movement of the market as a whole (usually the stock price index).

Bull One who believes that (share) prices would go up.

Bull strategy A spread strategy reflecting bullish sentiments.

Call option An option contract which gives the buyer (holder) the right, and not the obligation, to purchase, and places upon the seller (writer) the obligation to sell, a specified quantity of the underlying asset (usually 100 shares of the underlying stock in case of option on stock) at the given strike price on or before the expiration date of the contract.

Capped option An option contract that is automatically exercised at any time that the price of the underlying security reaches a pre-established level and may be exercised during a period immediately prior to its expiration.

Cash market A market with immediate, or near immediate, delivery.

Cash price Price of an asset in the cash market.

Class (of options) Option contracts of the same type, i.e., call or put and style, i.e., American or European, that cover the same underlying security.

Clearing house The organization that guarantees performance of exchange-traded contracts by becoming counter-party to both sides of each transaction and oversees the settlement of such contracts.

Closing trade The transaction undertaken to close an open position and so terminate liability.

Combination A trading strategy involving positions in call and put options.

Commodity futures A futures contract where the underlying asset is a commodity like wheat, sugar, etc.

Condor An investment strategy involving four call and put options (two each).

Convenience return The return the holder realises for carrying inventory of a commodity in excess of his immediate short term requirements.

Contango When nearby futures prices are lower than the forward prices.

Contract month Specific month to which a futures or options contract relates.

Convergence Narrowing of the futures/cash differential as the contract progresses towards expiry.

Contract size The amount of underlying asset covered by a futures or options contract. In case of options on stock, it is usually 100 shares for one stock option unless adjusted for a special event, such as share split.

Covered call option writing A short call option position wherein the seller, i.e. the writer, owns the quantity of the underlying asset (number of shares of the underlying security, for example) represented by his option contract(s).

Delivery price The mutually agreed price in a forward/futures contract.

Delta A measure of the rate of change in an option's (theoretical) value for a one-unit change in the price of the underlying security. Also called hedge ratio (in the context of option).

Derivative security A financial contract whose value is derived principally from the spot value of another security, known as the underlying security.

Equity options See *stock options.*

European-style option An option contract that can only be exercised on the expiration date.

Exercise Formal notification to implement the right under which the buyer (holder) of an option is entitled to buy (in the case of a call) or sell (in the case of a put) the underlying security.

Exercise price See *strike price.*

Expiration cycle An expiration cycle relates to the dates on which options on a particular underlying security expire. A stock option is usually placed in one of three cycles, the January cycle, the February cycle or the March cycle. At any point in time, an option has contracts with four expiration dates outstanding, two in near-term months and two in far-term months.

Expiration date The last day (in the case of American-style) or the only day (in the case of European-style) on which an option may be exercised.

Fair-value The theoretical level at which a contract should trade relative to its underlying index (or other asset).

Forward A contract to buy (sell) an asset on a certain future date at a mutually agreed price.

Futures A legally binding contract to make or take delivery of a specified quantity (and quality) of a specified instrument at a specific date in the future, at a price agreed at the time of dealing.

Gamma The rate of change of delta for an incremental change in the underlying security.

Hedge ratio The number of futures contracts to long/short per unit of the spot position (in the context of hedging through futures contracts). Also see *delta.*

Hedging A conservate strategy for reduction or risk through futures, options or some other derivative, by opening an opposite position to that already held in the underlying market.

Holder The buyer of an option.

Initial margin A returnable deposit required by the clearing house as protection against default from option writers or for contracts entered into by traders in futures contracts.

In-the-money A call option is in-the-money if the strike price is less than the current market price of the underlying security. A put option is in-the-money if the strike price is greater than the current market price of the underlying security.

Intrinsic value The degree to which an option is in-the-money. It is non-negative.

Last trading day Final day for trading a contract in its expiry month.

Long position A position in which a person's interest in a particular series of options is as a net holder, meaning that the number of contracts bought exceeds the number of contracts sold. It is similar in case of futures contracts.

Margin The amount a buyer/seller of a futures contract, or an uncovered (naked) option seller (writer) is required to deposit and maintain to cover his daily position valuation and reasonably foreseeable intra-day price changes.

Mark to market Daily valuation of open options or futures positions of traders in order to reflect profits or losses.

Naked option See *uncovered call option* and *uncovered put option.*

Non-systematic risk An investment risk peculiar to a company (or industry) which can be reduced by diversifying one's portfolio.

On-line trading A system where trading is accomplished through terminals which are connected to a central computer.

Open interest The number of outstanding positions in futures or options contracts in an exchange in a particular class or series.

Open outcry system A system of trading in an exchange where offers and acceptances are made by loud voices and other gestures with hands.

Option A right, but not the obligation, to buy or sell something on or before a specified date at a stated price.

Out-of-the-money A call option is out-of-the-money if the exercise price is greater than current market price of the underlying security. A put option is out-of-the-money if the exercise price is less than the current market price of the underlying security.

Pit Designated area within an exchange where contracts are traded.

Position limit A limit imposed by some exchanges on the number of contracts that any one party may hold at a point of time.

Premium The price of an option (call or put) contract, determined in the competitive marketplace, which the buyer (holder) of the option pays to its seller (writer) for the rights granted to the former by the option contract.

Put-call parity principle A mathematical expression relating call and put option premia.

Put option An option contract which gives the buyer (holder) the right, and not the obligation, to sell, and places upon the seller (writer) the obligation to buy, a specified quantity of the underlying asset (usually 100 shares of the underlying stock in case of option on stock) at the given strike price on or before the expiration date to the contract.

Rho The effect on an option's value of a 1 per cent rise in interest rate.

Roll-over The transfer of a near futures or options position to a further contract, which involves closure of the near position and simultaneous opening of the further new position.

Series Options of the same class, call or put, that also have the same unit of trade, expiration date, and exercise price. Futures with the same exercise date.

Settlement price Price used for revalvation of open positions at the day-end.

Short position A position in which a person's interest in a particular series of options is as a net seller (writer) meaning that the number of contracts sold exceeds the number of contracts bought. It is similar in case of futures contracts.

Spreads Options and futures transactions involving two or more series of the underlying asset.

Stock index futures Futures contracts which have a stock price index as the underlying asset.

Stock options Options on shares of stock.

Straddle Buying/selling a call and a put option with matching exercise prices and expiration dates.

Strangle A strategy involving buying (selling) a call and put option with same expiration date but different exercise prices.

Strap Buying (selling) two call options and one put option with matching exercise prices and expiration dates.

Strike price also called *exercise price*. The price for which the underlying stock index or other asset may be purchased (in the case of a call) or sold (in the case of a put) by the option buyer (holder) upon exercise of the option contract.

Strip Buying (selling) one call option and two put options with matching exercise prices and expiration dates.

Systematic risk An investment risk which is common to all securities of the same class which cannot be avoided by diversifying one's portfolio.

Theoretical value An estimated fair value of a futures or options contract derived from a mathematical formulation/model.

Theta A measure of decline in option premium with passage of time.

Tick The smallest unit by which the price of a futures or options contract can move.

Time value of option Time value is the excess of premium over the intrinsic value. It is the portion of the option premium that is attributable to the amount of time remaining until expiration of the option contract and the fact that the underlying components that determine the value of the option may change during that time.

Type The classification of an option contract as either a put or a call.

Uncovered call option A short call option position in which the seller (writer) does not own the shares of underlying stock on which he has written the option contract.

Uncovered put option A short put option position in which the seller (writer) does not have a corresponding short stock position or has not deposited cash or its equivalent equal to the exercise value of the put in a cash account.

Underlying security The security which is to be purchased/sold on maturity of a futures contract or upon exercise of an options contract.

Unit of trading The minimum quantity or amount allowed when trading a futures or options contract. The minimum unit for stock options is one contract which generally covers 100 shares of the underlying stock.

Variation margin Payment made in order to restore or maintain the initial margin on adverse positions resulting from price movements in futures/options transactions undertaken.

Volatility The propensity of the market price of the underlying security like share price or index to change, in either direction, over a period of time.

Wasting asset An asset which has a limited life and tends to decrease in value over time.

Write The one who executes the opening sale, the seller, of an option contract.

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About FUTOP

(version 2.0.0)

FUTOP is a specially designed software package to help the user in making calculations much easier that otherwise appear bewildering, to aid in the learning of concepts and ideas related to futures and options, and enabling a ready reference to the expert committee reports in this field.

Contents of the software include the following:

1. **Options**
   - ➢ Valuation of Stock Options is given using Black & Scholes' formula. Prices of both, call and put options, are provided using put-call parity. Also given are the values of the 'Greeks'—indicating how the option prices are sensitive to changes in the input values.
   - ➢ Valuation of Stock Index Options is illustrated using Black, Scholes and Merton's model.
   - ➢ Volatility is a key input in valuation of option premiums, particularly for Black & Scholes' model. In this module, the calculation of standard deviation of continuously compounded rates of return, which is a measure of volatility, is provided.
   - ➢ Implied Volatility estimate in the market price of an option on a given security (in terms of Black & Scholes' model) is provided.
2. **Futures**
   - ➢ Futures on Stocks valuation using "cost of carry" model is provided in this module. It calls for selecting the particular stock out of a total of 31 stocks on which futures contracts are allowed in the Indian market at present, so as to consider the appropriate contract size in terms of the number of shares involved. In case no particular security is chosen, the contract size is taken to be one share.
   - ➢ Futures on Indices valuation using "cost of carry" model is given.
3. **Strategies**
   This section contains some of the commonly used strategies to work with futures and options contracts. For each of these, a bird's eye view of the situation where a strategy may be employed, the risk involved, the profit profile etc. is presented.
4. **Reports**
   In this module, two reports on derivatives are included. The reports included are in respect of the committees set up by Securities and Exchange Board of India, SEBI. The L.C. Gupta committee was set up by SEBI on the issues relating to introduction of derivatives trading in India while the J.R. Varma group was established subsequently to determine the margining system for such trading.
5. **Quiz**
   In this module, multiple-choice questions are given. For each question, a set of 4 alternative answers is given. It is required to select the correct alternative.
6. **Calculator**
   Calculator is provided as a ready help in case calculations are required to be made.

Installation Instructions for the FUTOP version 2.0.0 (CD)

System Requirements

The minimum system requirements for installing and operating the FUTOP software program are:

Software Requirements:

Windows 95 or upwards
Internet Explorer 5.01 or upwards

Hardware Requirements:

Pentium
32 MB RAM
800 by 600 pixels at 16-bit High Colour

It is suggested that before installation, ensure that your system resolution is set at 800 by 600 pixels and the Text-size of the internet explorer at medium. This will ensure that the FUTOP fits well on your screen.

Installation

The process of installation is given here:

1. Insert the diskette in the CD drive of your system and double click to open this drive.
2. Select the Setup file and press enter. The following screen will appear:

Click OK to proceed further.

3. Follow instructions on the screen. The installation would create a folder titled FUTOP under Program Files on C:\... by default. The following screen will appear:

4. You can change the folder and the directory where you want to install the software, if you like. Once you specify the folder and the directory, the installation begins and proceeds. A screen similar to one shown here will appear.

5. Once the installation is completed, it will be indicated like shown here.

6. After installation, make a shortcut. For this, enter the Program group and choose the FUTOP folder. Select the file by the name FUTOP2.exe and create the short cut by right-clicking the mouse.

Installation Troubleshooting

7. If you face a *version conflict* message during the installation, choose the favourable option. To illustrate, if a file on your system is relatively newer one, then choose to keep that file. The following figure provides an illustrative example.

8. If you get an error message like the one shown below, while registering a file or an *access violation error*, ignore it and proceed to follow the next instruction.

Cancellation

To exit or cancel the installation at any time, select Exit Setup button on the installation screen.

Un-Installation

To un-install the software, follow the following steps:

1. Open the control panel of your computer system.
2. Select *Add/Remove Programs*.
3. In Install/Uninstall tab, select the FUTOP software from the list and click on the Add/Remove button.
4. Follow the instructions on the screen to complete the process of un-installation.